Blunt Popliteal Artery Trauma

David Radvinsky MD
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Case Presentation

• 41 yo male s/p motorcyclist struck by motor vehicle (8PM)
  • + Helmeted
  • (+) LOC
  • On backboard with left lower extremity in splint
  • C-collar in place

• Primary Survey
  • Airway intact
  • Bilateral Breath sounds – 99% on 2L NC
  • Circulation - BP 155/95 HR 86
• No evidence of expanding hematoma

• Delayed capillary refill

• Cool compared to right foot
Secondary Survey

- HEENT: no scalp lesions, PERRLA, EOMI, no facial tenderness, no blood in the ear canal or nasal passages.
- C-spine: no midline tenderness
- Thorax: +5x5cm area of road rash over right shoulder (3rd degree). no chest wall tenderness, with equal chest rise. RRR
- Abdomen: soft, obese, NT/ND
- Pelvis: stable, tenderness over left posterior pelvis/hip
- T/L-spine: no midline tenderness
- Extremities: (as described)
  - Motor (LLE) – limited by pain
  - Sensory (LLE) – common peroneal nerve distribution
Sensory & Motor

- Superficial Peroneal
- Foot Eversion
- Deep Peroneal
- Foot Dorsiflexion
- Toe Extension
Re-Evaluation & Adjuncts

- Vitals: BP: 90/48  HR 98  SpO2: 96% on 2L NC
- Transfused 1 unit pRBC

- PMHx: denied
- PSHX: denied
- Allergies: NKDA
- Meds: None

- CXR: negative
- PXR: (as shown)
- FAST: negative

- Tib/Fib placed into traction
- Improved capillary refill
- Pulse exam unchanged
- NO expanding hematoma
Imaging

- CT Head: negative
- CT c-spine: negative
- CT chest: negative
- CT abd/pel: acute displaced left ASIS fracture with adjacent intramuscular hematoma
- CTA LLE: abrupt cutoff of contrast in the popliteal artery 2cm distal to Hunter’s canal

- Knee Dislocation?
CTA (9:15)
To OR

- EX- FIX FIRST!?!  
  - (10 PM)

- Left Lower extremity angiogram (11:30 PM)
Superficial Femoral Artery to Below Knee Popliteal Artery Bypass (12 AM)

- PTFE graft (25 cm)
- 4 compartment fasciotomy
• Completion Angiography (4 AM)
Post-Op

- EBL 1500 cc
- Ischemia Time – 6 Hrs
- Transfused 8 units pRBC, 4 FFP, 1 unit platlets, 1 cryo
- VAC closure

- POD#0 - DP/PT pulse present
  - 4 units pRBC, 2 units FFP
  - Hct 24 -> 21 (transfused additional 2 units pRBC) -> 27
  - CK peaked at 34K -> bicarb drip started
- POD#2 – Hct -> 20.7 (transfused additional 1 units pRBC) -> 20.7
- POD#3 – Hct -> 19.5 (transfused additional 2 units pRBC) -> 24.8
  - CTA – graft patent; iliac wing hematoma slightly larger; no collections
- POD#4 – Heparin gtt started once HCT stabilized
  - CK trending down -> 9K
Post-Op

- POD#7 – fever to 102 -> pan-cultured -> vanco/zosyn
  - Urine – Enterococcus
  - Diarrhea – Flagyl – c.diff negative x2
  - CTA LLE – no collections, patent graft
- POD#9 – OR for washout
  - Cultures – stenotrophomonas and Enterobacter -> Levaquin
- POD#11 – OR for washout – purulence from lateral fasciotomy site
- POD#14 – Guillotine BKA
  - Hardware removed -> Knee immobilizer
  - Myonecrosis
- POD#18 – MRI – posterior knee hematoma/collection
  - PCL, ACL, MCL, LCL, posterolateral corner and MPFL are all torn
- POD#20 – OR for evacuation of hematoma in posterior knee and debridement of guillotine stump
  - Cultures – Pseudomonas -> Gentamicin
- POD#25 – Graft excision and AKA
Questions?
Epidemiology

