Evaluation and Treatment of Vascular Injury

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Prior versions
Timothy McHenry, MD; March 2004
Heather Vallier, MD; January 2006

Goals

Identify vascular injuries

Confidently and accurately evaluate vascular injury

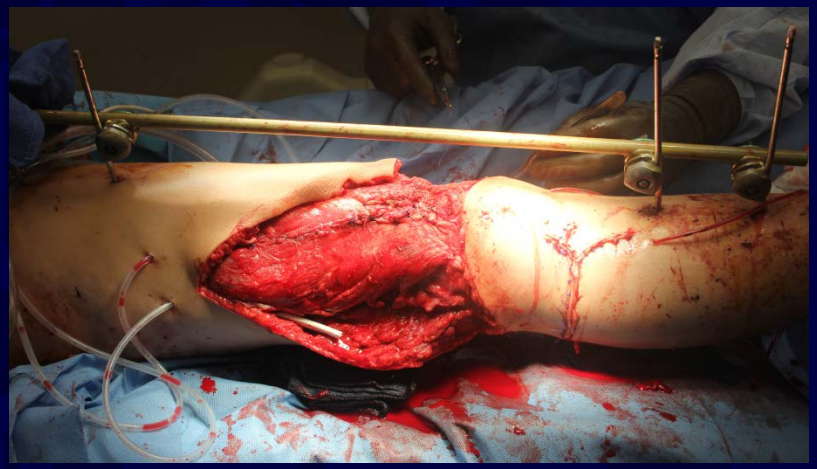
Coordinate treatment

A Rare Injury

1-3% of all extremity trauma

Occurs more with penetrating trauma

- GSW 46%
- Blunt 19%
- Stabbing 12%



Hafez et al J Vas Surg 2001

Pathology of Injury

- Spasm
- Intimal flap
- External compression
  - Compartment syndrome
  - Hematoma
- Thrombus
- Laceration/transsection
  - External projectiles
  - Bone fragments

Successful diagnosis and management of extremity vascular injuries requires:

***Thorough history and physical**

***High index of suspicion**

***Rapid administration of care**

Mechanism of injury heightens the surgeon's awareness of potential vascular insult

<u>Considerations:</u>

***Fracture Personality**

***Presence of dislocation**

***Blunt trauma vs penetrating trauma**

High Risk Fractures

- Open fractures
- Segmental diaphyseal fractures
- Floating limbs
- Associated crush injuries

Fracture Specific Vascular Injuries

Clavicle	Subclavian
Supracondylar humerus	Brachial
Pelvic ring	Gluteal, Iliac, Obturator
Distal femur	Popliteal
Tibia plateau	Popliteal
Tibia shaft	tibial

Dislocations Associated with Vascular Injury

- **Scapulothoracic dissociation**
  - **64-100%**
- **Knee dislocation**
  - **16%**

Flanagin et al OCNA 2013, Miranda et al JTrauma 2002

Blunt Trauma

Stretching or shearing of vessels

Intimal damage/dissection, thrombus

Subtle clinical findings

27% amputation rate

Penetrating Injury

Direct injury to vessel:
Laceration/transsection

Exam findings: May not always be obvious

Delayed pseudo-aneursym and AVF

9% amputation rate

Physical Exam

Hard Signs

Pulsatile bleeding

Expanding hematoma

Thrill at injury site

Pulseless limb

Soft Signs

Asymmetric limb temperature

Asymmetric pulses

Injury to anatomically-related nerve

History of bleeding immediately after injury

Hafez et al J Vas Surg 2001

Important

Vascular injuries are dynamic injuries!

Repeat examinations

Emergency Department Management

- **Control Bleeding**
  - Compressive dressing
  - Judicious tourniquet
- **Fluid resuscitation**
- **Reduce & splint fractures**
- **Re-evaluate**

Ankle Brachial Index

Indications

- **Asymmetric pulses**
- **Soft exam findings**
- **High energy tibia plateau fractures**
- **All knee dislocations**

Vascular consult and advanced imaging for ABI <0.9

ABI does not define extent or level of injury

Lynch et al Ann Surg 1991, Mills et al JOT 2004

Ankle Brachial Index

Benefits

- Cheap
- Easy
- Negative predictive value between 96% and 100%

Limited diagnosis

- Venous injuries
- False positive with arterial spasm
- Injuries can preclude cuff placement

Lynch et al Ann Surg, Mills et al Injury 2004

Duplex Scan

Technician dependent

Time intensive

Steep learning curve

Limited indication in acute trauma patients

Angiography

Historical Gold Standard

Localizes the lesion

Defines type and extent of lesion

- **Active hemorrhage vs occlusion**

Allows treatment planning

- **embolization vs bypass**

Angiography Disadvantages

Patient risks
- **Renal insult**
- **Anaphylaxis**
- **Iatrogenic vessel injury**

Expensive

Difficult to resuscitate patients

Delays operative intervention

Multi-Detector CT Angiography (MDCTA)

