Surgical treatment of vascular diseases

Faculty of Medicine, 4th year
Cardiology-angiology
2019
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Invasive treatment of arterial diseases - methods

• Percutaneous interventions

• Open surgical techniques
  - Arteriotomy
  - Embolectomy, thrombectomy, endarterectomy
  - Vascular reconstruction
    - vessel closure
    - bypass, interposition

• Hybrid techniques

• Graft materials
Arteriotomy and vessel closure

- Transverse arteriotomy and direct suture
- Longitudinal arteriotomy and patchplasty
Desobliteration

- Thrombectomy
- Embolectomy
- Endarterectomy
Embolectomy - thrombectomy
Embolectomy
Fogarty balloon catheter
Open endarterectomy—common femoral artery fixation of distal intima flap, PTFE patchplasty
Eversion endarterectomy

- Open endarterectomy, reimplantation
- Carotid surgery
Partially open endarterectomy

- Intima and media layers are removed with plaques to proximal and/or distal direction
- Ring stripper - w or w/o wire snare
Vessel closure - anastomosis

- End to end anastomosis

- End to side anastomosis
Vessel reconstruction

- vascular pathology is resected
- end to end anastomosis
- e.g. aneurysm

Interposition

- vascular pathology remains
- end to side anastomosis
- e.g. occlusive diseases

Bypass
Hybrid technique

- Endovascular intervention
- Open surgery

Optimal combination
Hybrid operating room

- Sterility
- Surgical equipments
- Fluoroscopy, DSA
- Endovascular devices
- Cone beam CT
Aneurysm reconstruction hybrid solution

- Via peripheral artery
- Seldinger technique
- Covered, self expandable stent implantation
Vascular graft materials – prosthesis

Dacron (polyethilene-terephthalate)
- the most frequently used prosthesis
- aorto-ilio-femoral reconstructions
- patchplasty
- Dacron prosthesis (1)
- Silver coated Dacron prosthesis (2)

PTFE (Polytetrafluoroethylene)
- aka Gore-tex, Teflon
- aorto-femoro-popliteal-crural reconstruction, artificial AV fistula
- Stretch on non-stretch
- Standard (1)
- Enforced with external rings (2)

Knitted or woven graft

Monolayer graft
Vascular graft materials: Auto–, allo– and xenogenic grafts

- Great saphenous vein - most common
- Femoral vein - septic surgery

Homograft (allograft) - septic surgery

Bovine pericardium patch

Porcine pericardium patch
Treatment of arterial diseases – anatomical regions

Presentations of Peripheral Arterial Diseases (PADs)

Aorta disease

Coronary Artery Disease (CAD)

Peripheral Arterial Diseases (PADs)

Atherosclerosis

Territories

Cerebrovascular diseases:
- Carotid artery disease
- Vertebral artery disease

Upper-Extremity Artery Disease (UEAD)

Mesenteric artery disease

Renal Artery Disease (RAD)

Lower-Extremity Artery Disease (LEAD)

Presentations

Stroke, Transient Ischaemic Attack (TIA), acute monocular blindness

Subclavian steal syndrome, pain on exertion, digital symptoms, acute ischaemia

Chronic Mesenteric Ischaemia (CMI)
Acute Mesenteric Ischaemia (AMI)

Hypertension, renal failure

Typical claudication, atypical symptoms, Chronic Limb-Threatening Ischaemia (CLTI), Acute Limb Ischaemia (ALI)
Acute arterial diseases

- Lower extremity ischemia
- Symptomatic carotid stenosis
- Aortic aneurysm rupture
Acute lower extremity ischemia (ALI)

- **Definition**: Significant disorder of the arterial blood supply of the lower extremity in 14 days
- **Etiology**: arterial or graft thrombosis, (cardiac) embolisation, dissection, trauma, popliteal-entrapment syndrome, phlegmasia cerulea dolens, etc.
- It may lead to irreversible tissue injury resulting AMPUTATION without ACUTE (in 6 hours) intervention
Symptoms of acute limb ischemia (ALI)