- Popliteal Vessel Injuries rare – 0.2% of all traumas
- High-energy mechanisms
  - Pedestrian Struck
  - Motorcycle Accidents
  - Automobile Accidents
- Mechanism of blunt injury to the popliteal artery
  - Anterior dislocation
  - Posterior dislocation
  - Tibial plateau fracture
- Associated fractures (80% to 100%)
- Associated venous injury (15% and 35%) – popliteal vein
- Associated nerve injury (10%) – common peroneal nerve
Anatomy

- Continuation of superficial femoral art.
- Hunter’s canal
- Popliteal fossa
- Lower border of popliteus muscle
- Branches to anterior tibial artery and tibioperoneal trunk
Diagnosis

• Physical Exam
  • Hard Signs
    • Absent distal pulse
    • Palpable thrill or audible thrill
    • Actively expanding hematoma
    • Active pulsatile bleeding
  • Soft Signs
    • Diminished distal pulse
    • History of significant hemorrhage
    • Neurologic deficit
    • Proximity of wound to named vessel
• An abnormal pedal pulse identified popliteal artery injuries with a sensitivity of 85% and specificity of 93%
• Ankle-to-brachial index (ABI) - less than 0.90 predicted the injury with 87% sensitivity and 97% specificity
• Imaging
  • Plain radiographs to evaluate for fractures and/or dislocations
  • CTA to evaluate vessel integrity
    • Transection
    • Dissection
    • Thrombosis
  • ANGIOGRAPHY
Management

1. Complex extremity trauma (resuscitation/exam)

2. Presence of factor(s) posing increased risk of limb loss?
   - Yes → Primary amputation
   - No → Hard signs of vascular injury?

3. If no, decision point:
   - Hard signs of vascular injury?
     - Yes → OR/On-table arteriogram (+)
     - No → Extensive soft tissue loss

4. Extensive soft tissue loss
   - Crush injury
   - Multiple fractures
   - Elderly with medical comorbidity
   - Severe contamination
   - Patient preference

5. OR/On-table arteriogram (+)

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Management

• Limb salvage vs. primary amputation
  • Mangled Extremity Severity Score
  • Gustilo III - C skeletal injuries
  • Transected tibial or sciatic nerve
  • Shock and life-threatening associated injuries
  • Below-knee arterial injury
  • Extensive soft tissue loss
  • Crush injury
  • Multiple fractures
  • Elderly with medical comorbidity
  • Severe contamination
  • Patient preference
Mangled Extremity Severity Score

• Successful limb salvage vs future amputation
  • MESS ≥7 had a 100% predictable value for amputation
• Lower Extremity Assessment Project (LEAP)
  • NIH funded, multicenter, prospective observational study
    • No support of any examined lower extremity injury severity index
    • Indices lack sensitivity, but were in some cases specific.
    • Not useful in identifying patients that would require amputation
    • Useful in predicting limbs which could be successfully salvaged
Limb Salvage vs. Amputation

- Mangled Extremity Severity Score

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
<th>Points</th>
</tr>
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<tbody>
<tr>
<td>Limb Ischemia*</td>
<td>Reduced Pulse but Normal Perfusion</td>
<td>+1</td>
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<tr>
<td></td>
<td>Pulseless, Paresthesias, Slow Capillary Refill</td>
<td>+2</td>
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<tr>
<td></td>
<td>Cool, Paralysis, Numb/Insensate</td>
<td>+3</td>
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<tr>
<td>Patient Age Range</td>
<td>&lt; 30</td>
<td>0</td>
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<tr>
<td></td>
<td>30-50</td>
<td>+1</td>
</tr>
<tr>
<td></td>
<td>≥ 50</td>
<td>+2</td>
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<tr>
<td>Shock</td>
<td>SBP &gt; 90 mmHg Consistently</td>
<td>0</td>
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<tr>
<td></td>
<td>Hypotension Transiently</td>
<td>+1</td>
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<tr>
<td>Injury Mechanism</td>
<td>Low Energy (stab, gunshot, simple fracture)</td>
<td>+1</td>
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<tr>
<td></td>
<td>Medium Energy (dislocation, open/multiple fractures)</td>
<td>+2</td>
</tr>
<tr>
<td></td>
<td>High Energy (high speed MVA or rifle shot)</td>
<td>+3</td>
</tr>
<tr>
<td></td>
<td>Very High Energy (high speed trauma with gross contamination)</td>
<td>+4</td>
</tr>
</tbody>
</table>