Replacing angiography as standard of care

95% sensitivity and 87% specificity

Decreased contrast load

Fast

Effective costwise

Reiger et al AJR 2006, Peng et al Am Surg 2008, Wallin Et al Ann Vasc Surg

MDCTA Disadvantages

Cannot exclude all arterial dissections

-May still require angiography

Limited resolution in presence of

-Foreign bodies

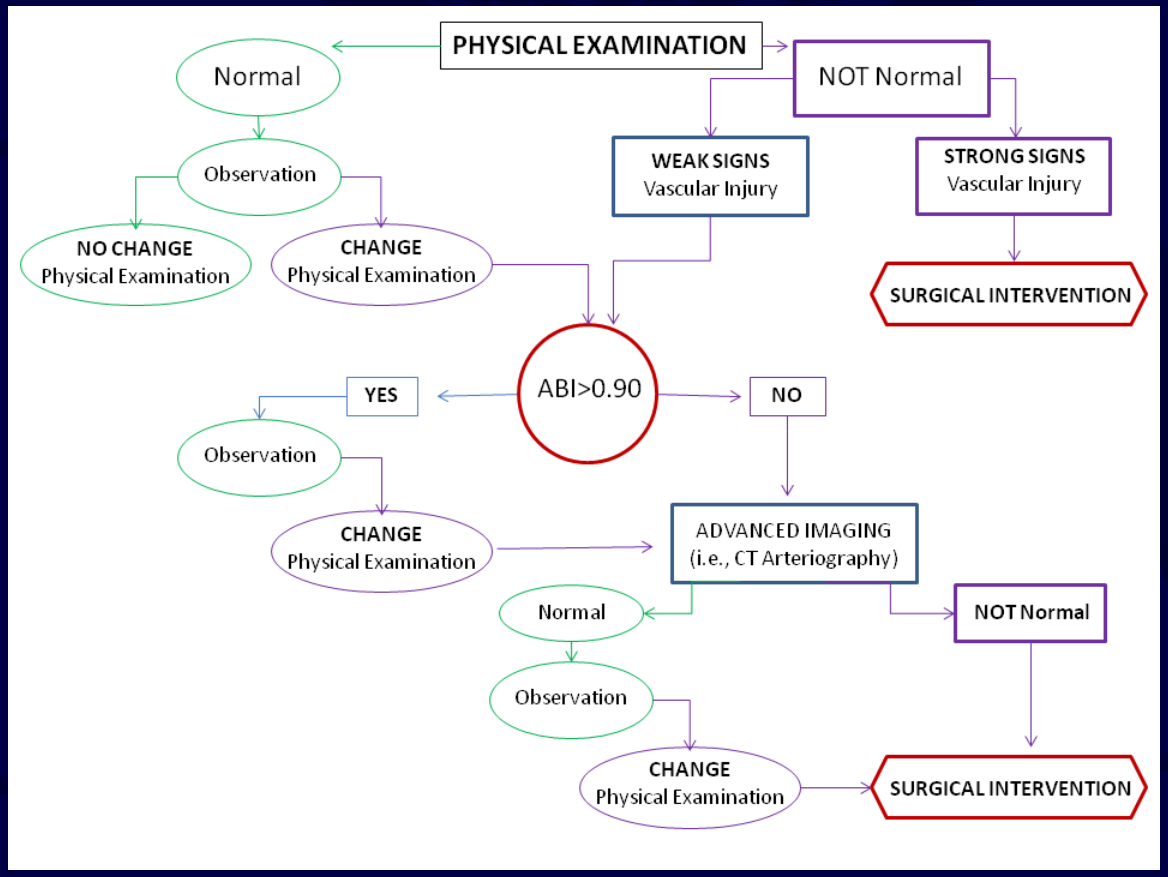
-Vascular calcifications

Surgical Exploration

Indications:

- **Frank vascular injury**
- **Vascular injury not amenable to endovascular repair**
- **Expanding/pulsatile hematoma**
- **Thrill at injury site**
- **Pulseless limb**

Evaluation Algorithm



Sequence of Surgical Treatment

Who goes first? Vascular or Orthopaedics

Who Goes First?

Meta-analysis shows sequence of fixation (vascular vs orthopaedic) does not affect amputation rate

Traction upon vascular repair is not shown to lead to vascular compromise

Fowler et al Injury 2009

Treatment

Have a protocol in place

Consider each patient individually

- Restore blood flow
- Debride devitalized tissue
- Stabilize fractures

Indications for Fasciotomy

Diagnosis of acute compartment syndrome

Arterial injury requiring repair

Combined arterial venous injury

Warm ischemia > 6hr

Cold ischemia > 12hr

Faber et al Injury 2012

Prognostic Factors

Soft tissue injury (crush)

