How to Maintain Patency of Vascular Access?

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Objectives

• Case presentation

• Describe reasons for AVF and AVG failure

• Describe strategies of maintaining access patency
Case Presentation

- A 44 year old male has a left upper arm AV fistula for hemodialysis placed 3 months ago
- But, he is unable to use it consistently, using a catheter for dialysis

Failure To Mature-
Occurs in 20-60% of AV Fistula
Failure To Mature-
How To Evaluate And Intervene

AV access creation

Physical Examination by a skilled operator at appropriate Interval

Identification of early access failure

Angiography

Intervention

Case Presentation

Examination shows increased pulsation of the outflow vein and accentuation of systolic bruit.
Case Presentation

- Left arm fistulogram shows two 50% stenotic lesions about 3 and 4 inches proximal to AV anastomosis-angioplasty is done
- Large collateral vein with retrograde blood flow between the two stenotic areas- becomes less prominent after angioplasty
- AVF is successfully used
- Catheter is removed
AVF and AVG Failure Are Common

- Eventually all accesses fail – No lifetime warranty
- New AVF – Primary failure rate is high
- Established AV access – AVF or AVG
  - Recurrent stenosis ➞ Poor blood flows
  - Thrombosis ➞ Access loss
Primary Patency of AVF Vs. AVG

Patency of AVF From Creation

Huijbregts H J et al. CJASN 2008;3:714-719
Patency After PTA vs After Thrombosis

N=818
1437 procedures in 560 PTs
703 In AVF, 734 in AVG
Early AVF Failure

- Problems with Inflow
  - Small or calcified artery
  - Juxta-anastomotic or anastomotic stenosis
- Problems with outflow
  - Small or fibrotic vein
  - Juxta anastomotic or proximal stenosis
- Accessory veins
Secondary AV Access Failure

- Thrombosis
- Prolonged bleeding
- Difficulty to cannulate or infiltrated access
- Low kt/v or URR (cannot be explained)
- High venous pressure (> +250 mm Hg)
- Low arterial pressure (< -250 mm Hg)
- Frequent pressure alarms
- Aneurysms
- Arm/face edema
- High recirculation rate
- Cannulation techniques
- Hand Ischemia
How To Maintain An AV Access Patency

- Monitor for access maturation
- Monitor for access patency
- Surveillance of AV access
- Intervene in dysfunctional access
- Plan for next AV access to prevent or minimize catheter exposure
- Role of antiplatelet therapy
Rationale For Monitoring AV Access

● Early detection of stenosis
  – Inflow, outflow and central vein

● Early intervention
  – Salvage non-maturing AVF
  – Improve blood flows and prevent under-dialysis
  – Possibly prevent thrombosis
  – Improve quality of life
  – Reduce healthcare costs
Basics of Access Monitoring

It only takes a minute to save your lifeline.

Look

Listen

Feel

www.esrdncc.org

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Look

The skin over the access is all one color and looks like the skin around it.

There is redness, swelling or drainage. There are skin bulges with shiny, bleeding, or peeling skin.

**Click on the eye to see a video on the “Look” check.**

**Click here for other resources.**

**GO**

Good to go!

**STOP**

Contact expert clinician if any “stop” signs noted.

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arteriovenous
FISTULA FIRST

AVF — The first choice for hemodialysis
**Listen (Stethoscope Bruit)**

The hum or buzz should sound like a “whoosh,” or for some may sound like a drum beat. The sound should be the same along the access.

No sound or decreased sound. Change noted. Sound is different from what a normal BRUIT should sound like.

Click on the stethoscope to hear how normal and abnormal accesses sound.

For other “Listen” resources click here.

Contact expert clinician if any “stop” signs noted.

---

**GO**

Sounding good!

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**STOP**

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[ESRD NCC logo]

[AVF Fistula First logo]
Listening to the AV Access

A. In the normal situation, the bruit is low pitched and with systolic and diastolic components.

B. With a stenotic lesion, the bruit becomes high in pitch and has only a systolic component.
Listening to the AV Access

- Thrill, bruit
- Dilated pulsatile
- Collapsed
  - With elevation
  - Dilated
Feel

Thrill: a vibration or buzz in the full length of the access.

Pulse: slight beating like a heartbeat. Fingers placed lightly on the access should move slightly.

