Case Presentation

KCHC/TRAUMA SERVICE
Arterial arterial circle (of Willis)
Penetrating Carotid Injuries

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NECK

• Small area unprotected by bone or dense muscular covering
• 5-10% of traumatic injuries
• Most common mech. : penetrating
• MR
  stab wound: 1-2%
  gunshot wounds: 5-12%
  Rifle or shotgun: 50%
  Up to 50% are preventable
NECK

Carotid and Vertebral injuries: acute cervical spine hyperextension

General guideline: all penetrating neck wounds that traverse the platysma muscle should be admitted to the hospital for evaluation, observation and treatment.
NECK

Anatomic triangles

Monson et al (Cook county hospital 1969):
Anterior neck divided into 3 zones
Figure 1
NECK

Initial management: ABC GUIDELINES
Provisions for a surgical airway should be at hand
Avoid hyperextension of the neck
Avoid blind clamping of vessels and probing
CXR
Lateral C-spine and soft tissue neck films
NECK

Controversial management of asymptomatic stable patients with penetrating injuries

Selective vs. Mandatory (ZONE 2)

similar rates of

1. Injury incidence
2. Overall mortality rates
3. Delayed complications
4. Hospital costs
NECK

Role of color flow doppler imaging “triple imaging”

CTA
MRA
NECK

40-60% rate of negative findings
Is it worth it?
MR for delayed vascular injury: 67%

MR for delayed esophageal injury: 44%
NECK

ZONE 1 & ZONE 3

Planning for operative approaches
NECK

25-50% of patients with penetrating neck trauma present with obvious signs of injury and req. exploration

Additional 10-20% without clinical signs of injury

Blood vessels are most commonly injured structures
NECK

Arterial: 18%
Venous: 26%

Another 2 cm of exposure by anterior subluxation of the mandible

20% of population has a complete COW

Repair 15% vs. ligation 50%

Defect >1-2 cm SVG interposition

Prosthetic bypass grafts have high incidence of reocclusion
Penetrating Carotid injuries

Cervival vessels are involved in 25% of head and neck trauma
Carotid injuries constitute 5-10% of all arterial injuries
Blunt trauma <10%
Mortality 10-30%
Incidence of permanent neurologic deficit: 40%
Penetrating Carotid injuries

The first report of successful management of CA injury by ligation was in 1522 by Ambroise Paré
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80 yrs old controversy over arterial repair versus ligation in patients with preop. Neurologic deficits or coma

Ligation continued to be used routinely in the management of CA injuries and was associated with high rates of hemiplegia and death
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The Korean conflict marked the advent of primary repair and was subsequently applied to civilian injuries, regardless of presence or absence of neurologic deficit.

Cohen & Bradley: routine revascularization potentiated the development of hemorrhagic infarct.
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Liekwig, Greenfield, Brown and most recently a review from Ramadan in the North Carolina Trauma Registry

“operative repair offers the best chances for recovery in all categories of patients”
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Teehan et al

“comatose patients with GCS <8 has adverse outcomes regardless of management”
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The hypothesis is that in pt. With neurologic deficits, there is an area of electrical failure surrounding the zone of irreversible cerebral injury “ischemic penumbra”

Restoration of perfusion to this area often reverses neuronal ischemia and result in neurologic improvement
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Hyperextension and rotation of the head stretch the tethered CA over the transverse process of C2 producing an intimal crack in distal ICA
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DIAGNOSIS

**Hard Signs**
- External or intraoral bleeding
- Audible Cervical bruit or palpable thrill
- Rapidly expanding hematoma
- Absent CA pulse with neurologic deficit
Penetrating Carotid injuries

DIAGNOSIS

Soft Signs
Pulse deficit in superf. Temporal artery
Stable hematoma
Proximity to CA
Loss of pulse without neurologic deficit
Signs of air embolism
Widened mediastinum
Ipsilateral Horner’s syndrome
CN 9-12 dysfunction
Penetrating Carotid injuries

Zone 1 & Zone 3 mandatory angio
Zone 2: duplex
Brain CT to assess head trauma
Role for CTA
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Findings</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuzniec et al\textsuperscript{15}</td>
<td>1998</td>
<td>91% Sensitive, 100% specific, 96% accurate</td>
<td>Reproduces results of angiography</td>
</tr>
<tr>
<td>Ginzburg et al\textsuperscript{10}</td>
<td>1996</td>
<td>100% Sensitive, 85% specific</td>
<td>Primary investigation of choice, patient-friendly, cheap</td>
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<tr>
<td>Fry et al\textsuperscript{8}</td>
<td>1994</td>
<td>100% Accuracy</td>
<td>As effective as angiography, procedure of choice</td>
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<tr>
<td>Cogbill et al\textsuperscript{5}</td>
<td>1994</td>
<td>86% Accuracy</td>
<td>Potential role in diagnosis and follow-up</td>
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<tr>
<td>Bynoe et al\textsuperscript{4}</td>
<td>1991</td>
<td>95% Sensitive, 99% specific, 98% accurate</td>
<td>Cost-effective, reliable method of diagnosis</td>
</tr>
<tr>
<td>Meissner et al\textsuperscript{19}</td>
<td>1991</td>
<td>100% Accuracy</td>
<td>Rapid, effective screening tool</td>
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<tr>
<td>Greenwold et al\textsuperscript{12}</td>
<td>1991</td>
<td>94% Sensitive, 99% specific, 99% accurate</td>
<td>Accurate screening tool</td>
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</table>
Penetrating Carotid injuries

