Penetrating Subclavian Vessel Injuries

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Injury Demographics

- Penetrating subclavian vessel injuries are uncommon and may be lethal.
- They are generally associated with multiple life threatening injuries.
- These injures have a high incidence of exsanguination.
- Knowledge of the anatomy is a critical aspect of management:
  - The left subclavian artery originates directly from the aortic arch and the right subclavian from the brachiocephalic artery.
  - The first part of the subclavian artery lies behind the sternocleidomastoid muscle and medial to the scalenus anterior muscle. The second part lies behind the scalenus anterior muscle, and the third part lateral to the scalenus muscle.
  - The subclavian vein is in front and below the artery.
  - The scalenus anterior muscle separates the vessels.

Clinical Presentation

- Many patients succumb at the scene of the traumatic incident; arrive in cardiopulmonary arrest or profound shock.
- Hemorrhage may be external and /or intrathoracic.
- Hard signs that are diagnostic of vascular injury:
  - severe external bleeding
  - massive hemothorax
  - significant continuous bleeding from the thoracostomy tube in patients with thoracic inlet injuries
  - absent or diminished peripheral arm pulses
  - bruit or murmur
- Soft signs that make one suspicious of a vascular injury:
  - hematoma in the supraclavicular fossa or axilla
  - unexplained anemia or hypotension in the presence of a penetrating injury
- Brachio-Brachial Index (BBI) is part of the standard examination.
  - A Brachio-Brachial Index higher than .9 is unlikely to be associated with a significant arterial injury.
  - Small arterial injuries contained by hematoma may be associated with a normal BBI.
- The presence of a peripheral pulse does not exclude a proximal arterial injury given the rich collateral circulation around the shoulder.

Diagnostics/Imaging

- Preoperative imaging studies are contraindicated in hemodynamically unstable patients or in the presence of a threatened extremity.
- In patients who are hemodynamically normal or responsive to resuscitation, preoperative imaging may help determine operative planning including the location of an incision especially for patients with thoracic inlet injuries.
- Chest radiograph may show an associated hemopneumothorax, the presence of a missile, or a local hematoma.
- Doppler probe interrogation can be performed of both the subclavian artery and vein to ascertain arterial and venous signals.
- Color Flow Doppler may be utilized if the patient is hemodynamically stable:
    - it is not invasive
    - it can evaluate both arteries and veins
    - it has a high sensitivity and specificity in experienced hands
    - it is operator dependent
    - in obese patients it may not be possible to visualize the proximal vessels, especially on the left side.
- CT-Angiography has become the diagnostic test of choice.
- Catheter based arteriography may be particularly helpful in patients with shotgun injuries. Digital subtraction techniques enable one to identify arterial injuries with the scatter evident on CT imaging from the pellets.

Pre-operative Preparation

- No intravenous lines should be placed in the injured extremity or distal to a potential subclavian injury.
- If direct pressure cannot control bleeding, balloon tamponade may be effective. A Foley catheter is inserted in the wound and advanced as far as it can go. The balloon is then inflated and in most cases, the bleeding is effectively controlled. If the Foley enters onto the pleural cavity through a supraclavicular wound, the balloon is again inflated and firm traction is applied on the catheter. The traction is maintained by applying a Kelly forceps on the Foley, just above the skin. The balloon compresses the bleeding subclavian vessel against the first rib or the clavicle and the bleeding is controlled. This technique controls bleeding in the chest. If external bleeding persists, a second Foley may be inserted and inflated in to the wound tract.

Indications for Operative Intervention

- Patients with active bleeding, hemodynamic instability, or an ischemic arm, need immediate operation, without any vascular studies.
- Patients in cardiac arrest or impending cardiac arrest will require a resuscitative left anterolateral thoracotomy, which can be extended into the right hemithorax if needed (clamshell thoracotomy). Bleeding from the subclavian vessel can be controlled with direct pressure at the apex of the affected hemithorax.

Operative Technique

Incision

- A clavicular incision provides exposure for distal subclavian and proximal axillary vascular injuries. The incision starts at the sternoclavicular joint, extends directly over the medial half of the clavicle and curves downwards into the deltopectoral groove. The clavicle can be excised and/or the sternoclavicular joint is disarticulated and the clavicle retracted. The retroclavicular space is carefully dissected and the subclavian vessels are identified.
- A median sternotomy (an extension of clavicular incision) provides exposure for both, left and right proximal subclavian injuries and exposes the mediastinal vessels.

Management of the vascular injury

- Arterial injuries should be repaired or an interposition graft placed in almost all cases. Ligation of the artery is not desirable because it may cause ischemia and aggravate the systemic condition of the patient.
- If amenable, subclavian venous injuries should be repaired by primary venorrhaphy. For destructive injuries, the subclavian vein may be ligated.

Endovascular Management

- Emerging trends towards the repair of subclavian arterial injuries with covered stent grafts are increasing and performed with excellent technical success.
- A favorable stent candidate is a hemodynamically stable, high-risk surgical patient, with a focal, easily crossed arterial injury that does not involve coverage of the vertebral artery or extension into the axilla. Unstable patients with transections that are easily exposed are best treated with open surgical techniques.

- A hybrid operating room with ceiling mounted digital subtraction fluoroscopy enables the surgeon to perform high resolution diagnostic angiography and best define the injury.
- Retrograde trans-femoral balloon occlusion may achieve temporary proximal control and permit conversion from "Endo" to a routine open procedure.
- Alternatively, a stent can be passed over a wire from the femoral or brachial approach using a 9-11 Fr. Sheath and deployed to cover a pseudoaneurysm or transected segment.

Wound Care

- Excisions of the medial half of the clavicle does not result in permanent disabilities. Regeneration of the bone occurs within a few months.
- If disarticulation of the sternoclavicular joint has been performed, the anatomy should be restored by suturing the periosteum and the ligaments over the joint.

Suggested Readings

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