The Management of Peripheral Arterial Injuries

February in Phoenix - Trauma Symposium
February 15th, 2019
- No disclosures.
Objectives

- Identify peripheral arterial injuries.
- Basic management of arterial injuries.
- Identify common pitfalls when managing peripheral arterial injuries.
Outline

- History
- Mechanisms
- Types of injuries
- Diagnosis
- Management
- Repairs
- Special Topics (shunts, fasciotomies, endovascular repair)
History
Valentine Mott (1785-1865)

- Father of American vascular surgery.
- Known for experimenting with ligations and amputations.
Vascular Repair

1759 - Hallowell attempted a brachial artery repair.

1891 - Jassinowsky demonstrated the first repair of an artery with preserved patency.

1896 - Jaboulay and Briau describe a successful end-to-end anastomosis of the carotid.

1896 - J.B. Murphy of Chicago performed the first successful human femoral artery and vein repair.
Alexis Carrel (1873-1944)

French surgeon

Moved to the US in 1905.

Developed advances in grafting and vessel preservation.

Awarded the Nobel Prize in Physiology or Medicine.
Military Conflict

WWI - Ligation was primary method of treatment.

WWII - DeBakey described 81/2471 arterial repairs.

Korean War - Restoration of vascular continuity in injured vessels by direct anastomosis, lateral repair, or graft placement.


Iraq/Afghanistan - Notable for highest incidence of vascular injuries with a shift to peripheral injuries.
Mechanisms

- **Blunt**
  - High velocity impact.
  - Areas receiving high kinetic forces.

- **Penetrating**
  - Low velocity: stab, puncture
  - High velocity: missile, projectile

- Intraluminal entry
Types of Injury

- Intimal injuries
- Wall defects with pseudoaneurysms or hemorrhage
- Complete transection with hemorrhage or occlusion
- Arteriovenous fistulas
- Spasm
Management

ABCs

Hemorrhage control

Triage of other injuries

Examine and decision to operate is appropriate with occlusion or major bleeding

** Pitfall: missed peripheral vascular injury.**
Diagnosis

Clinical presentation

Injury patterns
Hard signs for vascular injury

- Arterial bleeding
- Pulsatile hematoma
- Absent pulse
- Limb ischemia: pulseless, pallor, paresthesia, pain, paralysis, poikilothermy.
- Bruit/thrill
Soft signs for vascular injury

- Nonpulsatile hematoma
- Decreased pulses or pressure index
- Hypotension
- Anemia, unexplained
- Injury to closely associated structure (nerve)
Common Patterns

Clavicle, Sternum, Manubrium → subclavian artery/vein, thoracic duct, brachial plexus

Shoulder Dislocation → axillary artery injury

Supracondylar Humerus → brachial artery

Pelvis, Sacrum → iliac vessels, cecum, sigmoid, bladder, ureter

Femur (distal), Tibial plateau, Knee Dislocation → popliteal vessels
Peripheral Injuries

- Physical Exam
- ABI, BBI, or API
- CT angiography
- Traditional angiography
ABI

National Heart Lung and Blood Institute (NIH) - https://www.nhlbi.nih.gov/health/health-topics/topics/pad/diagnosis
Triage Categories and Management Guidelines for Wartime Extremity Vascular Injuries

Category I: Isolated Vascular Injury
- One surgical team required
- Vascular injury, restoration of flow, reconstruction, and limb salvage take priority
- Extremity tourniquet may be removed in the operating room in coordination with the anesthesia team
- Venous injury should be repaired
- Complex or lengthy reconstructions acceptable

Category II: Vascular Injury in Conjunction with Other Non-Life-Threatening Injuries
- Two-team approach preferable to treat vascular and other injury
- Vascular injury, restoration of flow, reconstruction, and limb salvage take priority
- Extremity tourniquet may be removed in the operating room in coordination with the anesthesia team
- Venous injury should be repaired
- Complex or lengthy reconstructions acceptable

