Contemporary Management of Mycotic Aneurysms and Prosthetic Graft Infections

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Case 1

- 78 Y.O. male with multiply thrombosed right AFB graft limb. Thrombosed and managed at outside facility, 15 unit blood loss. Presented back to us with healed wound, moderately large hematoma, became infected with sepsis, culture pos for MRSA.

- Underwent right groin exploration, partial graft excision, in-situ replacement with PTFE, Sartorius flap, Wound Vac.
- Healed after 6 weeks, did well for 4 months and thrombosed right graft limb without signs of infection.
- Obturator or Fem/Fem bypass considered
- Underwent unilateral Ax/Fem bypass with profundal popliteal bypass. Remains alive with salvaged limb and no sign of infection at one year.

Arterial/Graft Infection

- Rare but potentially catastrophic vascular surgical problem
- Consequences and therapy dictated by anatomic location, extent of infection and virulence of organism
- Historically, excision of infected tissue and reconstruction through clean tissue planes has been considered most effective treatment
- Recently, treatment has become more individualized with in-situ reconstruction, tissue flaps and endovascular modalities used in some situations
- Antibiotic therapy should be directed by cultures and prolonged, 6 weeks to lifelong

Arterial/Graft Infection

- Review current diagnostic approaches
- Highlight differences between arterial and graft infections
- Review results of treatment
- Review and contrast results of more contemporary treatment
Arterial Infections

- **Graft Infection**
  - Extent of foreign body contamination
  - Anastomotic involvement, arterial integrity
  - Identity of organism
  - Re-do operative field
  - More often have established collaterals

- **Mycotic (Primary Arterial)**
  - Defining extent of infectious process, tissue integrity critical
  - Identity of organism
  - Patients immunocompromised
  - May be multiple

### Diagnosis

- **Clinical Suspicion**
  - Fever, leukocytosis, drainage, graft occlusion, septic emboli, pseudoaneurysm

- **Computed Tomography**

- **CT Guided Needle Aspiration**

- **MRI**

- **Duplex scan**
  - Neck and Infrainguinal
  - Labeled WBC scanning
  - Positron Emission Scanning

### Prosthetic Graft Infection

- **Incidence 0.2 – 5% depending on site, indication, host defenses**
- **Risk potentiated by foreign body**
- **May occur as a result of peri-op contamination, bacteremia, mechanical erosion or extension by contiguous process**

### Clinical Classifications of Prosthetic Graft Infection

#### TIME OF APPEARANCE AFTER IMPLANTATION
- Early: <4 mo
- Late: >4 mo

#### RELATIONSHIP TO POSTOPERATIVE WOUND INFECTION (SZILAGYI'S CLASSIFICATION)
- Grade I: cellulitis involving the wound
- Grade II: infection involving subcutaneous tissue
- Grade III: infection involving the vascular prosthesis

#### EXTENT OF GRAFT INVOLVEMENT (BUNTS CLASSIFICATION MODIFIED)
- Peripheral graft infection
  - P0 graft infection: infection of a cavitary graft (e.g., aortic arch; abdominal and thoracic aortic interposition)
  - P1 graft infection: infection of a graft whose entire anatomic course is noncavitary (e.g., carotid-subclavian, femoral-femoral, etc.)
  - P2 graft infection: infection of the extracavitary portion of a graft whose origin is cavitary (e.g., infected limb of aortofemoral graft)
  - P3 graft infection: infection involving a prosthetic patch angioplasty (e.g., carotid-sternal endarterectomy patch infection)
- Graft-enteric erosion
- Graft-enteric fistula
- Aortic stump sepsis after excision of an infected aortic graft
Prosthetic Graft Infection

- **Bacteriology**
  - S. aureus
  - MRSA
  - S. epidermidis
  - Strep species
  - Pseudomonas*
  - Other Gram (-) *
  - Fungal

