Arterio-venous fistula preparation
overview

- Natural history of AVF
- Understanding of cause of fistula failures
- Patient selection
- Duplex USG evaluation
- Site selection
- Algorithm
- conclusion
Natural history of AV fistula

Following an iatrogenic creation of an arterio-venous anastomosis

- the recipient vein will undergo certain ‘predictable’ changes which will make them

  - suitable for repeated puncture
  - withstand the stress of high volume flow
  - withstand high pressure flow
  - creates a high venous return (preload) to the heart
Changes that can appreciated in the recipient vein
- Increase in calibre
- Increase in the thickness of the tunica media hence wall thickness
  - Both create a condition of ‘Arterialisation of the vein’
- Elongates in length
  - becoming more tortuous
- Endothelial lining changes to withstand high flow/high pressure volume
Changes that can appreciated in the donor artery

- Increase in calibre
  - In order to support the increase in arterial shunting over time
- No gross increase in the thickness of the tunica media hence wall thickness
- Reduces peripheral arterial resistance / capillary beds
  - in order to allow significant blood flow to reach the distal vascular beds
Natural history of AV fistula

Changes that can appreciated in the donor artery

- Increase in flow
  - In order to support the increase in arterial shunting over time
  - eg: radial artery flow changes
    - Normal flow: 21-30 ml/min
    - Matured RCF: 650-800 ml/min
  - eg: brachial artery flow changes
    - Normal flow: 85-100 ml/min
    - Immediately after fistula creation: 400-500 ml/min
    - 6-8 weeks after fistula creation: 700-1000 ml/min
    - (10X increase in flow volume)
Changes that can appreciated in the donor artery

Flow into the outflow veins not only will come from the inflow artery in antegrade manner but also a smaller percentage from retrograde manner from distal arterial segment
Why fistula fail?

- Poor vein maturation
- Non maturation
- Poor flow volume studies
- ‘Too deep’ to puncture
- ‘Too tortuous’
  - Limited ‘straight’ segment for needling
- Venous hypertension in the limb
- High output cardiac failure
- Distal ‘Steal syndrome’
- Infection
- Bleeding
  - requiring fistula ligation in order to save the life
- Thrombosis
  - Immediate…technical
  - late
When fistula fail?

- Early failures
- Late failures
When fistula fail?

- Early failures
  - Inflow issues
  - Outflow issues
When fistula fail?

- Early failures
  - Inflow issues
  - TECHNICAL
    - Pre-existing arterial problem
      - Anatomically small donor artery selected
      - Advance artherosclerosis in the donor artery selected
    - Acquired arterial problem
      - Arterial anastomotic stenosis
        - Too small artery to start with
        - Accidental / inadvertent suturing of the posterior wall at ‘heel’ and ‘toe’ areas of the anastomosis
      - Juxta anastomotic stenosis
        - Both are technical issues
When fistula fail?

- Early failures
  - Outflow issues
    - Anatomically small recipient vein
    - mid ‘segment’ stenosis
    - Juxta anastomotic stenosis / proximal vein stenosis
      - Kink / anastomosis under tension / twisting/torque
    - Fibrotic vein
    - Accessory vein (parallel veins / side branches)
    - Anastomotic dehiscence
      - Pseudoaneurysm formation
      - technical
  - Central vein critical stenosis / occlusion
When fistula fail?

- Early failures
- Late failures
When fistula fail?

- Late failures
  - Venous stenosis
    - due to repeated puncture / wall damage
  - Thrombosis
  - Infection
  - Pseudoaneurysm formation
    - +/- haemorrhage
  - Acquired arterial lesion
    - Arterosclerotic plaque causing luminal stenosis at inflow site
  - Excessive flow
    - ‘giant fistula’ – flow in excess of 3-4L/min
    - High output cardiac failure
    - Distal ischemia
  - Aneurysm formation
What to assess prior to AVF creation?