Management

Angiographic “minimal” injuries
1. Intimal defects
2. Pseudoaneurysms <5mm in size
3. Adherent or nonobstructive downstream intimal flaps
4. Intramural hematoma

1, 3, 4 heparinization associated with improved neurologic outcome and survival
right internal carotid artery
Penetrating Carotid injuries

Management
A large pseudoaneurysm may cause compressive symptoms

Rx.
1. Surgical
2. angiographic embolization +/- stent(near base of skull)
3. Observation 1-2 weeks (small), but heparinization may risk expansion
Penetrating Carotid injuries

Management
Carotid artery-Jugular vein AV fistula
Potential for HOCF
Surgery in zone 2
Embolization in zone 3
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An occlusive ICA injury in a patient with a *normal neurologic* examination may be managed solely by anticoagulation for 3 months to limit cranial extension of the thrombus.

Avoid systemic hypotension for at least 72 hours postinjury to prevent thrombus propagation and aid collateral brain perfusion.
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Airway management in symptomatic patients

Manual compression

Intra-oral packing: cricothyroidotomy
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Management

Pt. With CA occlusion on angiography
Dense neurologic deficits
Large brain infarct on CT

Poor outcome regardless of treatment, may be observed
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*Open surgical management*

Prep. From umbilicus to the mandible and an uninjured leg

Vascular control proximally and distally before approaching arterial injury

Control of bleeding from distal ICA a vascular balloon either through a proximal arteriotomy or through injury itself
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*Open surgical management*

Use of shunts
Not needed

1. Repairs in 15-20 min.
2. Back-bleeding is usually vigorous
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*Open surgical management*

if direct repair is not feasible because of the location of the injury, the artery may be thrombosed by leaving the inflated balloon in place.

Every effort to preserve ECA because it provides collateral cerebral flow.
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Open surgical management

High velocity injuries tend to damage vascular intima for a considerable distance from obvious site of injury and hence meticulous debridement of arterial wall to normal appearing intima
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Open surgical management
Ligation when distal, thrombosed or nonreconstructible ICA injuries.
Followed by anticoagulation for 3 months to prevent thrombus propagation
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Open surgical management

Injuries to the carotid bulb or proximal ICA reconstructed with an interposition graft or transposition of distal ICA

Sacrifice of ECA :8 named branches

Segmental defects in CCA SVG/PTFE
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*Open surgical management*

Routine completion angiography/duplex

Routine shunting recommended (systemic anticoagulation is needed)

CCA injuries do not need a shunt
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Open surgical management

In presence of associated aerodigestive tract injury, repair protected by interposing SCM to protect from salivary juices

Risk of blowout since leak rate is 20% from cervical esophageal repairs

SCM tripartite segmental blood supply from thyrocervical trunk, superior thyroid artery and occipital artery
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*Open surgical management*

ET preferable to tracheostomy to decrease contamination

If no coverage of arterial repair, primary ligation
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Open surgical management in zone 3
Oblique cervical incision control inflow but for outflow
1. Proximal arteriotomy #3-4 Fogarty
2. Blind passage into wound Fogarty or 5 ml foley ballon
Penetrating Carotid injuries

*Open surgical management in zone 3*

Options

1. Continue balloon catheter tamponade
2. Formal high cervical exploration
3. Arteriographic emb. +/- stent

If chose #1, immediate EEG

If documents cerebral ischemia, a SVG from ICA TO petrous portion of ICA through a small temporal craniotomy
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Open surgical management in zone 3

Options

If normal postop EEG: NO further intervention and the balloon withdrawn in ICU 48-72 hrs after inflation
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**Endovascular Therapy**

Rx. Of choice for traumatic pseudoaneurysms in noncritical arteries

Carotid-cavernous fistulas

Embolization of false aneurysm in distal ICA

Prior to occlusion: monitor neurologic status

Deployment of covered stents: anecdotal experience confined to few centers
Penetrating Carotid injuries

Results
Weaver et al: operative management regardless of initial neurologic deficit
improve mortality 11% vs. 5%
final neurologic status 44% vs. 16%
Neurologic improvement 18% vs. 6%