6 P-s
Pain
Pallor
Pulselessness
Paralysis
Paresthesia
Poikilothermia
## Rutherford classification of ALI

**TABLE 2**

### Clinical classification of acute limb ischemia

<table>
<thead>
<tr>
<th>Category</th>
<th>Prognosis</th>
<th>Findings</th>
<th>Doppler signals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sensory loss</td>
<td>Muscle weakness</td>
</tr>
<tr>
<td>I Viable</td>
<td>Not immediately threatened</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>II Threatened</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIa Marginally</td>
<td>Salvageable if promptly treated</td>
<td>Minimal (toes)</td>
<td>None</td>
</tr>
<tr>
<td>IIb Immediately</td>
<td>Salvageable with immediate revascularization</td>
<td>More than toes</td>
<td>Mild, moderate</td>
</tr>
<tr>
<td>III Irreversible</td>
<td>Major tissue loss or permanent nerve damage inevitable</td>
<td>Profound anesthesia</td>
<td>Profound paralysis</td>
</tr>
</tbody>
</table>

ALI – Acute treatment

- **Acute conservative treatment:** i.v. Heparin, pain management, oxygen

- **Individual decision making:**
  - **Open surgery**
    - Embolectomy
    - Thrombendarterectomy
    - Patchplasty
    - Bypass
  - **Percutaneous intervention**
    - Intraarterial selective catheter thrombolysis
    - Thrombus aspiration with catheter
    - PTA (percutan transluminal angioplasty)
    - Stent implantation
Algorithm of treating ALI

Acute limb ischaemia

Heparin and pain management

Viable, no neurological deficit (Rutherford I)

Initial work-up (DUS, CTA, DSA)

Revascularization within hours: (Thrombolysis/thrombectomy/bypass)

Viable with neurological deficit (Rutherford II)

Urgent* revascularization: Thrombectomy/bypass

Irreversible (Rutherford III)

Amputation

Underlying vascular lesion?

Present

Endovascular therapy and/or surgery

Absent*

Medical therapy and follow-up
Acute arterial diseases

- Lower extremity ischemia
- Symptomatic carotid stenosis
- Aortic aneurysm rupture
Carotid stenosis - symptom - urgency

- Asymptomatic (≥60% - elective surgery) (???)
- Symptomatic: TIA or stroke in 6 months
- Urgent surgery: symptoms in 2 weeks
  - **Stroke in evolution/recurrent TIA**
- Timing of acute surgery: 2-14 days
- Main factors influencing the indication of surgery:
  - **Degree of stenosis**
  - Plaque morphology (soft plaque, floating thrombus)
  - Intracerebral lesion (size of new ischemic lesion, ≥3 cm)
Time is money! - Time is brain!
Risk of stroke following TIA / stroke
Timing of CEA (endarterectomy) following TIA or stroke

- There is a 30 day-stroke reduction in symptomatic 70%-os ACI stenosis, if CEA is performed:
  - within 2 weeks: 30%
  - 2-4 weeks: 18%
  - 4-12 weeks: 11%

AHA guideline: CEA in 2 weeks, if there is no contraindication (Class IIa; Level of Evidence B)
Acute arterial diseases

- Lower extremity ischemia
- Symptomatic carotid stenosis
- Aortic aneurysm rupture
<table>
<thead>
<tr>
<th>Recommendation 4</th>
<th>Class</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal aortic aneurysm repair should not be performed in centres with a yearly case load &lt;20.</td>
<td>III B</td>
<td></td>
</tr>
</tbody>
</table>
## ESVS Guideline 2019

<table>
<thead>
<tr>
<th>Recommendation 63</th>
<th>Class</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>In haemodynamically stable patients with suspected ruptured abdominal aortic aneurysm, a prompt thoracoabdominal computed tomography angiography is recommended as the imaging modality of choice.</td>
<td>I</td>
<td>B</td>
</tr>
</tbody>
</table>
Ruptured abdominal aortic aneurysm (rAAA) – imaging - CTA