- History
- Physical examination
- Duplex USG
- +/- venography
Patient selection

- GFR < 15-29 ml/min/1.73m² (CKD stage 4)
- 5 stages of CKD, stage 5 is ESRF stage
- Age
- Premorbid conditions
- Dominant limb
## History

<table>
<thead>
<tr>
<th>Factors</th>
<th>The issue’</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>Vascular damage, multiple admissions for uncontrolled DM</td>
</tr>
<tr>
<td>Central vein catheterisation</td>
<td>Iatrogenic central vein stenosis</td>
</tr>
<tr>
<td>Previous arterial or venous catheterisation</td>
<td>Conduit damage</td>
</tr>
<tr>
<td>Previous vascular access</td>
<td>Need to know why previous fistula fails (recurring cause ?), location will affect future fistula placement</td>
</tr>
<tr>
<td>History of congestive cardiomyopathy</td>
<td>Poor fistula maturation, altered haemodynamics may trigger high output cardiac failure</td>
</tr>
<tr>
<td>History of cardiac valves procedure / prosthesis</td>
<td>May need to be considered to avoid prosthesis infection. AVF preferred over catheter / AVG</td>
</tr>
<tr>
<td>History of pacemaker use</td>
<td>Central vein stenosis</td>
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</table>
# History

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<tr>
<th>Factors</th>
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<tr>
<td>Prev. trauma, surgery over the ipsilateral arm/neck/chest</td>
<td>Think of vein stenosis, consider other side if possible</td>
</tr>
<tr>
<td>Neck / chest irradiation</td>
<td>Think of vein stenosis, consider other side if possible</td>
</tr>
<tr>
<td>Use of anticoagulants / antiplatelets use / haemophiliacs</td>
<td>Self explanatory. Aspirin…non issue</td>
</tr>
<tr>
<td>h/o cancer, advance coronary disease, disease with limited life expectancy</td>
<td>Why not catheters?</td>
</tr>
<tr>
<td>Anticipating kidney transplant in <strong>near</strong> future</td>
<td>Why not catheters?</td>
</tr>
<tr>
<td>SLE / RA / connective tissue diseases</td>
<td>Small, easily thrombosed vessels, refer to tertiary center with better technical skills so as not to damage possible AVF option</td>
</tr>
</tbody>
</table>
### Examination

<table>
<thead>
<tr>
<th>What to look for?</th>
<th>issue</th>
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<tbody>
<tr>
<td>Arterial tree</td>
<td>Do not attempt if no palpable distal pulse or feeble pulse</td>
</tr>
<tr>
<td>Peripheral pulses</td>
<td>Pulse volume</td>
</tr>
<tr>
<td>State of arterial wall</td>
<td>‘rock’ hard arteries- poor candidate as inflow arteries</td>
</tr>
<tr>
<td>Allen test</td>
<td>Poor collateralization result-&gt; do not attempt distal fistula</td>
</tr>
<tr>
<td>Bilateral arm BP</td>
<td>Use the higher of the 2 if BP difference &gt; 20 mm Hg</td>
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Non palpable pulse in thick forearm / swollen limb -> supplement with handheld doppler evaluation for systolic pressure evaluation
## Examination

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<th>What to look for?</th>
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<tbody>
<tr>
<td>Venous system</td>
<td>Tortuous vein not suitable for puncture (with or without tourniquet)</td>
</tr>
<tr>
<td>Visible vein</td>
<td>‘Missing segment’</td>
</tr>
<tr>
<td>Straight vs tortuous</td>
<td>If on-tourniquet... missing segment of dilated veins noted... choose other outflow vein</td>
</tr>
<tr>
<td>(with or without tourniquet)</td>
<td></td>
</tr>
<tr>
<td>Limb oedema</td>
<td>Limb not suitable for vascular access creation</td>
</tr>
<tr>
<td>Arm size</td>
<td>Larger arm (if not dominant arm) may denote underlying venous congestion</td>
</tr>
<tr>
<td>Collateral veins</td>
<td>Possibility of central vein obstruction / stenosis</td>
</tr>
<tr>
<td>Multiple visible cutaneous veins</td>
<td></td>
</tr>
</tbody>
</table>
Post puncture staining