  *groin level & below

Limitations of Graft Excision and Extra-anatomic Bypass

- **Long difficult operations, problematic graft routing**
  - 10-30% peri-operative mortality
  - 15-25% amputation rate at 5 years
  - 10-20% aortic stump blowout (mortality >75%)
  - 5-15% graft re-infection rate
  - Primary patency 40-72% at 3 years

Alternative Treatment Modalities

First reported in 1990's

- **Local debridement and topical care with graft preservation**
- **In situ-replacement**
  - Prosthetic grafts
  - Dacron/PTFE
  - Antibiotic Impregnated/Soaked
  - Arterial homografts (Allografts)
  - Autogenous grafts
- **Adjuncts**
  - Rotational muscle flaps
  - Negative pressure therapy
  - Antibiotic beads
  - Omental wrap

Graft Preservation or In-situ Replacement

- **Advantages**
  - May reduce risk of stump blowout
  - Improved patency with larger, shorter conduits
  - Shorter operations, single operative field

- **Disadvantage**
  - Reconstruction in contaminated field
    - Re-infection, thrombosis
    - Hemorrhage, anastomotic disruption

Autologous In-situ Replacement

- **Greater saphenous, upper extremity or femoral vein, endarterectomized SFA**
  - Caution in setting of virulent Gram (-) infection such as pseudomonas
  - Saphenous performs poorly as Fem/Fem conduit or in abdomen
  - Generally used with muscle flaps, omental wrap +/- wound vac

Neo-aortoiliac System Reconstruction

- Clagett, et al, 1993
  - Long (8 – 12 hour) difficult procedure
  - Harvest femoral vein from groin to below knee, often bilateral
  - Vein size matters, > 6 mm
  - Extensive debridement 6 – 8 weeks of antibiotics
Neo-aortoiliac System Reconstruction
- 240 patients 1991 – 2005
- 30 day mortality 10%
- Mean op time 9 hours
- Vein < 7.2 mm, CAD, smoking predict stenosis
- Late survival 50% less in AEF patients

Cryopreserved Aortic Allograft
- Primary experience in Europe
- Cryopreserved grafts have performed better than fresh allografts
- Availability for urgent cases is problematic

Cryopreserved Aortic Allograft
- 179 patients, 30% with Aortic-Enteric involvement
- Operative mortality 20%
- 88 with cryopreserved grafts, eliminated early graft related problems, later results comparable to other in-situ techniques

Antibiotic-soaked Grafts
- 117 patients, extra-anatomic (65) or in situ (52) with Gel sealed Rifampin soaked graft
- 9% 30-day mortality
- 11% re-infection
- 63% 5-year survival
- 89% primary patency
- Better patency and less complications in in-situ group

Aortic Graft Infection
- Pooled Results

Evolution from axillofemoral to in situ prosthetic reconstruction for the treatment of aortic graft infections at a single center. Oderich et al, JVS, 2006
Aorto-enteric fistula

- Worst short and long outcomes regardless of management
- High percentage require emergency operation because of bleeding
- Proximal aorta often infected
  - Anastomotic and aortic stump blowout

Aorto-Enteric Fistula

- First proposed by Denton Cooley’s group in 1987
- Oderich et al, 2011 Mayo Clinic
  - 54 patients, total excision 31, partial in 23
  - Patients with large abscess, extensive purulence excluded
  - Replacement with Rifampin soaked graft in situ, omental wrap, lifelong antibiotics
  - 9% mortality, 4/5 in shock at time of operation
  - 100% limb salvage at 5 years

Aorto-Enteric Fistula

- Endovascular management
  - Nearly 100 reported cases managed with EVAR
  - Mortality 30 – 50%, re-infection >60%
  - May be considered in conjunction with antibiotic Rx and percutaneous drainage in extremely high risk patients
  - Greatest utility probably as a “bridging” strategy to control bleeding and allow planning of definitive Rx