Category III: Multiple Vascular Injuries
- Two-team approach preferable to treat multiple vascular injuries
- Vascular injury, restoration of flow, reconstruction, and limb salvage take priority
- Extremity tourniquet may be removed in the operating room in coordination with the anesthesia team
- Diminished role for venous injury repair
- Diminished role for complex or lengthy reconstructions

Category IV: Vascular Injury in Conjunction with Life-Threatening Injuries
- Two-team approach optional after life-threatening injury is stabilized
- Life-threatening torso, neck, or head injury takes priority
- Extremity tourniquets should remain in place until the life-threatening injury* is stabilized
- Diminished role for venous injury repair
- Diminished role for complex or lengthy reconstructions

*Includes severe physiologic derangement from shock (e.g., severe acidosis, anemia, coagulopathy, hypothermia, electrolyte disorder).
Isolated Vascular Injury

- Repair should be undertaken
- Restoration of flow with limb salvage as a priority
Vascular Injury with Non-Life-Threatening Injury

- Vascular injury takes priority
- Two team approach preferred in this setting
- For concomitant ortho injury, stepwise repair recommended
Multiple Vascular Injuries

- Repair should be undertaken
- Restoration of flow with limb salvage as a priority
- Proximal vessels take priority
- Lower extremities take priority
- Shunts can be used
Vascular Injury with Life Threatening Injuries

- Life-threatening injury takes priority
- Tourniquet application until life threatening injury stabilized
- Consider two team approach
- Decreased role for repair or complex, length reconstruction
Tourniquets

- Lowest effective pressure
- Minimize time
- Apply early
- Close monitoring for ischemia
- Wide area of tourniquet application

** Pitfall: failure to recognize who should be managed with a shunt.
Repair

- Wide drape
- Proximal and distal control
- Debridement of unhealthy tissue
- Proximal and distal thrombectomy
- Systemic or regional heparin
- Coverage or closure
- Consider completion angiography
- Check pulses

** Pitfall: not prepping widely.

** Pitfall: incision directly over hematoma rather than over areas of proximal and distal control.
Simple Lateral Repair
Other repairs

- Patch angioplasty
- End-to-end anastomosis
- Interposition graft
- Bypass graft
- Extra-anatomic bypass graft
Patch Angioplasty
End-to-End
Bypass
Shunts

- Gustilo IIIC open fracture
- Need for distal perfusion as a complex revascularization is performed
- Damage control
- Perfusion of an amputated part of an upper extremity prior to replantation.
Fasciotomy

- Hypotension in the field
- Delay in reperfusion for 4-6 hrs
- Disproportionate pain in an extremity
- Crush injuries
- Combined arterial and venous injuries
Endovascular repair of arterial trauma
Sapan S. Desai, MD, PhD
Kristopher M. Charlton-Onu
and Ali Azizadeh, MD, PhD

Applying peripheral vascular injury guidelines to penetrating trauma
Vincent E. Chong, MD,
and Gregory P. Victorin
Department of Surgery, University of Chicago

Endovascular Management of Peripheral Vascular Trauma
Chatt A. Johnson, M.D., F.A.C.S.

Endovascular management of traumatic peripheral arterial injuries

Endovascular management for peripheral arterial trauma: The new norm?
Anand Ganapathy, Ahmed F. Khouqueer, S. Robb Todd, Joseph L. Mills, Ramyar Gilani
Department of Surgery, Baylor College of Medicine, Houston, TX, USA
Endovascular Treatment

- Endovascular repairs have increased from 2.2% (1994-2003) to 6% (2007-2009)
- Absolute contraindication is inability to cross the lesion
- Decreased intraoperative blood loss
- No clear role although may be helpful for neck, subclavian, and iliac lesions in a stable patient.
References

2. Donaldson IML. Ambroise Pare's accounts of new methods for treating gunshot wounds and burns. JLL Bulletin: Commentaries on history of treatment evaluation.