- Rupture into the peritoneal cavity
- Contained aortic rupture
- Retroperitoneal rupture (most common)
<table>
<thead>
<tr>
<th>Recommendation 65</th>
<th>Class</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptomatic non-ruptured abdominal aortic aneurysms should be considered for deferred urgent repair ideally under elective repair conditions.</td>
<td>Ila</td>
<td>B</td>
</tr>
<tr>
<td>Recommendation 66</td>
<td>Class</td>
<td>Level</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>In patients with ruptured abdominal aortic aneurysm, a policy of permissive hypotension, by restricting fluid resuscitation, is recommended in the conscious patient.</td>
<td>I</td>
<td>B</td>
</tr>
</tbody>
</table>
## Recommendation 70

<table>
<thead>
<tr>
<th>Class</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>B</td>
</tr>
</tbody>
</table>

Selection of patients with ruptured abdominal aortic aneurysm for palliation based entirely on scoring systems or solely on advanced age is not recommended.
ESVS Guideline 2019

<table>
<thead>
<tr>
<th>Recommendation 74</th>
<th>Class I</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>In patients with ruptured abdominal aortic aneurysm and suitable anatomy endovascular repair is recommended as a first option.</td>
<td>I</td>
<td>B</td>
</tr>
</tbody>
</table>
Elective AAA treatment

- Indication for elective AAA surgery: in men 5.5 cm, in women 5.0 cm

- Urgent surgery is indicated:
  - large size (above 8 cm in diameter)
  - saccular morphology
  - symptoms
  - signs of infection or inflammation
  - rapid growth
Treatment of chronic critical limb ischemia (CLTI) and diabetic foot

### Fontaine classification

<table>
<thead>
<tr>
<th>Stage</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>II</td>
<td>Claudication</td>
</tr>
<tr>
<td>IIIa</td>
<td>Pain-free, claudication walking (&gt;200) m</td>
</tr>
<tr>
<td>IIIb</td>
<td>Pain-free, claudication walking (&lt;200) m</td>
</tr>
<tr>
<td>III</td>
<td>Rest/nocturnal pain</td>
</tr>
<tr>
<td>IV</td>
<td>Necrosis/gangrene</td>
</tr>
</tbody>
</table>
## CLTI – WIfI - classification

<table>
<thead>
<tr>
<th>Wound (W)</th>
<th>Ischaemia (I)</th>
<th>fl (foot infection)</th>
<th>Estimate risk of amputation at 1 year for each combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-0</td>
<td>Ischaemia - 0</td>
<td>fl-0</td>
<td>VL</td>
</tr>
<tr>
<td>W-1</td>
<td>Ischaemia - 1</td>
<td>fl-1</td>
<td>VL</td>
</tr>
<tr>
<td>W-2</td>
<td>Ischaemia - 2</td>
<td>fl-2</td>
<td>L</td>
</tr>
<tr>
<td>W-3</td>
<td>Ischaemia - 3</td>
<td>fl-3</td>
<td>M</td>
</tr>
</tbody>
</table>

fl = foot infection; H = high-risk; L = low-risk; M = moderate risk; VL = very low risk; W = wound.

Localization of lower limb disease

In 78% the lesions are multilevel!

Below the knee (BTK) lesions are common (74%)

Mostly diffuse disease, long stenoses and occlusions (66% occlusion, 50% occlusion >10 cm)
Invasive treatment of CLTI

- Many patients are not suitable for open surgery (*No saphenous vein, severe comorbidities*).
- Endovascular techniques has less morbidity, is less invasive, can be repeated.
- High success rate of peripheral intervention with good indication.
- GSV is saved for later.
- Consider long term treatment!
Distal crural (ADP) bypass
Hybrid (endo+open) surgery

-Multilevel disease” may require complicated one stage surgery –
Alternative solution if percutaneous or open surgery is impossible or dangerous (TASC C, D lesions)
Surgical treatment of venous diseases

