FISTULA ANATOMY

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fistula n. L. shepherd’s pipe, tube, water pipe
TYPES OF FISTULAS

Native Fistula
- Cephalic-based
  - Cimino-Brescia
  - Brachiocephalic
- Basilic-based
  - Radiobasilic
  - Brachiobasilic ± transposed
- Saphenous-based
  - Transposed to forearm
    - Loop, straight
    - Thigh
- Superficial Femoral Vein

Grafts
- Loop vs straight
- Forearm, arm vs thigh
- “Necklace”
  - Axillo-axillary
ARTERIES
BRACHIAL 4-7mm
RADIAL
2-5 mm
≥ 3mm
CEPHALIC
≥ 2.5-3mm
HIGH BRACHIAL BIFURCATION

- 5-10%
- Axillary 23%
- Upper 1/3 brachial 65.4%
- Middle 1/3 brachial 7.7%
- Lower 1/3 brachial 3.9%
SUPERFICIAL RADIAL ARTERY

- 0.5%
- Normal origin but crosses over the tendons at snuffbox
- Normal course into hand
Wide patent upper extremity arteries – normal arterial waveforms

- There is a high bifurcation of the radial artery from 7cm above the elbow crease and this is small in the upper arm, normalising in the lower arm.
- The brachial artery has a good calibre at the elbow crease with no significant calibre evident. This flow into the ulnar artery which is small in the forearm.
- The radial artery is also small in the forearm but no significant calibre was seen.

Patent deep veins of the upper extremity – normal phasic venous flow

- Moderate calibre basilic vein in the upper arm and small in the forearm.
- The cephalic vein is reasonable in the upper arm however small below the elbow crease.

FBI

<table>
<thead>
<tr>
<th></th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachial (cystolic reflux)</td>
<td>122</td>
<td>124</td>
</tr>
<tr>
<td>Finger PDA</td>
<td>129</td>
<td>126</td>
</tr>
<tr>
<td>Pressure Index (PBI)</td>
<td>1.01</td>
<td>1.61</td>
</tr>
</tbody>
</table>

- Finger pressures within normal limits bilaterally. On the right the pressures reduce to 100mmHg with the radial artery compressed. On the left the pressure remains, unaffected.
- On the right Ultrasound Allen’s test is positive with no flow in the palmar arch with compression of the radial artery.
CEPHALIC VEIN
CUBITAL FOSSA
BASILIC VEIN
BASILIC VEIN
Wide patent upper extremity arteries – normal arterial waveforms and no significant calcification.
- Good calibre distal brachial A which continues as the ulnar artery.
- There is a high bifurcation of the radial artery
- Ultrasound Allen's test was negative with flow in the palmar arch with compression of the radial artery this indicates adequate flow through the superficial arch of the palmar arteries.

- Patent deep veins of the upper extremity – normal phasic venous flow
  - Good calibre cephalic V upper arm; small area of thrombophlebitis in left cephalic V.
  - Good calibre medial cephalic vein however it courses dorsally; moderate upper arm basilic vein.
FISTULA

USABLE SEGMENT

4a Outflow CV arm (to SCV)
4b Outflow elbow perforator (to brachial vein)
3 Useable segment

CV Distal "swing vein"

2 Anastomosis

1 Inflow radial artery

4c Outflow median cubital vein to basilic vein

5 Central veins (to R atrium)

Basilic vein

Outflow radial artery
RETROGRADE or UPSTREAM

ANTEGRADE or DOWNSTREAM
PROXIMAL

DISTAL
THIGH VEIN FISTULA

**LEFT LEG**

**COMMENTS**
- Widely patent lower extremity arteries with no plaque formation seen and excellent triphasic flow.
- The deep veins of the lower extremity were widely patent with phasic flow seen.
- The GSV is patent throughout with a good thigh calibre.
**HOW TO DEFINE STENOSIS**

**Diagram:**
- **Vp:** Normal peripheral artery flow.
- **Vs:** Stenotic peripheral artery flow with increased velocity and turbulence.

