AAST Acute Care Surgery Didactic Curriculum

Subclavian and Axillary Injury

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Anatomy:

Highlights:

Subclavian Artery

Origin of the Subclavian artery differs according to their anatomic location (right versus left).

Right: arises from the innominate artery.

Left: arch of the aorta.

Subclavian artery is divided into three segments based on the anterior scalene muscle:

1st: origin to the medial border of the anterior scalenus muscle

- vertebral artery, internal mammary, and thyrocervical trunk
- left costocervical artery

2nd: posterior to the anterior scalene muscle

-right costocervical artery

3rd: lateral edge of the anterior scalenus muscle to the lateral border of the first rib

- dorsal scapular artery
-continuous with the axillary artery

Axillary Artery

Begins at the lateral border of the first rib and ends at inferior border of the teres major.

Axillary artery is divided into three parts by the pectoralis minor.

1st: proximal to pectoralis minor

Superior thoracic artery

2nd: posterior to pectoralis minor

Thoracoacromial and lateral thoracic arteries

3rd: lateral to pectoralis minor

Subscapular, anterior and posterior humeral circumflex

The brachial plexus lies in close proximity of the axillary artery and can result in some degree of neurologic impairment.

Injury Demographics

Highlights:

Subclavian & Axillary artery injuries:

- Relatively rare and commonly result from penetrating injury.
- Majority of blunt injuries are the result of rapid deceleration injury and bony fractures.

- Mortality rates are as high as 30%:
    - Difficulty in gaining access and hemorrhage control.
    - Higher mortality rates with combined arterial and venous injuries.
    - Significantly influenced by the number of associated injuries.
- Account for up to 10% of all acute vascular injuries.
- Highest incidence of severe neurologic impairment is observed in axillary artery injuries.
    - Nearly one-third of patients have a brachial plexus injury.

Clinical Presentation

Highlights:

Subclavian & Axillary artery injuries:

- Patients commonly present with hemodynamic instability or in cardiopulmonary arrest.
- Hard signs of a vascular injury:
    - severe external hemorrhage
    - massive hemothorax or bleeding from the thoracostomy tube with thoracic inlet injuries
    - absent or diminished peripheral arm pulses
    - bruit or murmur
    - expanding hematoma
    - cold and pale extremity
    - bruits
- Soft signs suspicious of a vascular injury:
    - hematoma in the supraclavicular fossa or axilla
    - unexplained anemia or hypotension in the presence of a penetrating injury
    - brachial plexopathy

Figure 1. Right chest gunshot wound, hemodynamically unstable with expanding hematoma

- Brachio-Brachial Index (BBI) is part of the standard examination.
    - A BBI < 0.9 is highly suspicious for an arterial injury.

- Normal indices can be present due to the rich collateral circulation.
- Small intimal flaps, pseudoaneurysm or contained hematomas can have a normal BBI.

Diagnostics/Imaging

Highlights:

Preoperative radiographic imaging should only be performed in hemodynamically stable patients.

- Chest radiograph may demonstrate a hemothorax, retained ballistic, local hematoma or mediastinal widening (proximal subclavian injuries).
- When stable, readily available CT angiography is commonly used to identify injury location.
    - helps determine operative approach especially with thoracic inlet injuries.
    - CTA sensitivity and specificity are 95–100% and 87%, respectively.
    - Contrast injection should be performed on the contralateral upper extremity IV access.
    - Doppler probe can ascertain arterial or venous signals.

- Color Flow Doppler is an additional noninvasive technique.
    - Suboptimal if large body habitus or proximal injuries particularly left subclavian
    - Operator dependent with high sensitivity/specificity in experienced hands

• Catheter-based arteriography and digital subtraction techniques can be helpful to identify arterial injuries with the scatter streak artifact on CTA imaging from retained ballistics.

Small intimal flaps or pseudoaneurysms can be observed and treated nonoperatively with close observation and follow-up CTA imaging.

