Peripheral Vascular Disease

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Contents

- Arterial Disease
  - Aneurysm
  - Acute arterial occlusion
  - Chronic arterial occlusion
  - Others - Diabetes foot, Buerger's disease, Trauma
- Venous Disease
  - Varicose vein
  - Deep vein thrombosis
  - Chronic venous insufficiency
- Lymphatic Disease
  - Lymphedema
Arterial Substitutes

- **Autogenous Vessel** – saphenous vein, internal iliac artery
- **Biologic Graft**
- **Polymergraft**
  - Textile - Dacron, Teflon
  - PTFE, Gortex®

**PTEF (Gortex®)**

: 6 - 10 mm φ

Vascular Diagnostic Tools

- **Doppler ultrasonic flow detector**
- **Duplex scan**
  - Real-time B-mode scan + Doppler
- **Segmental blood pressure measurement**
  - ABI (Ankle/Brachial Index) , less than 0.5
- **Plethysmography : flow change**
- **Arteriography - Conventional and digital**
Doppler Scan

Normal flow

Turbulent flow

Duplex Scan

Real-time B-mode scan + Doppler
Doppler Scan

Arteriography

; Gold standard

Duplex scan : popular mode
Pre-operative Cardiologic evaluation

- History and P/E + ECG
  - No cardiac history
  - History (+)
    - Stable Sx
    - History(+)
      - Sx > 2
      - Thallium scan
  - No further evaluation
  - Echocardiogram
  - Coronary angiography

Aneurysm

- Definition: irreversible dilatation of artery
- True vs. false aneurysm
- According pathogenesis
  - Non-specific = atherosclerotic, aging process
  - Traumatic
  - Dissecting
  - Mycotic = infected
  - Anastomatic, almost false aneurysm
  - Aneurysm of childhood, rare
  - Aneurysm associated with pregnancy, high rupture rate and mortality
Abdominal Aortic Aneurysm

Asymptomatic and pulsatile mass
Radiologic study by U/S, C-T scan, MRI, Arteriography

Principles of Management

“More than 6 cm = High risk group”
“Slow growth of aneurysm: 0.45 cm/year”

The circumferential stress $\tau$ developed within an arterial wall is directly proportional to the transmural pressure $p$. Transmural pressure is the difference between the blood pressure within the artery and the surrounding tissue pressure. Wall stress is also directly related to the inside radius $r_i$ of the artery and is inversely proportional to its wall thickness $\delta$:

$$\tau = \frac{pl_i}{\delta}$$
Operation for Aortic Aneurysm

Aims: prevention of rupture, atheroembolization, occlusive disease, pressure or erosion

Indication: > 6cm in φ

Method: Graft insertion

Endovascular treatment for Aortic Aneurysm

Benefit: minimal invasive, simple, short stay day

Risk: endoleak, rupture

<table>
<thead>
<tr>
<th>Type of Endoleak</th>
<th>Description</th>
<th>Incidence in major series (%/2008–2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Attachment-sia leak</td>
<td>0.2–10.0%</td>
</tr>
<tr>
<td>A</td>
<td>Proximal end of prosthesis</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Distal end of prosthesis</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Non occluder</td>
<td></td>
</tr>
<tr>
<td>Type II</td>
<td>Branch leak</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Simple (only 1 patent branch)</td>
<td>7.8–29.4%</td>
</tr>
<tr>
<td>B</td>
<td>Complex (2 or more patient branches producing flow into the sac)</td>
<td></td>
</tr>
<tr>
<td>Type III</td>
<td>Device defect</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Junctional leak or modular disconnect</td>
<td>0.7–3.8%</td>
</tr>
<tr>
<td>B</td>
<td>Fabric disruption (mid-device hole)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minor (&lt; 2 mm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Major (&gt; 2 mm)</td>
<td></td>
</tr>
<tr>
<td>Type IV</td>
<td>Device wall fabric porosity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(&lt; 30 days after device placement)</td>
<td>--</td>
</tr>
</tbody>
</table>
Acute Arterial Occlusion

**Etiology = Emboli and thrombosis**

<table>
<thead>
<tr>
<th>Emboli</th>
<th>Cardiac origin</th>
<th>Arterial fibrillation</th>
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<tbody>
<tr>
<td></td>
<td>Peripheral</td>
<td>Rheumatic heart dis.</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>Myocardial infarction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Atherosclerotic lesion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aneurysm</td>
</tr>
<tr>
<td>Thrombosis</td>
<td>Narrow atherosclerotic segment</td>
<td>+ flow disturbance</td>
</tr>
<tr>
<td></td>
<td>Drug abuse</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intraplaque hemorrhage</td>
<td></td>
</tr>
</tbody>
</table>