- Varicose veins: endovenous surgery, varicectomy
- Thrombophlebitis: GSV, LSV ligation
- Proximal (ilio-femoral) deep vein thrombosis
- Superior vena cava – PTA, stent
- Inferior vena cava:
  - Acute thrombosis: lysis, thrombus aspiratio, cava filter
  - Chronic stenosis/occlusion – PTA, stent
  - Tumor thrombus – cava thrombectomy
International Consensus
CEAP

Symptoms

C₀S
Heavy legs, pains in the legs, pruritus... But no clinical or palpable signs of venous disease
read more

C₁
Telangiectasia or reticular veins
read more

C₂
Visible and palpable varicose veins
read more

C₃
Venous oedema (without trophic changes)
read more

C₄
Trophic changes of venous origin: atrophie blanche, pigmented purpuric dermatitis, varicose eczema
read more

C₅
Healed ulcer with trophic changes
read more

C₆
Presence of one or more active venous leg ulcers, often accompanied by trophic changes
read more

Clinical signs

C₀ - C₆: description of the progression of the disease on the basis of the clinical signs present
C: clinical signs  E: etiological classification  A: anatomical distribution  P: pathophysiological dysfunction
**CLASSIFICATION**

(CEAP) classification from the American Venous Forum, last revised 2004.

<table>
<thead>
<tr>
<th>Clinical</th>
<th>Etiologic</th>
<th>Anatomic</th>
<th>Pathophysiologic</th>
</tr>
</thead>
<tbody>
<tr>
<td>C₀ - No visible or palpable signs of venous disease</td>
<td>Ec – Congenital</td>
<td>As - Superficial veins</td>
<td>Pr – Reflux</td>
</tr>
<tr>
<td>C₁ - Telangiectases or reticular veins</td>
<td>Ep – Primary</td>
<td>Ap - Perforator veins</td>
<td>Po – Obstruction</td>
</tr>
<tr>
<td>C₂ - Varicose veins</td>
<td>Es - Secondary (post-thrombotic)</td>
<td>Ad - Deep veins</td>
<td>Pr,o – Reflux and obstruction</td>
</tr>
<tr>
<td>C₃ - Edema</td>
<td>En – No venous cause identified</td>
<td>An - No venous location identified</td>
<td>Pn - No venous pathophysiology identifiable</td>
</tr>
<tr>
<td>C₄a – Pigmentation or eczema</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C₄b – Lipodermatosclerosis or atrophie blanche</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C₅ – Healed venous ulcer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C₆ – Active venous ulcer</td>
<td></td>
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</tbody>
</table>
Traditional varicectomy

- Crossectomy
- Stripping
- Perforant vein ligation
- Side branch removal
Contemporary varicose vein surgery

Thermal procedures

• Radiofrequency
  – monopolar/bipolar
• Laser
  – Different wavelength
  – linear/radial fiber
• Steam
• Cryostripping

Non-thermal procedures

• Foam sclerotherapy
• Mechanochemical ablation
• Glue (cyanoacrylate)
Radiofrequency catheter ablation

- RF energy affects collagen in vein wall
  - fast ablation
- Lumen decreases, vein closure and scarring
Treatment of incompetent perforant veins

- Laser ablation
- Radiofrequency ablation
- Foam sclerotherapy
- SEPS (endoscopic)
Treatment of acute spf. thrombophlebitis

- Ambulation
- Local Heparin cream
- Compression stockings
- Venotonic drugs
- NSAD
- **Ascending GSV or LSV thrombophlebitis require anticoagulation** (therapeutic LMWH) or high ligation

- **Not required**: bedrest, antibiotic (only in infection)
Angio Vac – system
Inferior vena cava hybrid surgery for thrombosis
Indication for cava filter implantation

- contraindication to therapeutic anticoagulation
- complication of anticoagulation
- failure of anticoagulation (pulmonary embolism)