Pulsatile: The beat is stronger than a normal pulse. Fingers placed lightly on the access will rise and fall with each beat.

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Click on the arm & hands to see a video on the "Feel" check.

---

GO

Good to go!

---

STOP

Contact expert clinician if any "stop" signs noted.

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arteriovenous FISTULA FIRST
AVF — The first choice for hemodialysis
Feeling The Pulse

- Is there a pulse present downstream from the anastomosis?
  
  Pulse strength indicates downstream resistance
  
  - **Soft** indicates low resistance, no stenosis
  
  - **Firm** indicates high resistance, suggests outflow stenosis

Salman and Beathard. CJASN 2013:1220-1227
Feeling The Thrill

**Normal** Thrill is soft and continuous in systole and diastole

**With stenosis**, the thrill is increased, localized to area of lesion, and systolic only

Salman and Beathard. CJASN 2013:1220-1227
Pulse Augmentation Test

A. The arteriovenous fistula is occluded.
B. The pulse is assessed for augmentation.

Salman and Beathard. CJASN 2013:1220-1227
Sequential Occlusion Test

A. With occlusion at this point, the thrill will disappear.

B. With occlusion at this point, the thrill will persist because of the side branch.

Salman and Beathard. CJASN 2013:1220-1227
Arm Elevation Test

Upper Arm AVF
The AVF outflow vein **partially collapses** when the arm is raised above the level of the heart. It may feel “flabby” when palpated.

Lower Arm AVF
The AVF outflow vein **collapses** when the arm is raised above the level of the heart.

Click on the diagram to see a video on the Arm Elevation Test.

**GO**
Good to go!

**STOP**
Contact expert clinician if any “stop” signs noted.

ESRD NCC
SEEING, SHARING, SPREADING
IMPROVING PATIENT OUTCOMES
NETWORK COORDINATING CENTER

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CMS Contract Number: HHSN-500-2013-NW002C.
Arm Elevation Test
Central Vein Stenosis Findings

Localized thrill and bruit
Old catheter insertion sites
AVF may not be very visible
Swollen arm
Cardiac pacemaker
Network of collateral veins
Pulsatility of AVF is variable
# One Minute Access Assessment

## Access Assessment Components

<table>
<thead>
<tr>
<th>Who</th>
<th>Look</th>
<th>Listen</th>
<th>Feel</th>
<th>Arm Elevation Test</th>
<th>Augmentation Test</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Daily</td>
</tr>
<tr>
<td>Dialysis Staff</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Each Dialysis</td>
</tr>
<tr>
<td>Expert Clinician</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Monthly or problem focused</td>
</tr>
</tbody>
</table>
Physical Examination Is Sensitive And Specific In Detecting Stenosis

- 142 consecutive patients
  - Upper arm AVF 95 (67%)
  - Forearm AVF 47 (33%)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Sens</th>
<th>Spec</th>
<th>PE + Angio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflow stenosis</td>
<td>85%</td>
<td>71%</td>
<td>83%</td>
</tr>
<tr>
<td>Outflow Stenosis</td>
<td>92%</td>
<td>86%</td>
<td>89%</td>
</tr>
<tr>
<td>Coexisting inflow-outflow stenosis</td>
<td>68%</td>
<td>84%</td>
<td>79%</td>
</tr>
<tr>
<td>Central vein stenosis</td>
<td>13%</td>
<td>99%</td>
<td>Low sens. by PE alone</td>
</tr>
</tbody>
</table>

Asif et al CJASN 2:1191;2007
Access Surveillance

● Periodic evaluation of by special tests requiring special instruments that would suggest presence of pathology

● Traditional methods of surveillance include:
  – Access flow measurement
  – Intra access pressure and resistance
  – Doppler duplex ultrasound imaging
Access Flow (Qa) and Stenosis
(Based Upon Mathematical Model)

Good news:
25% decrease in flow indicates a 50% or greater stenosis in all three categories of A/V ratio

Most accesses have a low A/V ratio

Bad news:
With a low A/V ratio this degree of change in Qa does not occur until quite late