Related condition: Smoking, Medication, Hypertension, Diabetes, Previous operation, Hyperlipidemia

Common Site of Emboli Obstruction

Bifurcation site: aorto-iliac, iliac, femoral
Acute Arterial Occlusion - Symptoms

- Pain
- Paresthesia ➔ Paralysis: most critical/ ominous sign
- Pulseless: Good indicator of obstruction site
- Pallor
- Poikilothermia
  = coolness

One joint below

Acute Arterial Occlusion - Treatment

“Reestablish blood flow and Prevent propagation of thrombotic process in distal artery”

1. Heparin infusion - 300 unit/kg, 60-70 unit/kg/hr
2. Embolectomy technique - Fogarty balloon catheter
   Arteriotomy
   Bypass surgery
3. Postoperative anticoagulation - oral anticoagulant

cf) Fibrinolytic therapy - TPA, Streptokinase, Urokinase
   success rate = 80-90%, but high recurrent rate
Acute Arterial Occlusion - Treatment

Forgaty embolectomy catheter

Complication: rupture, perforation, intimal injury, fragment and emboli

Chronic Arterial Occlusive disease

“Inadequate to meet the metabolic demand of the end organ”

Intermittent Claudication
1. Pain during exercise
2. Large muscle involve
3. Gradual disappears
4. Repetitive

Atrophy musculature
Decreased hair
Hypertrophic nail

Critical Ischemia
1. Ischemic rest pain - positional dependency
2. Non-healing ulcer
3. Frank gangrene
Aortoiliac Occlusive disease

Subclassification according the anatomical distribution
Leriche syndrome = claudication + impotence + pulseless

<table>
<thead>
<tr>
<th>Type I (10%)</th>
<th>Type II (25%)</th>
<th>Type III (65%)</th>
</tr>
</thead>
</table>

Chronic Arterial Occlusive disease

Anatomical Position of Occlusion

<table>
<thead>
<tr>
<th>Aortoiliac occlusive</th>
<th>Infra-inguinal occlusive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buttock, thigh &gt; calf Importance Limb loss due to emboli</td>
<td>Calf claudication Rest pain, ulcer, gangrene Limb loss due to atherosclerosis</td>
</tr>
<tr>
<td>Aortofemoral bypass with Dacron Endarterectomy PTA Extra-anatomic bypass</td>
<td>Non-operative management Bypass procedure with PTFE Endarterectomy PTA</td>
</tr>
</tbody>
</table>
Aortoiliac Occlusive disease - Treatment

**Aortobifemoral bypass ; Dacron > PTFE**

Extra-anatomic bypass ; Axillofemoral bypass

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**Aortoiliac Occlusive disease - Treatment**

Endarterectomy

Endovascular procedure ; PTA
Infrainguinal Occlusive disease

Non-operative management
- cessation of tobacco
- regular exercise
- vasodilator
- phentolamine

Bypass operation
- femoropopliteal
- femorotibial
- use saphenous vein or PTFE (Gortex)

cf) Three year patency rate

<table>
<thead>
<tr>
<th>Bypass</th>
<th>Saphenous v.</th>
<th>PTFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-P</td>
<td>76 %</td>
<td>54 %</td>
</tr>
<tr>
<td>F-T</td>
<td>49 %</td>
<td>12 %</td>
</tr>
</tbody>
</table>

Diabetic Foot

- Relative Risk = x 50 than non-diabetes
- Main pathology: typical large-vessel atherosclerosis + microangiopathy
- Involve site: distal profunda femoral, distal popliteal, distal tibial, digital artery
- Clinical manifestation: Ulcer and gangrene with infection
- Treatment: Control of hyperglycemia
  - Local wound care
  - Avoidance of trauma
  - Use of fitted shoes
  - Revasculation if arterial occlusion (+)
  - Limited amputation
  - Prostaglandin (PGE₁) / prostacyclin (PGI)
**Buerger’s disease**
= Thromboangiitis obliterans

*Inflammatory vasculopathy*

*of medium-sized and small artery*

*in young male smoker*

**Histopathology:** panangitis involving all layer,
segmental pattern
contracted artery with fibrosis ➔ *ischemia*

**Clinical manifestation:**
rest pain and gangrene without claudication
recurrent superficial thrombophlebitis

**Treatment:**
Cessation of tobacco
pain control – analgesics / Sympathectomy
Amputation

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**Arterial Injury**

**Hard Signs**
pulsatile hematoma
pulsatile bleeding
bruit or thrill
ischemia

**Treatment**
control of hemorrhage
Normal Venous Anatomy of Leg

Superficial Vein

Deep Vein

Saphenofemoral junction

Saphenopopliteal junction
Normal Venous Physiology of Leg

Ambulatory pressure: 20-40 mmHg

- **Obstruction**
- **Post-thrombotic**
- **Varicose vein**
- **Normal**

Varicose vein

- Elongated, dilated, tortuous change of vein
- **Incompetence of one-way valve**
  - Back flow during ambulation