*If Limb Ischemia present > 6 hours, Limb Ischemia Points are multiplied by 2
Approach
Semimembranosus
Semitendinosus
Biceps Femoris
Popliteal Artery
Popliteal Vein
Lesser Saphenous Vein
Medial Head
Lateral Head
Gastrocnemius
Revascularization (Shunting)
Fasciotomy

- Anterior compartment
- Anterior tibial artery and vein and deep peroneal nerve
- Lateral compartment
- Peroneal artery and veins
- Superficial posterior compartment
- Posterior tibial artery and vein and tibial nerve
- Deep posterior compartment
Orthopedic repair follows vascular repair
  • Temporary fixation
  • Definitive repair delayed
Options for Definitive repair

- Lateral arteriorrhapsy or venorrhapsy
- Patch angioplasty
- Resection with end-to-end anastomosis
- Resection with interposition graft
- Bypass graft
- Extraanatomic bypass
Autogenous vs. Graft

• 1 year patency rates in infrapopliteal position
  • 70-80% with autogenous vein
  • 30-50% for prosthetic grafts
• Autogenous – saphenous vein (ipsilateral or contralateral)
• Prosthetic options
  • Dacron
  • PTFE
  • Antiplatelets or anticoagulants
• Adjunctive vein cuff at the distal anastomosis of graft improves patency
Role for Endovascular?

• Becoming more popular with newer techniques
• Case reports in the literature
  • Thrombosis
  • Pseudoaneurysm
  • AV Fistula
  • Dissection
Venous injury

- Up to 1/3 of patients with arterial injuries have venous injury
- **Vein injury should be repaired**
  - Leg edema
  - Compartmental hypertension
  - Occlusion of arterial repair
  - Higher amputation rates
  - Allow for collateralization
  - Risk of acute thrombosis at the site of repair
    - pulmonary embolism
Soft Tissue

- Soft tissue debridement at initial operation
  - Cover vascular repair with viable muscle
  - Decreases risk of infection and limb sepsis
- Monitor for Infection
  - Devitalized tissue
  - Hematoma
  - Fasciotomy sites
- Wound sepsis -> return to the OR
- Open contaminated wounds -> broad spectrum abx
- VAC assisted closure to promote healing of fasciotomy sites
- Fasciotomy that cannot be closed primarily
  - Skin graft once the muscle swelling has subsided
Nerve Injury

- **Common Peroneal Nerve** – 10%
  - Loss of function of foot - dorsiflexion
  - High-stepping walk (steppage gait or footdrop gait).

- Should undergo surgical exploration at emergency
- Recover spontaneously
  - Full recovery of partial peroneal palsy (76% to 87%)
  - Full recovery of complete lesions (20% to 35%)
- Repair indicated for lack of recovery after 2-5 months
- **Direct Repair** – 84%
  - Grafting (sural nerve)
    - <6 cm – 75%
    - >6cm – 16-38%
- **Tendon transfer**
  - Restoration of dorsiflexion
Post-Op

- Secondary Amputation
  - Failure of the arterial repair
  - Limb sepsis in the presence of a patent artery
  - Extensive muscle necrosis and nerve injury with a patent repair

- Patient’s functional status
  - Persistence of nerve deficit
  - Ankle–foot orthosis
  - Remedial operations to correct foot drop deformity

- REHAB
Meta-analysis of prognostic factors for amputation following surgical repair of lower extremity vascular trauma

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• Meta-analysis
• 45 studies – lower extremity vascular trauma
• Significant prognostic factors
  • associated major soft tissue injury
  • compartment syndrome
  • multiple arterial injuries
  • duration of ischemia exceeding 6 h
  • associated fracture
  • Blunt mechanism of injury
  • age over 55 years
  • Male sex
## Post-Op