Missing segment

Post phlebitic staining at IV line insertion sites

Multiple visible superficial veins
# Examination

<table>
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<th>What to look for</th>
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<tbody>
<tr>
<td>Neck</td>
<td></td>
</tr>
<tr>
<td>Puncture site scar</td>
<td>Suspect central vein stenosis / occlusion</td>
</tr>
<tr>
<td>Collateral veins</td>
<td>Possibility of central vein obstruction / stenosis</td>
</tr>
<tr>
<td>Multiple visible cutaneous veins</td>
<td></td>
</tr>
<tr>
<td>operative scar neck, upper chest</td>
<td>Possibility of vein damage</td>
</tr>
<tr>
<td>Indurated skin of previous irradiation</td>
<td>Possibility of vein damage</td>
</tr>
<tr>
<td>Marks of trauma / bony fractures</td>
<td>Possibility of vein damage</td>
</tr>
<tr>
<td>Clavicular #</td>
<td></td>
</tr>
</tbody>
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## Examination

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<tr>
<td><strong>Limb</strong></td>
<td>Paralysed / post stroke limb</td>
<td>Consider contralateral limb</td>
</tr>
<tr>
<td></td>
<td>Marks of trauma / eschar / fracture</td>
<td>Underlying vein already damage</td>
</tr>
<tr>
<td></td>
<td>Post phlebitic staining along vein length</td>
<td>Consider other outflow veins</td>
</tr>
<tr>
<td><strong>Cardiovascular system</strong></td>
<td>Raised JVP</td>
<td>Possible valvular damage or CCF</td>
</tr>
<tr>
<td></td>
<td>Other signs of cardiac failure</td>
<td>May not be suitable for AVF / AVG…consider catheter</td>
</tr>
</tbody>
</table>
Duplex ultrasound evaluation

- Show real time state of arterial and venous wall
- Few criterias need to be considered
- Formal training in ultrasound?
- Especially important in ‘re-do’ cases
Duplex ultrasound evaluation

be familiar with a normal superficial venous anatomy
Duplex ultrasound evaluation

- Venous duplex
  - Vein size
    - 2.0-2.5 mm at a minimum
  - Vein continuity
    - Should have adequate length for puncture once matured
Duplex ultrasound evaluation

- Venous duplex
  - Vein stenotic segment
    - May require arm tourniquet to see the segment if not obvious
    - Pay special attention to segments where regular sites of venepuncture / blood taking and IV line locations
Duplex ultrasound evaluation

- Venous duplex
- Thickened segment
- Intraluminal echogenicity
  - Recanalised thrombosed vein... good
Duplex ultrasound evaluation

- Venous duplex
  - Depth of vein
    - > 6mm depth or thick SC fat, be prepared for secondary ‘lift’ procedure
  - Distance to possible arterial inflow
    - > 2 cm apart, careful during mobilization to avoid kink/twist/sharp angulation causing juxta anastomotic stenosis and non maturation
Duplex ultrasound evaluation

- Venous duplex
  - Multiple chest vein visible on B-mode USG
  - Neck vein
    - Especially multiple puncture neck,
    - Scarred neck looking for possible IJV thrombosis/occlusion as marker of ipsilateral central vein stenosis/occlusion
Duplex ultrasound evaluation

- Arterial duplex
  - Artery size
    - Nothing less than 1.6 mm artery (espc RCF)
  - Arterial wall expansile pulsation
  - B-mode USG
- Wall echogenicity
  - Bits of posterior acoustic shadowing vs whole length shadowing
Duplex ultrasound evaluation

- Arterial duplex
  - A- fairly normal
  - B- echogenic wall
  - C- stenotic artery
Duplex ultrasound evaluation

- Arterial duplex
  - Posterior acoustic shadowing
  - Doppler signal of the arterial flow
    - Triphasic…nothing less
  - ‘If possible’…duplex of whole length of donor artery till location of anastomosis looking for stenosis / turbulence flow / occlusive segment
Venography

Indications

- ‘Re-dos’
- Multiple failed AVF
- Visible chest / shoulder veins
- h/o ‘non puncturable’ neck veins
- Venous hypertension changes in UL
“AVF commandments”

I/ Distal over proximal

II/ Non dominant over dominant UL

III/ Superficial over deep (outflow) vein

IV/ Native vein over graft

V/ Upper Limb over lower limb
“In the end”

- Reconfirm the indication for vascular access
- Clinical history
- Perform physical examination
  - By which time should have an idea
    - on possible limb and site/arterial inflow location
    - whether to avoid AVF/AVG placement…..catheter instead
- Duplex USG evaluation
  - Confirm previous evaluations
- +/- venography +/- venoplasty/stenting
- Follow the AVF commandments
- DECIDE on best fistula placement for the individual
Thank you for your attention