- Clinical manifestation
  - Dull, heavy, bursting ache
  - Swelling and heaviness of leg
  - Venous ulcer
  - Superficial thrombophlebitis

- Diagnosis
  - Trendelenburg / Perthe’s test
  - Duplex scan / venogram
Venogram and Doppler

Trendelenburg Tourniquet Test

1. Evacuation of varicose vein
2. Apply tourniquet at sapheno-femoral junction
3. 1st. Step : Standing position
4. 2nd. Step : Decompression of tourniquet

Significance : Incompetence of sapheno-femoral junction and/or perforating vein
**Trendelenburg Tourniquet Test**

- Incompetence of sapheno-femoral junction
- Incompetence of perforating vein
- Incompetence of sapheno-femoral junction and perforating vein

**Perthes test**

- ? Deep Vein Obstruction
- No interval change ➔ incompetent perforator
- More prominent, pain(+) ➔ deep vein obstruction

Elastic wrap ➔ Exercise ➔ Ache
Varicose vein - Treatment

- **Conservative**: “Sx improvement but not cure”
  - elastic support stocking
  - avoid long period standing, leg elevation
- **Sclerotherapy**
  - STD injection with long bandaging time
  - Ix: incompetent perforators or focal varicose vein
- **Surgery**
  - Flush ligation - disconnect the deep and superficial vein
  - Stripping - removal all varicose vein
  - Phlebectomy – removal focal varicose vein

cf) pregnancy and varicose vein
resolved within 3 - 4 month after delivery

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**Phlebectomy**

**Stripping**
Deep Vein Thrombosis

Pathogenesis of thrombosis

- **Stasis**
- **Endothelial injury**
- **Hypercoagulability**

**Healing**

50%

**Chronic venous insufficiency**

Clinical Manifestation
- Phlegmasia alba dolens (mil leg): pain, pitting edema
- Phlegmasia cerulea dolens: arterial ischemia

Diagnosis
- Radioactive-labeled fibrinogen
- Duplex scan: routine check-up
- Impedance Plethysmography
- Venography: most accurate

Treatment
- **Prophylaxis**: early ambulation, low-dose heparin, intermittent pneumatic leg compression
- **Medical**: anticoagulation (heparin ➔ caumadin)
- **Surgical**: Operative thrombectomy, Vena Cava interruption
Chronic Venous Insufficiency

Venous deformity
- Venous pressure > 100 mmHg
- Fluid and protein loss into the tissue

Clinical manifestation:
- Brawny edema,
- Pigmentation,
- Skin atrophy,
- Skin ulcer, necrosis
- Venous claudication

Diagnosis:
- Trendelenburg test
- Perthes test
- Ochsner-Mahorner test

Treatment

Supportive therapy
- Stocking support, elevation of leg, avoidance of sitting
- Skin care and patient education

Operative
- Perforator vein ligation
- Venous reconstruction
- Valvuloplasty
- Vein segmental transfer
- Autologous vein transplantation

"Unsatisfactory"
**Lymphedema**

**Classification of Lymphedema**

- **Primary lymphedema**
  - Primary hypoplastic
  - Primary hyperplastic - megalymphatics

- **Secondary lymphedema**
  - Malignancy - direct or post-operative
  - Radiation
  - Trauma or surgical excision
  - Inflammation or parasite infection
  - Paralysis

**Visualization of Lymphatics**

1. Dye injection
2. Radiologic lymphangiogram - lipiodol injection
3. Lymphoscintiscan (radionuclide lymphatic clearance) - obstruction site?