Groin/Infrainguinal Graft Infection

- Graft removal, debridement and extra-anatomic bypass classical Rx
- Various in-situ approaches used more frequently than for aortic grafts
  - Graft preservation
  - New prosthetic
  - Autogenous

Groin Infection/Graft Preservation

- Debridement, Antibiotics, Wound Care
  - Calligaro & Veith, 1994
    - Salvaged 75% (32/42) with aggressive debridement, antibiotic soaked gauze
    - No anastomotic involvement
  - Antibiotic polymethyl methacrylate beads
      - 89% salvage (32/36)
      - 81% salvage (34/42) *19% limb loss

* PTFE fares better than Dacron

Groin Infection/Graft Preservation

- Bandyk (Stone) approach
  - Culture and aggressive wound debridement
  - Irrigation with H2O/betadine mixture, closure of wound over antibiotic beads (Vanco, Tobra, Gent)
  - Bead removal and closure when sterile
Groin Wound/Graft Infection

- **Wound Vac Alone**
  - Dosluoglu et al, 2010
  - 26 deep early groin infections
  - 12 exposed grafts, predominantly PTFE
  - 9 exposed anastomoses included
  - Ag gel until wound was clean, then VAC (median 3.0 days)
  - Mean healing time 49+/– 21 days
  - Two treatment failures, both with pseudomonas

Groin Infection

- **Muscle Flaps +/- VAC**
  - Reiffel et al, 2012
  - 29 patients, 21 sartorius, 6 rectus femoris, 2 gracilis
  - 100% salvage of autogenous grafts, 92% synthetic, 4% limb loss
  - Illig et al, 2004
  - 41 patients, 30 grafts, 26 exposed suture lines
  - 85% rectus femoris flaps
  - 88% success, 36/41, 97% limb salvage at 6 months

Muscle Flaps for Groin Infection

- **Sartorius**
  - Small, thin muscle with segmental blood supply
  - No morbidity
  - Detach from anterior superior iliac spine and rotate

- **Rectus femoris**
  - Bulky muscle
  - Blood supply from profunda
  - Requires separate thigh incision
  - Short term disability in knee extension
  - Probably best flap because of better bulk and blood supply

- **Gracilis**
  - Little bulk
  - Increase donor site morbidity
  - Difficult to harvest

Prosthetic Graft Infection

**Summary**

- Trend in both cavitary and non-cavitary infection is toward “in situ” replacement and/or graft preservation
- Omental wraps, muscle flaps, Wound Vac, prolonged antibiotic Rx are important adjuncts
- Results are generally excellent with NAIS, cryopreserved allograft and antibiotic treated prosthetic for Aortic graft infection; 80 – 90% success in eradicating infection and salvaging limbs
- Aorto-enteric fistula and Pseudomonas infection remain problematic and may be best treated with excision and extra-anatomic bypass
Endovascular Graft Infection

- Generally due to bacteremia from remote sources, late procedures
- 1/3 manifest as aortoenteric erosions/fistulas
- Most managed with explantation and extra-anatomic bypass
- Wide variety of organisms, with Staph & Strep most common

Laser et al, 2011
- 9 patients, variety of grafts
- All explanted, 4 in-situ repairs, 5 Ax Bi-fem
- 4 patients culture negative
- 3 AEF, 2 deaths both with AEF, 7 survived to leave hospital
Setacci et al, 2010
- Literature review of 102 cases
- Explant with in situ replacement or extra-anatomic bypass did better than conservative Rx/graft preservation
- In situ replacement associate with lowest mortality

Case 2

- 64 Y. O. female admitted with epigastric and back pain, mild leukocytosis.
- CT showed peri-aortitis at level of celiac. Initially felt to be in inflammatory, possible Retroperitoneal fibrosis. Treated with steroids with improvement.

