Management of Postoperative Extremity Ischemia

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Disclosure

• I have no relevant commercial bias
• I will not discuss unapproved or off label devices or drugs

• I do not practice peripheral vascular surgery
  – Have mercy
Acute lower extremity ischemia

• Occurs in 14/100,000 patients per year
• 85% thrombotic
• 15% embolic
• 20-30% amputation rate
• 15% mortality
• 50% mortality in those that require amputation
Acute lower extremity ischemia

- 5 “P’s”
  - Pain
  - Pulseless
  - Pallor
  - Paresthesia
  - Paralysis
- Etiology: Embolic vs thrombotic vs dissection
- Clinical features can be challenging in post op patients
  - Intubated/sedated
  - Vasoconstrictor use
  - Leg prep
  - Superimposed chronic occlusive disease
Acute limb ischemia

• Severity grading:
  – Viable
    • Preserved Doppler signals, capillary refill
  – Marginally threatened
    • Delayed but present capillary refill
  – Immediately threatened
    • Absent capillary refill, pain and sensory loss, motor loss
  – Non-viable
    • Paralysis, possible rigor
Acute limb ischemia: Basic treatment strategy

• Heparin
  – Prevents propagation of thrombus
  – Prevents in situ thrombosis of low flow distal circulation

• Angiography
  – Define point of occlusion
  – Burden of intrinsic atherosclerotic disease
  – Distal run off
  – Limited to patients with viable and marginally threatened extremities
    • Preserved capillary refill, faint doppler signals

• Surgery
  – Thrombectomy/embolectomy
  – Lower extremity bypass/extra-anatomic bypass
  – Inflow, outflow, conduit
Femoral popliteal bypass

80% 5 year patency

Femoral tibial bypass

60% 5 year patency

Axillary femoral bypass

50% 5 year patency

Femoral femoral bypass

70% 5 year patency
Embolectomy catheters

Iliac artery stent

80% 5 year patency
Acute limb ischemia: Basic treatment strategy

- Lytics/catheter based treatment vs surgery
  - Decision dependent upon angiographic findings

**A COMPARISON OF RECOMBINANT UROKINASE WITH VASCULAR SURGERY AS INITIAL TREATMENT FOR ACUTE ARTERIAL OCCLUSION OF THE LEGS**

KENNETH OURIEL, M.D., FRANK J. VEITH, M.D., AND ARTHUR A. SASAHARA, M.D., FOR THE THROMBOLYSIS OR PERIPHERAL ARTERIAL SURGERY (TOPAS) INVESTIGATORS

<table>
<thead>
<tr>
<th>INTERVENTION</th>
<th>NATIVE-ARTERY OCCLUSIONS (N = 242)</th>
<th>BYPASS-GRAFT OCCLUSIONS (N = 302)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UROKINASE (N = 122)</td>
<td>SURGERY (N = 120)</td>
</tr>
<tr>
<td>Complete dissolution of clot on final angiogram — no./total no. of patients (%)</td>
<td>67/112 (60)</td>
<td>NA</td>
</tr>
<tr>
<td>Increase in ankle—brachial index</td>
<td>0.44±0.04</td>
<td>0.52±0.04</td>
</tr>
<tr>
<td>Mortality — %</td>
<td>20.8</td>
<td>15.9</td>
</tr>
<tr>
<td>6 mo</td>
<td>24.6</td>
<td>19.6</td>
</tr>
<tr>
<td>Amputation-free survival — %</td>
<td>67.6</td>
<td>76.1</td>
</tr>
<tr>
<td>6 mo</td>
<td>61.2</td>
<td>71.4</td>
</tr>
</tbody>
</table>

NEJM 1998
Etiology: Post cardiothoracic surgery

- Femoral artery obstruction
  - IABP
  - Femoral artery cannulation
    - ECMO
    - Min invasive cardiac surgery
- Embolic
  - Aortic atheroma
  - Intraventricular thrombus
  - IABP
- Dissection
  - Aortic
  - Local
- Low flow
  - Low cardiac output
    - Setting of chronic occlusive disease
    - Vasoconstrictors
Intra aortic balloon pump: literature review of risk factors related to complications of the intraaortic balloon pump