A: Normal  
B: Hypoplastic  
C: Hyperplastic  
D: Secondary
Lymphedema - Treatment

- **Conservative Management**
  - graduated compression support stocking
  - leg elevation
  - sequential pneumatic compression

- **Surgical management**
  - Excision: excision of lymphedematous tissue
    - Charles operation
    - Kinmonth’s modification of Homan’s procedure
  - Physiologic: provide or enhance lymph drainage
    - Thompson principles by small bowel/omentum
    - direct lymphovenous shunt

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Pneumatic stocking, anti-embolic stocking

<table>
<thead>
<tr>
<th>Type</th>
<th>Pressure</th>
<th>22mmHg</th>
<th>25mmHg</th>
<th>30mmHg</th>
<th>35mmHg</th>
<th>임원예방용 (18mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under-Knee</td>
<td>18</td>
<td>18 G100</td>
<td>200</td>
<td>201</td>
<td>300</td>
<td>453</td>
</tr>
<tr>
<td>(non anti-slip)</td>
<td></td>
<td>W100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thigh (anti-slip)</td>
<td>8</td>
<td>204</td>
<td>202</td>
<td>302</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thigh (with anti-slip)</td>
<td>8</td>
<td>205</td>
<td>212</td>
<td>463–S</td>
<td>468–M</td>
<td>473–L</td>
</tr>
<tr>
<td>Pantyhose</td>
<td>25</td>
<td>203</td>
<td></td>
<td>307</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternity Pantyhose</td>
<td>146</td>
<td>206</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arm Sleeve</td>
<td>122</td>
<td>122 (65–82mmHg)</td>
<td>222 (38–46mmHg)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Pneumatic stocking, anti-embolic stocking
AVF for hemodialysis

ESRD → Renal replacement therapy

Kidney transplantation

Dialysis

Hemodialysis

Peritoneal dialysis

External arteriovenous shunt: infection, exposure
Internal arteriovenous fistula
Central vein catheter

Flow rate: > 200 ml/min

<table>
<thead>
<tr>
<th>Average Blood Flow</th>
<th>Average Arterial Pressure</th>
<th>Average Venous Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graft</td>
<td>321 ml/min</td>
<td>188 mm Hg</td>
</tr>
<tr>
<td>Fistula</td>
<td>274 ml/min</td>
<td>194 mm Hg</td>
</tr>
<tr>
<td>Permacath</td>
<td>263 ml/min</td>
<td>203 mm Hg</td>
</tr>
<tr>
<td>Tesio catheter</td>
<td>230 ml/min</td>
<td>197 mm Hg</td>
</tr>
</tbody>
</table>
AVF for hemodialysis

Permanent catheter - double lumen

AVF Strategies - from distal

1. Non-dominant radiocephalic fistula (RCF)
2. Non-dominant brachiocephalic fistula (BCF)
3. Dominant radiocephalic fistula (RCF)
4. Dominant brachiocephalic fistula (BCF)
5. Brachiobrachial fistula with PTFE (polytetrafluoroethylene)
6. Axilloaxillary fistula with PTFE
7. Femoro-femoral fistula with PTFE
8. Permanent double lumen catheter insertion
AVF for hemodialysis

- Autogenous vein
- Brachio-cephalic
- Radio-cephalic
- Snuff-Box

- Brachio-basilic antecubital
- Ulnar-basilic

Radiocephalic fistula  Brachiocephalic fistula
AVF for hemodialysis

Artificial vein - PTFE

Brachio-brachial

There was no guideline for patency rate (Guideline 38)

<table>
<thead>
<tr>
<th>Study Year</th>
<th>Total Number</th>
<th>Type of Vein</th>
<th>Vein Location</th>
<th>Fistula Type</th>
<th>Patency Rate (1yr)</th>
<th>Patency Rate (2yr)</th>
<th>Patency Rate (3yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>n/a</td>
<td>CEPHALIC VEIN</td>
<td>BICEPS ARTERY</td>
<td>Brachial</td>
<td>75.5%</td>
<td>53.3%</td>
<td>61.1%</td>
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<tr>
<td>2003</td>
<td>n/a</td>
<td>CEPHALIC VEIN</td>
<td>BICEPS ARTERY</td>
<td>Brachial</td>
<td>75.5%</td>
<td>53.3%</td>
<td>61.1%</td>
</tr>
<tr>
<td>2001</td>
<td>n/a</td>
<td>CEPHALIC VEIN</td>
<td>BICEPS ARTERY</td>
<td>Brachial</td>
<td>75.5%</td>
<td>53.3%</td>
<td>61.1%</td>
</tr>
<tr>
<td>2001</td>
<td>n/a</td>
<td>CEPHALIC VEIN</td>
<td>BICEPS ARTERY</td>
<td>Brachial</td>
<td>75.5%</td>
<td>53.3%</td>
<td>61.1%</td>
</tr>
</tbody>
</table>

**Note:** RRF: radiocephalic fistula, SRF: Brachiocephalic fistula.
Patient Education

ESRD → Renal replacement therapy

Kidney transplantation

Dialysis

Hemodialysis

Peritoneal dialysis

Maintain Vascular Access

Proper Preoperative Operation evaluation

Postoperative management

Patient education

Nurse management
Thank You

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