Operative Exposure and Management

Highlights:

- Presence of uncontrolled hemorrhage and hemodynamic instability, imaging studies are deferred.
- Surgical approach is dictated by the clinical presentation and site of injury.
    - Resuscitative thoracotomy is performed in peri-arrest or cardiac arrest and extended to the right hemithorax as a clamshell thoracotomy.
        - Identified subclavian vessel bleeding is controlled with direct pressure.
            - Balloon tamponade in wound tract is a viable alternative with retroclavicular injuries.
- Most subclavian and axillary artery injuries undergo open repair.
- Diagnostic angiogram with endovascular repair is acceptable in selective patients.
- Open repair is associated with early failure rates of approximately 5%.

Operative management options include ligation, primary repair, interposition grafting or shunting.

- Ligation reserved unstable patients with multiple life-threatening injuries, ruptured aneurysm, extensive shoulder trauma.
    - Extensive collaterals of the shoulder and supraclavicular fossa provide upper extremity perfusion.
    - Reconstruction should be considered when feasible
- Temporary intravascular shunting provides preservation of extremity perfusion.

<u>Subclavian Artery</u>

- 1st portion: Proximal injuries are approached with a median sternotomy for proximal control with supraclavicular extension to allow distal control.

- 2nd and 3rd portion: Clavicular incision at sternoclavicular joint extends directly over the medial half of the clavicle and curves down into the deltopectoral groove if requiring distal control by axillary artery exposure.
    - Additional exposure:
        - Medial half of clavicle can be excised or divided and retracted.
        - Disarticulation of the sternoclavicular joint.

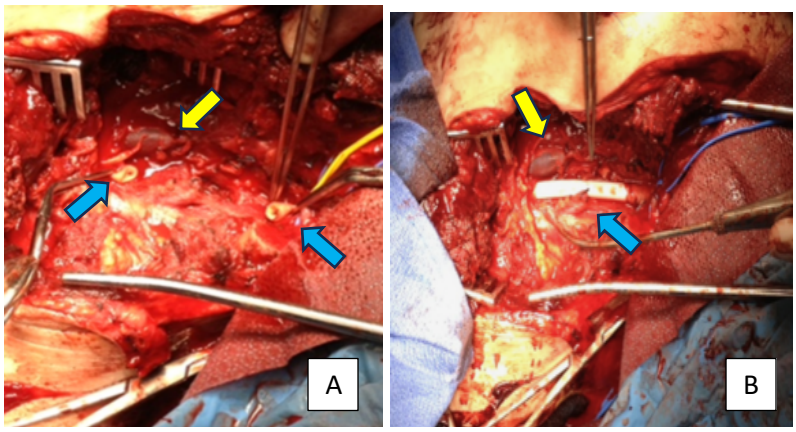

Figure 2. A. Combined injury of the 2nd segment of the subclavian artery (blue arrow) and subclavian vein ligation (yellow arrow) **B.** Left subclavian artery revascularization with prosthetic 6mm polytetrafluoroethylene (PTFE) graft.

<u>Axillary Artery</u>

- Infraclavicular incision at mid clavicle with extension to the deltopectoral groove.
    - Proximal injuries may similarly require clavicular division or excision.
    - Incision can extend to proximal arm into medial bicipital sulcus for additional exposure.
- Pectoralis major is divided 2 cm from the insertion to humerus.
- Underlying pectoralis minor is then divided near its insertion into coracoid process.

Vascular Repair and reconstruction:

Highlights:

- Debridement of the injured vessel edges
- Ligation and division of side branches to allow further mobilization and a tension-free anastomosis.
- Flush proximal and distal ends of transected vessel with heparinized saline
- Prior to repair, check for distal back bleeding and if needed pass appropriately size Fogarty.
- Vessel discrepancies may be addressed by spatulating.
- Repair of the injury should be performed with double armed polypropylene suture.
    - Simple lateral arteriorrhaphy
    - Primary end-to-end repair
    - Autogenous reverse saphenous vein or prosthetic grafts with end-to-end

Concomitant fasciotomy is performed if limb ischemia is in excess of 4 hours or clinically warranted.