* Courtesy of David Moore MD SCPMG, Panorama City

Patient had progressively worsening pain, WBC
- Repeat CT scan showed expansion with pseudoaneurysm
- Urgent operative repair with Rifampin soaked Dacron graft
- Intraop cultures – S. aureus
- Doing well 16 months out on chronic suppressive antibiotics

Mycotic Aneurysm

- Arterial seeding from endocarditis
- Common in the past, infrequent now
- Microbial arteritis
- Seeding from non-cardiac bacteremia
- Constitutes a larger percentage now
- More gram (-) infections
- Infection of Existing Aneurysm
- Post-traumatic False Aneurysm

Bacteriology (Aorta)
- Salmonella – 30%
- Staph species – 20%
- Strep species – 7%
- E. coli – 5%
- Bacteroides – 5%
- Culture neg – 20%
- Other – 17%
  - Wide variety including fungal and mycobacteria
Mycotic Aneurysm

- Principles of treatment traditionally similar to graft infection
  - Control of hemorrhage
  - Debridement/Removal of infected tissue
  - Extra-anatomic bypass
  - Specific and prolonged antibiotic therapy
  - Ongoing wound care to achieve healing
- Current trend to in-situ and endovascular Rx, at least as a bridging strategy

Mycotic Aortic Aneurysm

- Extra-anatomic Bypass
  - Bacourt and Koskas, 1992
  - Multi-center review of 98 cases
  - Early mortality 24%, overall mortality 32%
  - 8 aortic stump blowouts
  - 82% 5-year limb salvage
  - Weiss-Muller et al, 2011
  - 25 patients since 1995, most extra-anatomic bypass & resection
  - 24% 90 day mortality
  - Only rupture status predicted mortality, not type of repair

Mycotic Aortic Aneurysm

- In Situ Repair
  - Prosthetic grafts, few allografts and NAIS
  - Oderich et al, 2001 Mayo Clinic
    - 43 patients, 53% ruptured
    - Op mortality 21%
    - 35 in situ repairs
    - Extra-anatomic with extensive purulence
    - 90% free of graft related comp at 1 & 5 years
  - Yu et al, 2011
    - 56 patients, 33 in situ or patch repairs
    - Salmonella in 34
    - Op mortality 23%
    - In situ graft infection rate – 9%
    - Mortality related to anatomic location of aneurysm

Mycotic Aortic Aneurysm

- Endovascular Repair
  - Mostly isolated case reports or collected series of case reports
  - Wide variety of anatomic sites
  - Reports likely biased toward favorable outcomes
  - Lew et al, 2009 (USC)
    - 9 patients, 6 with fistulas, MRSA – 56%
    - 56% aneurysm related mortality in 1 year
  - Kritpracha et al, 2011 (Thailand)
    - 21 patients, 17 abdominal, 4 thoracic, 5 fistulas
    - 10 positive blood cultures, 80% Salmonella
    - Mortality 60% in fistula group, 6% in others
  - Kan et al, 2012 (Taiwan)
    - 12 patients, 7 abdominal, 3 thoracic, 2 thoracoabdominal, no fistulas
    - All (+) blood cultures, Salmonella in 10, 1 each Strep and Staph
    - 3 percutaneous drainage, one mini-lap
    - No operative mortality, no infections at 24 months, one late death

Peripheral Mycotic Aneurysms

- Resection and reconstruction/bypass preferably via clean tissue planes
- Rare isolated case reports of endovascular repair

*Case courtesy of Tom Rehring, MD
Colorado PMG
Mycotic Aneurysm Summary

- **Aorta**
  - Open in-situ repair is probably superior to resection and extra-anatomic bypass
  - Endovascular repair appropriate for Salmonella aortitis/aneurysms and selected Gram (+) infections (not MRSA)
  - Percutaneous drainage or debridement may be required as an adjunct
  - Endovascular therapy may be useful as a "Bridge" in aorto-aeortic digestive fistulas but is not definitive therapy

- **Peripheral**
  - Resection and Bypass

*Courtesy of Tom Rehring, MD Colorado PMG*