Haralabos Parissis*, Alan Soo and Bassel Al-Alao

- 70,000 IABP inserted per year
- 5-10% cardiac surgical procedures have IABP
- Bleeding/ischemia 8-18%
  - Major ischemia ~2%

J Cardiothor Surg 2011

The Current Practice of Intra-Aortic Balloon Counterpulsation: Results From the Benchmark Registry

James J. Ferguson III, MD, FACC,* Marc Cohen, MD, FACC,† Robert J. Freedman, Jr, MD, FACC,‡ Gregg W. Stone, MD, FACC,§ Michael F. Miller, PhD,‖ Debra L. Joseph, BSN¶ E. Magnus Ohman, MD, FACC#

- 16,000 patients
- Major vascular complications 2.8%
- Mortality 21%

JACC 2001
Acute Lower Extremity Ischemia After Cardiac Surgery

Robert C. Allen, MD, Joe Schneider, BS, Lani Longenecker, BS, Andrzej S. Kosinski, PhD, Robert B. Smith III, MD, Alan B. Lumsden, MD, Atlanta, Georgia

- 65/7620 cardiac surgery patients had limb threatening ischemia (0.85%)
- 56/65 (86%) associated with IABP
- 56/312 (18%) IABP inserted for cardiac surgery procedures had limb ischemia
- 20 limbs lost in 15 patients
- 30/65 (46%) mortality
  - 52% mortality in those with IABP
  - 11% in those without IABP
- 9/65 had no IABP
  - 6 thrombotic
    - History of PVOD
    - Vasoconstrictors
  - 3 embolic

American Journal of Surgery 1993
Acute Lower Extremity Ischemia After Cardiac Surgery

Robert C. Allen, MD, Joe Schneider, BS, Lani Longenecker, BS, Andrzej S. Kosinski, PhD, Robert B. Smith III, MD, Alan B. Lumsden, MD, Atlanta, Georgia
• 187 IABP patients
• Incidence of limb ischemia 10% (n=19)
  – Mortality of entire IABP population 63%!
    • May underestimate limb ischemia frequency
• Risk factor: Duration of IABP use
  – Others reported Age, PVOD, female, HTN, obesity, DM
• 16% (n=3) ischemia upon removal of balloon
• 84% (n=16) during balloon use
• 47% (n=9) underwent embolectomy
  – 4 required amputations (all died)
• 5 treated with IABP removal only
Balloon removal technique

- Inactivate and deflate balloon
- Fibrin sheath forms around balloon catheter
- Occlude femoral artery DISTAL to insertion site
  - Prevents distal emboli
- Withdraw balloon until it engages sheath
- Swiftly pull balloon and sheath
  - Allow blood to eject out of insertion site 2 seconds
    - Evacuation of clot
- Move pressure proximally to occlude arteriotomy
- 30 minutes direct pressure
  - Assessment of distal flow
    - Reduced but present Doppler signals
Aortic dissections

• **Malperfusion**
  – Branch obstruction from true lumen collapse
  – Ostial occlusion by intimal flap
  – Extension into branch vessels

• Brain, spinal cord, gut, kidneys, extremities

• Type A or Type B
Aortic dissections
Contemporary management of aortic branch compromise resulting from acute aortic dissection

Stephen R. Lauterbach, MD, Richard P. Cambria, MD, David C. Brewster, MD, Jonathan P. Gertler, MD, Glenn M. LaMuraglia, MD, Eric M. Isselbacher, MD, Alan D. Hilgenberg, MD, and Ashby C. Moncure, MD, Boston, Mass

- 53 (28%) incidence of malperfusion
- 24 (13%) lower extremity ischemia
  - 2 fem-fem bypass
  - 1 aorto-iliac bypass
  - 3 open fenestration
  - 2 endovascular fenestration
  - 9 ascending aortic replacement (one death)
  - 1 descending aortic replacement (amputation)
  - 3 medical treatment (one death)

