Non-Infectious Complications in Vascular Surgery

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Complications Following Endovascular Surgery
Complications of Endovascular Therapy:

• Endovascular Revolution in Vascular Surgery
  - Less morbidity than traditional open surgery
  - Introduction of distinct set of complications
  - Different specialists performing interventional procedures with different skill sets
Complications of Endovascular Therapy: Femoral Complications: Incidence

- Recent Northern New England PCI Registry-18,137 patients
- Overall incidence of femoral complications was 3%

<table>
<thead>
<tr>
<th>Complication</th>
<th>Incidence (%)</th>
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<tbody>
<tr>
<td>Bleeding or hematoma</td>
<td>1.2-8.9</td>
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<tr>
<td>Pseudoaneurysm</td>
<td>1.1-7.7</td>
</tr>
<tr>
<td>Arteriovenous fistula</td>
<td>0.86</td>
</tr>
<tr>
<td>Dissection</td>
<td>0.42</td>
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<tr>
<td>Thrombosis</td>
<td>0.07-0.1</td>
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Complications of Endovascular Therapy: Femoral Access Site Complications

Risk Factors:

- Inexperience (July/August)
- Multiple (back wall) punctures
- Anticoagulants and antiplatelet agents
- Lack of ultrasound guidance
- Vessel calcification
- Inadequate manual pressure
- Closure device failure
Complications of Endovascular Therapy: Femoral Access Site Complications

Management:

• Immediate assessment - Conservative vs. Surgical decompression

• Correction of underlying coagulopathy

• Bedrest/Transfusion

• US/CT to rule out extension into retroperitoneum and pseudoaneurysm
Indications for Femoral Exploration:

- Hemodynamic instability
- Lack of response to transfusion-Ongoing bleeding
- Necrosis of overlying skin
- Nerve compression
- Intractable pain
Complications of Endovascular Therapy: Retroperitoneal Hematoma

- Due to “high stick” of external iliac or proximal femoral artery
- Retroperitoneal space can accommodate large quantity of blood
- Less likely to be tamponaded by surrounding structures
- High index of suspicion
- Acute lower abdominal/back pain
- Low hematocrit, oliguria, hypotension
- Grey Turner or Cullen’s sign
Complications of Endovascular Therapy: Retroperitoneal Hematoma

• **Management:**
  - Bedrest
  - Serial hematocrit
  - Correction of coagulopathy
  - Transfusion (Six units of blood max)
  - Serial CT
  - Preferred surgical approach: Arterial exploration and repair through the groin
  - Covered stent if proximal to inguinal ligament
  - Avoid entering retroperitoneum—High morbidity!
Complications of Endovascular Therapy: Femoral Pseudoaneurysm
Complications of Endovascular Therapy: Femoral Pseudoaneurysm

- Incidence: 0.05%-8.0%
- Pulsatile mass at puncture site
- No elements of arterial wall are incorporated into aneurysm sac
- Arterial flow into pseudoaneurysm with defined neck
- Duplex- “To-and-fro pattern of arterial flow”

Management:
- Ultrasound guided compression-Success 60%-80%
- Ultrasound guided thrombin injection- Requires adequate neck
- Surgical exploration
Complications of Endovascular Therapy: Arterial Dissection

- Over-inflation during balloon angioplasty
- Subintimal passage of wire, catheter or device
- Bulky, calcified plaque
- Pulsatile flow propagates dissection
- Flow limiting stenosis, occlusion or perforation
Complications of Endovascular Therapy: Management of Arterial Dissection

Focal Dissections:

- Low pressure angioplasty to “tack down” dissection flap
- Self-expanding or balloon expandable stent

Large iatrogenic dissections:

- Requires immediate treatment
- Passage of low profile catheter to segment of wire resistance
- Low pressure hand injection
- Withdrawal of catheter until blood aspiration occurs
- Self-expanding or balloon expandable stent
Complications of Endovascular Therapy: Distal Embolization
Complications of Endovascular Therapy: Management of Distal Embolization