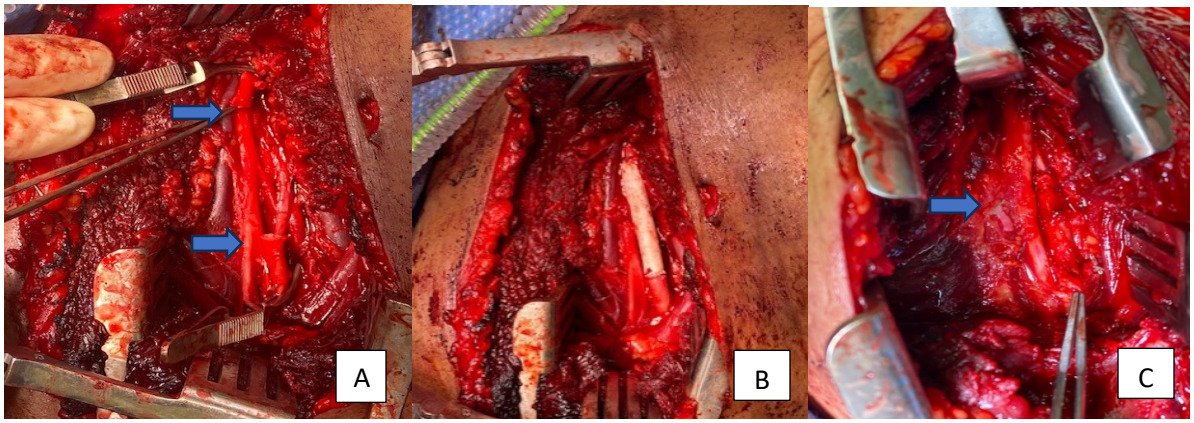

Figure 2: **A.** Transected right axillary artery injury (arrows) following vascular control and debridement of the edges. **B.** Revascularization with prosthetic 6mm polytetrafluoroethylene (PTFE) graft. **C.** Primary repair end-to-end of the right axillary artery injury (arrow).

Endovascular Management

Highlights:

Contemporary endovascular treatment is determined by hemodynamic stability, type of injury and anatomic location.

- Is performed in conjunction with a diagnostic arteriogram commonly in stable patients.
    - Guidewire traverses injured segment, a covered stent can be deployed across the injury.
    - Hybrid techniques include balloon catheter for proximal control in conjunction with open subclavian repair.
        - Prevents the need for thoracotomy or sternotomy for difficult proximal control.

- In a multicenter review of subclavian/axillary injuries: 17% completed endovascular repairs.
    - preferred technique for pseudoaneurysm

-Estimated ~ 50% penetrating subclavian artery injuries are amendable to endovascular techniques.
-Successes rates of > 93% in stable patients reported with subclavian artery injuries.
-Overall complication rate with endovascular techniques is 10-12%.

- Arm claudication, stent thrombosis, and stent fracture.

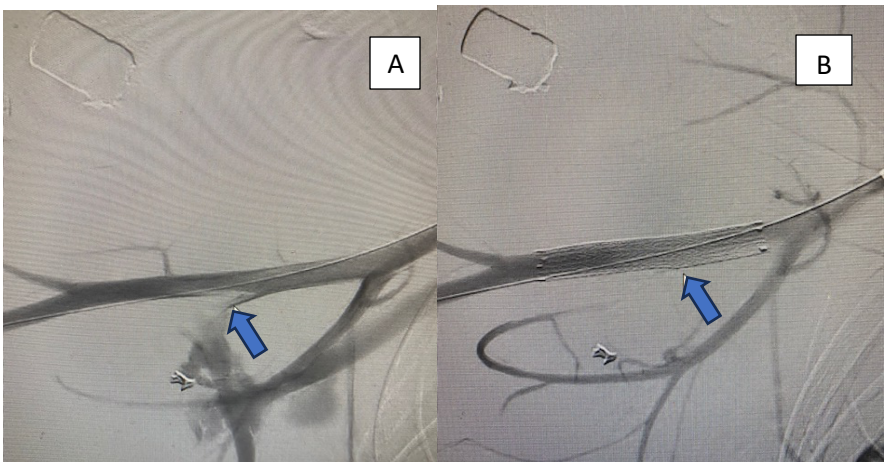

Figure 4: A. Gunshot wound and axillary artery injury with extravasation (arrow) on diagnostic arteriogram. **B.** Stenting of the axillary artery injury with revascularization.