J Vasc Surg 2001
Contemporary management of aortic branch compromise resulting from acute aortic dissection

Stephen R. Lauterbach, MD, a Richard P. Cambria, MD, a David C. Brewster, MD, a Jonathan P. Gertler, MD, a Glenn M. LaMuraglia, MD, a Eric M. Isselbacher, MD, b Alan D. Hilgenberg, MD, b and Ashby C. Moncure, MD, a Boston, Mass
Angiographic fenestration
Operative delay for peripheral malperfusion syndrome in acute type A aortic dissection: A long-term analysis

Himanshu J. Patel, MD, David M. Williams, MD, Narasimham L. Dasika, MD, Yoshikazu Suzuki, MD, and G. Michael Deeb, MD

- 70/196 (35%) type A dissections with evidence of malperfusion
  - 12% extremity ischemia
- Treated with endovascular fenestration
  - Delayed operative intervention
- 23/70 did not survive to surgery
  - 12 ruptured
  - 11 from effects of malperfusion
- 47 surgery median 4 days
ECMO

- Femoral vessels easily accessible
- Percutaneous cannulation rapid during CPR
- Hazards for ischemia
  - Large size cannulae
  - Coexistent peripheral vascular disease
  - Multiple vasoconstrictors
Limb ischemia after common femoral artery cannulation for venoarterial extracorporeal membrane oxygenation: an unresolved problem☆

- Incidence of lower extremity ischemia in VA ECMO using the femoral artery up to 50%
- Pediatric experience
- 21 patients 2-22 years old
- 43% mortality
- 11/21 (52%) with leg ischemia
- No significant differences in cannula size, BSA, female sex, or age
- More vasoconstrictors in ischemia group (insignificant)
Options

• Femoral cut down with end to side graft
• Reperfusion cannula
  – Antegrade
    • Superficial femoral artery
  – Retrograde
    • Posterior tibial artery
• Axillary cannulation
Perfuses body and lower extremity simultaneously

Time consuming

Limited bedside tools

Prone to bleed
Options

• Femoral cut down with end to side graft
• Reperfusion cannula
  – Antegrade
    • Superficial femoral artery
  – Retrograde
    • Posterior tibial artery
• Axillary cannulation
A Simple Technique of Distal Limb Perfusion During Prolonged Femoro-Femoral Cannulation

Navid Madershahian, M.D., Ragi Nagib, M.D., Jens Wippermann, M.D., Justus Strauch, M.D., and Thorsten Wahlers, M.D.

Department of Cardiothoracic and Vascular Surgery, Friedrich-Schiller University, Jena, Germany

- Direct vascular exposure
- Sheath down SFA
- Target flow 100-150 ml/min
Limb ischemia during femoral cannulation for cardiopulmonary support

Paul J. Foley, MD, a Rohinton J. Morris, MD, b Edward Y. Woo, MD, a Michael A. Acker, MD, b Grace J. Wang, MD, a Ronald M. Fairman, MD, a and Benjamin M. Jackson, MD, a Philadelphia, Pa

- 43 patients cannulated via the femoral artery
- 10 had prophylactic SFA “reperfusion” cannulae inserted
- 7/33 (21%) had limb ischemia
- Younger patients more likely to have limb ischemia
  - Smaller vessels, less collaterals
- Expectant approach may be reasonable
- 79% mortality
  - Limb ischemia may be underestimated

J Vasc Surg 2010
• Open exposure of femoral vessels
• Retrograde cannulation of CFA
• 23 Ga puncture of distal SFA
  – < 50 mmHg pressure, reperfusion cannula inserted
• 8.5 Fr single lumen arrow catheter
• 9 patients
  – Average flow 250 ml/min
  – No cases of limb ischemia
  – Survival 50%

JTCVS 2004
A simple technique to prevent limb ischemia during veno-arterial ECMO using the femoral artery: the posterior tibial approach