Level of vascular injury

Collateral circulation

Ischemia time

Patient factors

Complications of Vascular Injury

Blood Loss

Compartment syndrome

Tissue necrosis

Infection

Amputation

Death

Case Example

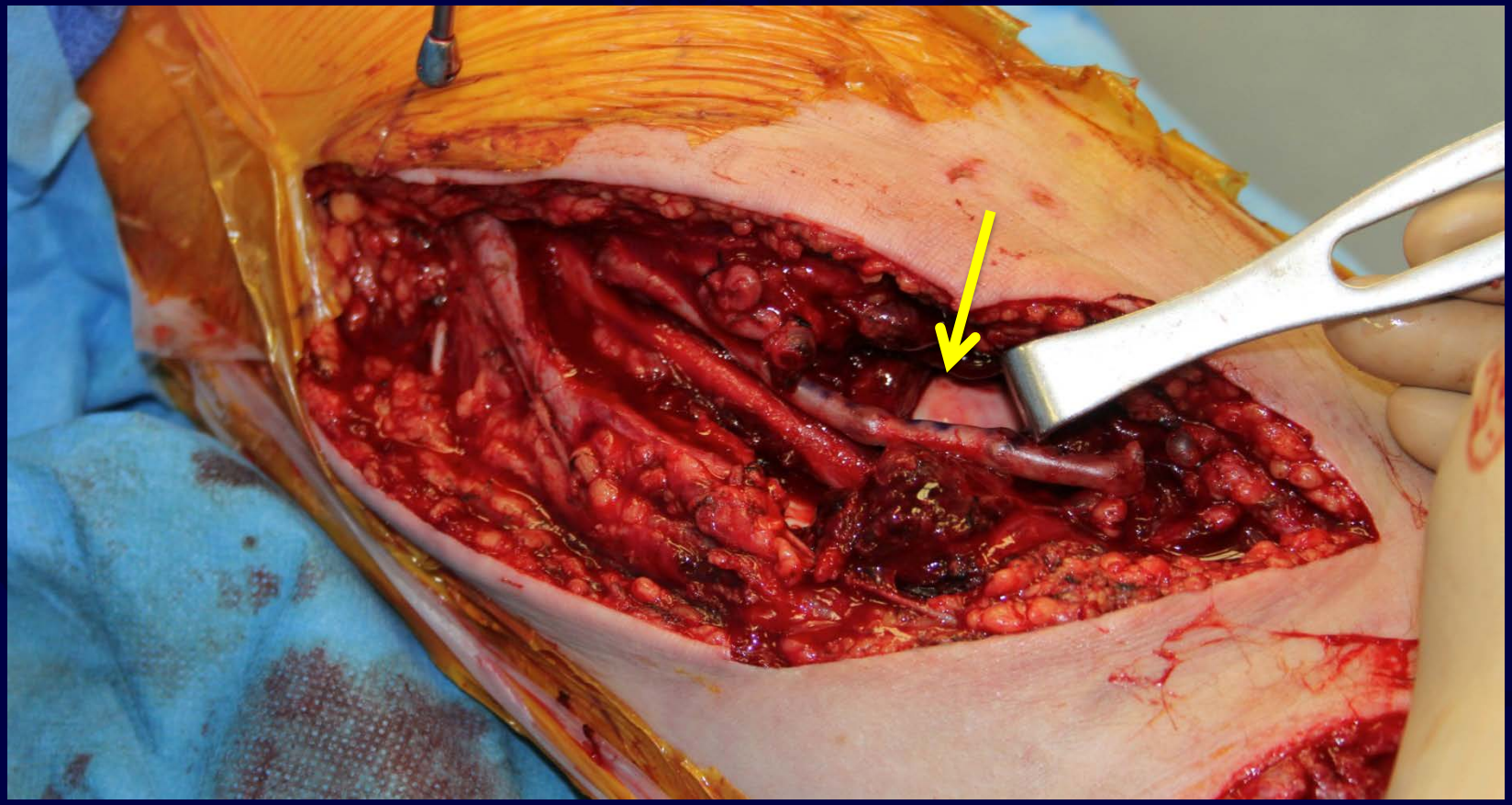
30 yr old presents with elbow dislocation and report of bleeding at the scene

Arterial bleeding is observed in ED

Vascular is consulted

Patient to OR within 3 hours of injury

Direct arterial repair of brachial artery



Ligament repair of elbow

Case Example

29 yr old MVC with bilateral open lower extremity injuries

Cold feet bilateral

mangled RLE

No pulses

No pulse with traction

- Foot perfusion improves

CT angiogram ordered/vascular consult

- Normal LLE

Patient taken to OR for I&D ex-fix left and guillotine amputation right

- Pulse returns LLE
- Q2 hour vascular checks

12 hours post op patient loses pulse

Taken to OR emergently by vascular for on-table angio and endovascular bypass of intimal flap

Infection develops HD #4, sepsis, and AKA is performed

Vascular Injuries: Summary

Maintain high index of suspicion

- ***Recognize common injury patterns**
- ***Thorough, repeated examination**

Rapid recognition and treatment is paramount

Have a protocol for evaluation and treatment

References

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- **For questions or comments, please send to ota@ota.org**