<table>
<thead>
<tr>
<th></th>
<th>Pooled odds ratio</th>
<th>P*</th>
<th>I²</th>
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</thead>
<tbody>
<tr>
<td><strong>Demographic factors</strong></td>
<td></td>
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<tr>
<td>Age (≤ 55 versus &gt; 55 years)</td>
<td>0.33 (0.05, 1.43)</td>
<td>0.07</td>
<td>0.30</td>
</tr>
<tr>
<td>Sex (M versus F)</td>
<td>0.64 (0.32, 1.14)</td>
<td>0.07</td>
<td>0.26</td>
</tr>
<tr>
<td><strong>Mechanism of injury</strong></td>
<td></td>
<td></td>
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<tr>
<td>Blunt versus penetrating</td>
<td>1.88 (1.05, 3.04)</td>
<td>0.97</td>
<td>0.13</td>
</tr>
<tr>
<td>Blast versus penetrating</td>
<td>2.86 (0.90, 12.19)</td>
<td>0.98</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Anatomical level of injury</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Iliac versus femoral</td>
<td>3.02 (0.32, 20.20)</td>
<td>0.86</td>
<td>0.07</td>
</tr>
<tr>
<td>Popliteal versus femoral</td>
<td>1.85 (1.14, 2.58)</td>
<td>0.99</td>
<td>0.09</td>
</tr>
<tr>
<td>Tibial versus femoral</td>
<td>1.42 (0.39, 4.34)</td>
<td>0.72</td>
<td>0.46</td>
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<tr>
<td><strong>Associated injuries (present versus absent)</strong></td>
<td></td>
<td></td>
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<tr>
<td>Multiple arterial injuries</td>
<td>4.85 (1.15, 18.90)</td>
<td>0.98</td>
<td>0.65</td>
</tr>
<tr>
<td>Soft tissue injury</td>
<td>5.80 (1.87, 16.56)</td>
<td>&gt;0.99</td>
<td>0.63</td>
</tr>
<tr>
<td>Fracture</td>
<td>4.30 (1.89, 7.02)</td>
<td>&gt;0.99</td>
<td>0.24</td>
</tr>
<tr>
<td>Nerve injury</td>
<td>1.50 (0.66, 2.92)</td>
<td>0.86</td>
<td>0.12</td>
</tr>
<tr>
<td>Vein injury</td>
<td>1.08 (0.65, 1.82)</td>
<td>0.63</td>
<td>0.43</td>
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<tr>
<td><strong>Complications (present versus absent)</strong></td>
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<tr>
<td>Shock</td>
<td>2.27 (0.51, 7.31)</td>
<td>0.88</td>
<td>0.37</td>
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<tr>
<td>Duration of ischaemia &gt; 6 h</td>
<td>4.40 (1.57, 11.67)</td>
<td>&gt;0.99</td>
<td>0.46</td>
</tr>
<tr>
<td>Compartment syndrome</td>
<td>5.11 (2.29, 10.81)</td>
<td>&gt;0.99</td>
<td>0.40</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td></td>
<td></td>
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<tr>
<td>Graft versus primary repair</td>
<td>1.45 (0.95, 2.10)</td>
<td>0.96</td>
<td>0.03</td>
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<tr>
<td>Vein repair versus ligation</td>
<td>0.17 (0.06, 0.39)</td>
<td>&lt;0.01</td>
<td>0.25</td>
</tr>
<tr>
<td>Prophylactic fasciotomy (yes versus no)</td>
<td>0.68 (0.15, 3.13)</td>
<td>0.30</td>
<td>0.41</td>
</tr>
</tbody>
</table>
Summary

- Limb Salvage vs. **Primary Amputation**?
- OR – on table arteriogram
- Arterial Shunt
- 4 compartment fasciotomy
- External Skeletal fixation
- Definitive vascular repair
- Soft tissue Debridement/Nerve

- Definitive Orthopedic repair
- Close fasciotomy vs. skin graft
- Nerve Repair vs. tendon transfer
- Limb Salvage vs. **Secondary Amputation**?

- Gustilo III - C skeletal injuries
- Old age/severe co-morbidity
- Sciatic or tibial nerve injury
- Destructive soft tissue injury
- Significant wound contamination
- Multiple/severely comminuted fx
- Elderly with medical comorbidity
- Shock and life-threatening associated injuries

- Prolonged ischemia (6 hr)
- Muscle Necrosis
- Failed revascularization
- Limb sepsis
References

- Fischer’s Mastery of Surgery, 6e Edited by Josef E. Fischer, Daniel B. Jones, Frank B. Pomposelli and Gilbert R. Upchurch. December 2011