DJ Spurlock, JM Toomasian, MA Romano, E Cooley, RH Bartlett and JW Haft

- Posterior tibial retrograde cannulation
  - 6-8 Fr cannula
- 36 patients
  - Average flow 155 ml/min
  - 60 % mortality
  - 3 cases of critical limb ischemia despite reperfusion cannula
    - All placed after 6 hours of initiation of ECMO
- All cases now have reperfusion catheter placed prophylactically at time of ECMO

Perfusion 2011
Options

• Femoral cut down with end to side graft

• Reperfusion cannula
  – Antegrade
    • Superficial femoral artery
  – Retrograde
    • Posterior tibial artery

• Axillary cannulation
• Infraclavicular exposure
  – In the operating room
• 8 mm end to side vascular graft
• 24 Fr cannula tunneled through separate exit site
• 20 patients
  – 45% survival
  – 3 complications
    • Infection, hematoma, arm swelling
• Limited to patients stable for intra-hospital transport
  – Time consuming
Near Infrared Spectroscopy (NIRS)

- Near infrared light penetrates tissue
- Absorbed differentially by oxygenated and deoxygenated hemoglobin
- Sensors detect reflected light
- Determines relative tissue perfusion
- Used frequently in arch surgery, carotid, pediatric cardiac surgery
• Sensors placed on head and calf
• Unilateral fall in rSO2 implies ischemia
• 6/17 patients with ischemia (35%)
• Resolved with insertion of distal perfusion catheter or fasciotomy
• No limbs lost
Compartment Syndrome

- Muscle/soft tissue injury causes swelling
  - Fracture
  - Hematoma
  - Ischemia/reperfusion
- Leg compartments have limited capacity to stretch
- Pain out of proportion to injury
- Compartment pressure
  - Muscle ischemia
  - Nerve injury
  - Arterial obstruction late finding
    - Too late!
- Confirm diagnosis with ICP
  - Normal 0-8 mmHg
  - ICP <30 from diastolic blood pressure indication for fasciotomy
Compartment Syndrome

- **Treatment:** urgent fasciotomy
  - Anterolateral: midway between tibial crest and fibula
    - Incise fascia full length of incision
    - Intermuscular septum incised for lateral compartment
      - Beware superficial peroneal nerve
  - Posteromedial: 2cm posterior to tibia
    - Incise superficial compartment along entire length
    - Deep compartment released distally where muscle is more bulky
Correlation Between Muscle Oxygenation and Compartment Pressures in Acute Compartment Syndrome of the Leg

By Michael S. Shuler, MD, William M. Reisman, MD, Tracy L. Kinsey, MSPH, Thomas E. Whitesides Jr., MD, E. Mark Hammerberg, MD, Maria G. Davila, MD, and Thomas J. Moore, MD

Investigation performed at Grady Memorial Hospital, Atlanta, and Emory University, Atlanta, Georgia

- Simultaneous measurement of ICP and NIRS in patients with suspected compartment syndrome
- Excellent correlation with NIRS as compared to contralateral limb

J Bone Joint Surg 2010
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The Use of Near-Infrared Spectrometry for the Diagnosis of Lower-extremity Compartment Syndrome

Jason T. Bariteau, MD; Bryan G. Beutel, BS; Robin Kamal, MD; Roman Hayda, MD; Christopher Born, MD

• Measuring compartment pressure gold standard
  – Intermittent measurement
  – Invasive

• No correlation between NIRS and compartment pressure
Summary

• Lower extremity ischemia is uncommon in cardiac surgery
• Challenges in making prompt diagnosis
• IABP is most frequent cause
  – High mortality with or without treatment
• Aortic dissection causes lower extremity ischemia 10-15%
  – Options include angiographic fenestration, open fenestration, extra-anatomic bypass, replacement of ascending aorta
• Variety of approaches available to prevent limb ischemia in ECMO
  – Tailor strategy to patient circumstances
• Mortality of lower extremity ischemia in cardiac surgery setting is daunting