Acute Ischemia of an Extremity

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Injury/Disease Demographics

- Although acute ischemia may occur in upper or lower extremities; it occurs 8 times more often in the lower extremities.
- Clinical presentation is considered to be acute if it occurs within 2 weeks after symptom onset.
- Urgent recognition with prompt revascularization is required to preserve limb viability.
- The most common causes of acute ischemia include:
    - recent onset of atrial fibrillation with embolization to the effected extremity
    - acute thrombosis of an artery or bypass graft
    - trauma with either blunt or penetrating disruption of the artery
- Thrombosis may also spontaneously occur in patients with hypercoagulable syndromes (e.g. antiphospholipid antibody syndrome) who do not have intrinsic arterial disease or trauma.

Clinical Presentation

- Physical findings may include:
    - reduced or absent pulses distal to the occlusion
    - cool and pale or mottled skin
    - reduced sensation
    - decreased strength.
- The features of acute limb ischemia are often grouped into a mnemonic known as the six Ps: paresthesia, pain, pallor, pulselessness, poikilothermia, and paralysis.

Evaluation/Diagnostics/Imaging

- Assessment of limb appearance, temperature, pulses (including by Doppler), sensation, and strength is used to determine whether the limb is viable, threatened, or irreversibly damaged.
- Intra-operative angiogram may help in delineating the exact location of the thrombosis or embolism, however often patients can be examined clinically to determine the level of deficit.
- Doppler pressure measurements comparing extremities provides quantitative measurements of arterial flow and can help localize a lesion; normal Doppler pulse will be present above the lesion, absent or reduced Doppler pulse will be noticed below the lesion.
- In viable or threatened extremities, it may be reasonable to perform imaging prior to intervention (CTA, MRA, Duplex ultrasonography) to better plan the procedure.
- If acute ischemia is caused by embolization, cardiac echo should be performed to assess for atrial thrombus and anticoagulation should be started to avoid repeat embolization.

Role of Conservative Management and Associated Considerations

- In patients with acute ischemia without an acutely threatened limb, catheter based and non-operative therapy can be considered and emergency operation may be avoided.
- Recent advances in catheter based therapy may allow for a hybrid (open and catheter based) approach if available, in selected cases of acute ischemia, even with immediately threatened limbs.

- In patients with acute limb ischemia, and immediately threatened limbs, preoperative anticoagulation with heparin may help avoid propagation of clot and be of benefit.
- In patients with irreversible damage to the limb, or a nonviable limb, the thought process should transition from emergent intervention for limb salvage towards a discussion with family and patient regarding goals of treatment and the need for amputation. Emphasis should be on life over limb in those with irreversibly damaged and frankly dead extremities. Perioperative planning should be for amputation rather than salvage.

Indications for Operative Intervention

- Acute ischemia with threatened but viable extremity.
- Non-viable extremity (amputation).
- AKI from Rhabdomyolysis (fasciotomy and debridement).
- Distributive shock.

Pre-operative Preparation

- Need for on-table lower extremity angiography should be anticipated and appropriate fluoroscopy including fluoro-compatible OR tables should be readied.
- Surgical prep should include circumferential access to bilateral extremities from the pubis distally.
- Basic vascular instruments, embolectomy catheters, heparinized saline, and vessel loops should be available.
- Surgeons should wear lead aprons as intraoperative imaging (completion angiogram) is necessary.
- Arterial access for on-table angiography can be obtained:
    - percutaneously at the femoral vessels with a standard arterial catheter
    - via femoral vessel exposure and direct cannulation
    - via distal SFA exposure just above the medial knee and direct cannulation
- In the upper extremity, percutaneous access can be obtained anterograde at the axilla or mid-biceps, or retrograde at the radial or ulnar artery. Open exposure for arterial access is possible at any level in the upper extremity.

Operative Techniques/Intraoperative Considerations

- Thrombotic occlusion usually occurs in patients with chronically diseased vascular segments. In such cases, correction of the underlying arterial abnormality is required for long term success. Acute thrombosis is an indication for catheter based lytic therapy. Chronic thrombosis is an indication for a bypass or interposition graft.
- Patients with suspected embolism are best treated by exposure of the common femoral artery bifurcation and balloon-catheter thromboembolectomy as described below.
    - Expose the femoral artery below the level of the inguinal crease through a longitudinal incision.
    - Obtain proximal and distal control with vessel loops (including the profunda femoris).

    - Create a longitudinal or transverse arteriotomy per surgeon preference.
    - Flush distally with dilute heparin (10U/cc) using a 20cc syringe and an olive tip catheter.
    - Pass a suitably sized Fogerty catheter 10 cm at a time (pass catheter, inflate the balloon with the appropriate amount of saline, and withdraw it).
    - Collect and retain any clot.
    - Continue to advance 10 cm at a time until removal of as much clot burden as possible is achieved and reperfusion is achieved as described below.
    - Close arteriotomy with running or interrupted Prolene suture (5-0 or 6-0 usually works fine).
    - In the case of a longitudinal arteriotomy, a vein or bovine pericardial patch may be used in closing to avoid narrowing of the artery.
    - Subcutaneous tissues and skin are closed in layers.
- Restoration of a palpable foot pulse, audible arterial Doppler signals, and visible improvement of foot perfusion (e.g., capillary refill, increased temperature, hyperemia) suggest success.
- Completion angiogram is necessary prior to leaving the OR in all patients, but especially those with absent palpable pulses regardless of Doppler signals.
- Proximal digital occlusion (pressure) at the femoral or axillary artery is helpful during on-table angiogram to help prevent rapid washout of IV contrast.
- Vasodilators (e.g., nitroglycerin and papaverine) instilled through the arterial exposure and perfused distally may be of benefit if evidence of vasospasm on completion angiogram.
- Be aware of the possibility of reperfusion injury and consider four compartment fasciotomy in those at risk (ischemic time > 4-6 hours).

Postoperative Management/Complications

- The vascular exam should be monitored hourly in the immediate postoperative period. Any change in pulse exam should herald recurrent thrombosis, occlusion of the arterial repair or development of compartment syndrome.
- Postoperative use of antithrombotics is individualized based upon the surgeon's impression of the durability of the repair, outflow considerations, and risk of bleeding. Antiplatelet agents are used in the majority with some receiving systemic heparin infusions in the first postoperative week to allow for endothelialization of the suture lines or graft.
- Prosthetic graft infections are rare complications but preventing bacteremia is imperative. Preoperative and perioperative antibiotics should be given.
- Long-term arterial graft complications such as stenosis or pseudoaneurysms are uncommon, and routine graft surveillance is rarely performed.

Considerations for Special Populations

- ABI measurements in older patients may be reflective of atherosclerotic disease rather than acute ischemia. This must be incorporated into the decision making for ancillary imaging.

Suggested Readings

- Fogarty TJ, Cranley JJ, Krause RJ, Strasser ES, Hafner CD. A method for extraction of arterial emboli and thrombi. Surg Gynecol Obstet1963;116:241-4.

- Collins R, Burch J, Cranny G, et al. Duplex ultrasonography, magnetic resonance angiography, and computed tomography angiography for diagnosis and assessment of symptomatic, lower limb peripheral arterial disease: systematic review. BMJ 2007;334:1257.

- Henke PK. Contemporary management of acute limb ischemia: factors associated with amputation and in-hospital mortality. Semin Vasc Surg 2009;22:34-40.

- Baril DT, Patel VI, Judelson DR, et al. Outcomes of lower extremity bypass performed for acute limb ischemia. J Vasc Surg 2013; 58:949.