- Immediate heparinization with ACT monitoring
- Aspiration catheters (Export ®)
- Percutaneous embolectomy
- Mechanical thrombectomy
- Thrombolysis
- Open thromboembolectomy
- Bypass
Complications of Endovascular Therapy: Vessel Perforation:
Complications of Endovascular Therapy: Arterial Perforation-Aorta and Iliac

- Potentially fatal
- 0.8% incidence
- Balloon oversizing and overinflation
- Heavy calcification
- Complaints of acute pain
- Hypotension
Complications of Endovascular Therapy: Arterial Perforation—Aorta and Iliac

Management:

- **Maintenance of guidewire access**
- Balloon across area of perforation
- Contralateral access
- Rapid exchange to large diameter sheath
- Covered stent or stent graft
- Laparotomy
<table>
<thead>
<tr>
<th>Causes:</th>
<th>Management:</th>
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<tbody>
<tr>
<td>• Guidewire perforation</td>
<td>• Balloon tamponade</td>
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<tr>
<td>• Angioplasty</td>
<td>• Covered stent</td>
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<tr>
<td>• Atherectomy</td>
<td>• Embolization</td>
</tr>
<tr>
<td>• Stent fracture</td>
<td>• External compression</td>
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<tr>
<td>pseudoaneurysm</td>
<td>• Reversal of anticoagulation</td>
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<td></td>
<td>• Surgical management</td>
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<td>• Recognition of compartment syndrome</td>
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Compartment Syndrome:

Endovascular

- Prolonged sheath occlusion (FEVAR)
- Arterial perforation
- Reperfusion (TPA)

Open

- Ischemia-Reperfusion
  - Prolonged clamp times
  - Thromboembolectomy
  - Bypass
- Trauma
- Fractures
Compartment Syndrome: Early Signs

- High index of clinical suspicion!
- Fullness and tenderness of compartment
- Pain disproportionate to physical findings
- Paresthesia
- Loss of two-point discrimination
- Mild-moderate weakness of involved muscles
- Early loss of pulses: suspect arterial injury
Compartment Syndrome: Late Signs

• Change in pulse examination
• Paralysis
• CPK levels 1000 to 5000 U
• Myoglobinuria
• Hyperkalemia
• Hypocalcemia
• Acidosis
• Thrombocytopenia
Measurement of Compartment Pressures

Normal Compartment Pressure

0-10 mm Hg
Interosseous membrane

Superficial Posterior compartment

Deep posterior compartment

Lateral compartment

Anterior compartment
Compartment Syndrome: Indications for Fasciotomy:

• Pain with passive flexion
• Evidence of sensory or motor loss
• Limb ischemia greater than 6 hours
• Circumferential full-thickness burns
• No critical compartment pressure exists for fasciotomy
• Low compartment pressures do not rule out compartment syndrome
Diagnostic Pitfalls:

- Lack of appropriate monitoring for high risk patients
- Attributing pain to injury alone
- Absolute reliance on compartment pressures
- Incomplete examination because of dressings, cast or splints
- CS occurs in patients with open fractures!
Abdominal Compartment Syndrome:

Incidence: 10-20%

- Ruptured AAA
  - EVAR and Open

- Massive fluid resuscitation
- Abdominal Trauma
- Post Operative Bleeding
- Mesenteric reperfusion
Abdominal Compartment Syndrome:

Diagnosis

• Physical examination alone is unreliable

• Bladder pressure
  • > 20 mmHg
  • Evidence of organ dysfunction
Treatment:

• Improve abdominal wall compliance
  • Sedation
  • Paralysis
• Evacuate intraluminal contents
  • NG tube
  • Rectal decompression
• Percutaneous Decompression
• Correct Positive Fluid Balance
• Surgical decompression
Complications Following Open Vascular Surgery
Complications of Open Vascular Surgery
Open Aortic Aneurysm Repair
Complications of Open Vascular Surgery

Medical Causes of Postoperative Bleeding

Medical Causes:

• Hypothermia

• Acidosis

• Platelet dysfunction

• Unrecognized coagulopathy

Treatment:

• Heating blankets

• Warm blood and fluids

• Increase room temperature

• Transfusion of clotting factors
  • RBC’s
  • FFP
  • Fibrinogen
  • Platelets

• ACT monitoring

• Activated Factor VII
Complications of Open Vascular Surgery
Intraoperative Venous Injury

- Left renal vein
- Iliolumbar vein
- Left, posteromedial wall of IVC
- Left common iliac vein
- Right common iliac vein
Complications of Open Vascular Surgery
Retroaortic Left Renal Vein (1.7%-3.4%)
Avoidance and Management of Venous Injury During AAA Repair

- Identification of anomalies on preoperative imaging
- Careful operative dissection
- Complete separation of iliac veins not always necessary
- Balloon occlusion for distal control
- Clearly define caudal border of left renal vein when clamping infrarenal aortic neck
Avoidance and Management of Venous Injury During AAA Repair

- Division of adrenal, gonadal, and lumbar branches

- Gentle finger pressure or sponge stick in event of venous injury

- Avoid clamping iliac veins

- Interrupted pledgeted prolene repair
Aortocaval Fistula

- Ruptured AAA or Penetrating injury
- Continuous bruit
- Signs of lower extremity venous hypertension
- Systemic Hypotension
- Oliguria
- Hematuria
- Heart Failure
Complications of Open Vascular Surgery
Aortocaval Fistula
AortoFemoral Graft Thrombosis:
Complications of Open Vascular Surgery
Causes of Early Graft Thrombosis

1. Presence of inflow disease
2. Graft kinking
3. Compression by the inguinal ligament
4. Diseased target vessels
5. Distal intimal flap
6. Distal embolus or thrombus
Complications of Open Vascular Surgery
Late Graft Thrombosis

- Outflow obstruction-SFA, Profunda
- Anastomotic aneurysm
- Inflow obstruction
- Embolism
- Prosthesis-Kink, dilatation
- Cardiac failure
- Infection
- Hypercoagulable states
Complications of Open Vascular Surgery
Late Graft Thrombosis

Progression of proximal atherosclerosis

- Bilateral symptoms
- Bilateral limb occlusion
Complications of Open Vascular Surgery
Late Graft Thrombosis

Management Strategy

• Asymptomatic, mild symptoms—Observe?

• Acute ischemia or lifestyle limiting symptoms
  • IV heparin
  • Revascularization—Must weigh severity vs. risks
Complications of Open Vascular Surgery
Late Graft Thrombosis
Complications of Open Vascular Surgery
Treatment-Late Graft Thrombosis

- Thrombolysis
- Thrombectomy with endarterectomy-profundaplasty/bypass
- Extra-anatomic bypass
- Graft replacement
- Bypass
- Endovascular repair
Complications of Open Vascular Surgery
Late Graft Thrombosis

• Complications

• Re-thrombosis
• Prosthetic graft infection
• Anastomotic aneurysm
• Wound infection
• Lymphocele
• Cross over embolism
Complications of Open Vascular Surgery
Secondary Aorto-Enteric Fistula

- Aortic reconstruction with Dacron grafts
  - Aortic anastomosis
  - Graft enteric erosion (GEE)
- 3rd – 4th portion of duodenum
- Infection
- Pulsatile pressure on duodenum
Complications of Open Vascular Surgery
Aorto-Enteric Fistula: Diagnosis

• GI Bleeding
• “Herald bleed”
• Sepsis
• Abdominal pain
• Fever/Malaise
• EGD
• CT scan
Complications of Open Vascular Surgery
Prevention of Aorto-Enteric Fistula

• Meticulous sterile technique during aortic repair

• Prophylactic broad spectrum antibiotics

• Avoid ischemia and compression of duodenum with retraction

• Closure of retroperitoneal tissue over aortic repair and suture line
Complications of Open Vascular Surgery
Management of Aorto-Enteric Fistula

Stable Patient:

• IV antibiotics/fluids
• Axillo-femoral bypass
• Removal of all graft material
• In-Situ replacement with homograft
• Duodenal repair
Complications of Open Vascular Surgery
Management of Aorto-Enteric Fistula

Unstable Patient:

• Transabdominal approach preferred

• Supraceliac aortic control
  • Balloon control through graft
  • Supraceliac clamp

• Graft removal
• Closure of aortic stump
• Bowel repair
Complications of Open Vascular Surgery
Mesenteric Ischemia - Incidence

- Small bowel 0.15%
- Large bowel 0.2%-10%
- Endoscopy
  - 6% elective AAA
  - 60% - ruptured AAA
- Mortality 50-90%
Complications of Open Vascular Surgery
Mesenteric Ischemia - Signs and Symptoms

- Mental confusion
- Metabolic acidosis
- Diarrhea, abdominal distension
- Peritoneal signs, sepsis
Complications of Open Vascular Surgery
Mesenteric Ischemia-Collateral Circulation

Marginal Artery of Drummond
Complications of Open Vascular Surgery
Mesenteric Ischemia-Prevention

Pre-op CTA evaluation
Preserve primary & collateral vessels
Reimplant IMA
Gentle traction
Preservation of Hypogastric flow
Complications of Open Vascular Surgery
Mesenteric Ischemia-Management

Management

- **Mucosal (20%)**
- D-dimer, endoscopy
- Fluids, antibiotics
- Laparotomy

**Mucosa-muscularis (20%)**
- Resect stricture

**Transmural (60%)**
- Resection ± ostomy
Spinal Cord Ischemia—Endovascular

- Endovascular Repair of 142 TAA
  - 16% Spinal cord ischemia
    - 8%-Paraplegia
    - 8%-Paraparesis
  - Prophylactic placement of spinal drain
    - 6% paraplegia
- Percentage of thoracic aortic coverage—Most predictive of spinal cord ischemia
Spinal Cord Ischemia-Open Repair

• Open Repair of 2286 TAA

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<thead>
<tr>
<th>Extent of Repair</th>
<th>Patients (n)</th>
<th>Paraplegia/Paraparesis</th>
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<tbody>
<tr>
<td>I</td>
<td>706</td>
<td>23 (3.3%)</td>
</tr>
<tr>
<td>II</td>
<td>762</td>
<td>48 (6.3%)</td>
</tr>
<tr>
<td>III</td>
<td>391</td>
<td>10 (2.6%)</td>
</tr>
<tr>
<td>IV</td>
<td>427</td>
<td>6 (1.4%)</td>
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Overall Rate of Paraparesis/Paraplegia: 3.8%
Collateral Circulation to the Spinal Cord

Vertebral Arteries

Intercostal Arteries

Anterior Spinal Artery

Posterior Spinal Artery

Artery of Adamkiewicz (usually T8-L1)

Lumbars

Hypogastric arteries

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Risk Factors for Paraplegia After TEVAR

- Prior AAA Repair
- Atherosclerosis of thoracic aorta

Decreased collateral circulation

- Hypotension

Decreased perfusion pressure

- Injury to external iliac artery
- Occlusion of left subclavian or hypogastrics
- Extensive coverage of thoracic aorta by graft

Acute disruption of collateral circulation
Risk Factors for Paraplegia after Open TAAA Repair

- Acute dissection or rupture
- Postoperative hypotension

- Crawford Type I or II
- Ligation of spinal collateral vessels

- Prolonged cross clamp time

- Previous AAA Repair

Decreased perfusion pressure

Acute disruption of collateral circulation

Ischemia-reperfusion

Decreased collateral circulation
Evidence Based Guidelines: Recommendations for SCI Prevention:

- CSF drainage
  - High risk patients-TEVAR
  - All patients undergoing open TAA repair
  - Continued for at least 48 hours

- Primary subclavian revascularization-TEVAR

- Staged repair whenever possible
Recommendations for Treatment:

- Blood pressure elevation to MAP > 80 mmHg
- CSF drainage
- Adequate hemoglobin levels (> 10 mg/dl)
- Glucocorticoids
Thank You!

- Carotid occlusion after CEA
- EHIT after GSV ablation
- Chylo US ascities
- Pulmonary embolus
- Acute renal failure
- Stroke
- Ureteral injury
- ETC
Watch for Signs of Postoperative Vena Cava Thrombosis after EVAR