**Table: Duplex Classification of Peripheral Artery Occlusive Disease**

<table>
<thead>
<tr>
<th>Stenosis Category</th>
<th>Peak Systolic Velocity (cm/sec)</th>
<th>Velocity Ratio ((V_s/V_p))</th>
<th>Distal Artery Spectral Waveform</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20%</td>
<td>&lt;150</td>
<td>&lt;1.5</td>
<td>Triphasic, normal PSV</td>
</tr>
<tr>
<td>20%-49%</td>
<td>150-200</td>
<td>1.5-2</td>
<td>Triphasic, normal PSV</td>
</tr>
<tr>
<td>50%-75%</td>
<td>200-300</td>
<td>2-4</td>
<td>Monophasic, reduced PSV</td>
</tr>
<tr>
<td>&gt;75%</td>
<td>&gt;300 EDV &gt; 100</td>
<td>&gt;4</td>
<td>Damped, monophasic, reduced PSV</td>
</tr>
<tr>
<td>Occlusion</td>
<td>No flow, length of occlusion estimated by distance from exit and reentry collaterals</td>
<td></td>
<td>Damped, monophasic reduced PSV</td>
</tr>
</tbody>
</table>
INFLOW

JUXTA-ANASTOMOTIC STENOSIS

**Arterial Inflow**
- Subclavian A: 144 cm/sec
- Axillary A: 93 cm/sec
- Brachial: 137 cm/sec
- Ulnar: 84 cm/sec
- Radial Distal: -380 cm/sec

- Widely patent upper extremity arteries
- Ultrasound arterial flow volume is well within normal limits at 787 ml/min
- Widely patent arterial anastomosis

**Venous Outflow**
- There are two narrowed segments just beyond the anastomosis and 2.5 cm above the anastomosis forming 50-75% stenosis.
- A further narrowing segment over a 2 cm segment from anastomosis also forming a 50-75% stenosis.
- The venous ultrasound flow volume has remained within normal limits 637 ml/min.
- Dominant flow via still via the basilic vein however the cephalic vein is patent.
- Small hematoma noted at the diastension to the basilic vein.
INFLOW STENOSIS

Venous return 240 mL @ +80 mmHg

Arterial extraction 240 mL/min @ -200 mmHg

Stenosis diameter
1 mm

Jan Swinnen, 2011; 14(1):17-23
VALVES CAN BE EVIL
OUTFLOW STENOSIS

Venous return 300 mL/min @ +180 mmHg

Arterial extraction 300 mL/min @ -80 mmHg

Mean arterial pressure 80 mmHg

Jan Swinnen, 2011; 14(1):17-23
HOW DO YOU TREAT STENOSES

SURGERY VS ENDOTHERAPY?
FISTULOGRAM

- Day case
- No fasting
- Don’t cease drugs
- Ultrasound
- 4-7 Fr sheaths
- 0.018 platform
- 0.014 platform
FISTULOGRAM

- Day case
- No fasting
- Don’t cease drugs
- Ultrasound
- 4-7 Fr sheaths
- 0.018 platform
- 0.014 platform

BALLOON VENOPLASTY
CUTTING BALLOONS
DRUG ELUTION
COVERED STENTS
**VENOUS OUTFLOW**

- The swing vein is adequate at 3.9mm-4.4mm.
- The fistula is widely patent with the dominant runoff remaining via the cephalic vein.
  - The cephalic vein has remained at 5.8mm, with a slight increase in the flow volume.
  - Low flow tributary veins remain.

**Anastomosis** Now widely patent

- Swing vein
  - Anastomosis
  - Flow Volume: 624ml/min
    - 14mm Deep
    - 6.5mm Deep
    - 8mm Deep
    - 6mm Deep
    - 11mm Deep
    - 14mm Deep