# AVF Surveillance: RCT Evidence

<table>
<thead>
<tr>
<th>Name</th>
<th>Survey method</th>
<th>Preemptive angioplasty/surgical revision</th>
<th>Control group</th>
<th>Treatment group</th>
<th>Reduce thrombosis</th>
<th>Prolong survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polkinghorne et al. [15]</td>
<td>Qa (&lt;550 mL/min) and Clinical criteria versus Clinical criteria alone</td>
<td>No</td>
<td>No</td>
<td>68</td>
<td>69</td>
<td>*</td>
</tr>
<tr>
<td>Sands et al. [16]</td>
<td>Qa (&lt;800 mL/min), Static venous pressure and Doppler ultrasound versus Doppler ultrasound alone</td>
<td>No</td>
<td>40</td>
<td>63</td>
<td>Yes</td>
<td>*</td>
</tr>
<tr>
<td>Tessitore et al. [17]</td>
<td>Qa (&lt;850 mL/min), Qb, Ru, and Rhd</td>
<td>Yes</td>
<td>30</td>
<td>32</td>
<td>Yes</td>
<td>*</td>
</tr>
<tr>
<td>Tessitore et al. [18]</td>
<td>Qa (&lt;750 mL/min), Qb, and Ru</td>
<td>Yes</td>
<td>36</td>
<td>43</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* Data/values not reported or unavailable.
Qa: vascular access flow, Qb: blood flow, Ru: urea-based access recirculation, and Rhd: ultrasound dilution recirculation.
Flow or U/S Surveillance: Impact on Access Thrombosis

<table>
<thead>
<tr>
<th>Study</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fistula</strong></td>
<td></td>
</tr>
<tr>
<td>Sands 1999 F</td>
<td>0.31 (0.04, 2.5)</td>
</tr>
<tr>
<td>Sands 1999 VP F</td>
<td>0.25 (0.03, 2.06)</td>
</tr>
<tr>
<td>Tessitore 2003</td>
<td>0.43 (0.19, 0.96)</td>
</tr>
<tr>
<td>Tessitore 2004</td>
<td>0.37 (0.18, 0.75)</td>
</tr>
<tr>
<td>Polkinghorne 2006</td>
<td>1.48 (0.44, 5.01)</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>0.47 (0.28, 0.77)</td>
</tr>
<tr>
<td><strong>Graft</strong></td>
<td></td>
</tr>
<tr>
<td>Lumsden 1997</td>
<td>1.06 (0.66, 1.71)</td>
</tr>
<tr>
<td>Sands 1999 G</td>
<td>0.29 (0.04, 1.94)</td>
</tr>
<tr>
<td>Sands 1999 VP G</td>
<td>0.67 (0.22, 2.03)</td>
</tr>
<tr>
<td>Smits 2001 A</td>
<td>0.89 (0.25, 3.17)</td>
</tr>
<tr>
<td>Smits 2001 B</td>
<td>1.34 (0.71, 2.52)</td>
</tr>
<tr>
<td>Ram 2003 DU</td>
<td>0.59 (0.31, 1.15)</td>
</tr>
<tr>
<td>Ram 2003 UD</td>
<td>0.8 (0.46, 1.37)</td>
</tr>
<tr>
<td>Robbin 2006</td>
<td>1.03 (0.74, 1.43)</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>0.94 (0.77, 1.16)</td>
</tr>
</tbody>
</table>

Flow or U/S Surveillance: Impact on Access Survival

<table>
<thead>
<tr>
<th>Study</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fistula</td>
<td></td>
</tr>
<tr>
<td>Tessitore 2003</td>
<td>0.63 (0.22, 1)</td>
</tr>
<tr>
<td>Tessitore 2004</td>
<td>0.67 (0.19, 2.31)</td>
</tr>
<tr>
<td>Subtotal</td>
<td>0.65 (0.28, 1.51)</td>
</tr>
<tr>
<td>Graft</td>
<td></td>
</tr>
<tr>
<td>Mayer 1993</td>
<td>1.38 (0.81, 2.35)</td>
</tr>
<tr>
<td>Moist 2003</td>
<td>1.01 (0.42, 2.43)</td>
</tr>
<tr>
<td>Ram 2003 DU</td>
<td>1.05 (0.49, 2.28)</td>
</tr>
<tr>
<td>Ram 2003 UD</td>
<td>0.97 (0.65, 1.47)</td>
</tr>
<tr>
<td>Robbin 2006</td>
<td>0.97 (0.65, 1.47)</td>
</tr>
<tr>
<td>Subtotal</td>
<td>1.08 (0.83, 1.4)</td>
</tr>
</tbody>
</table>

New Techniques For Surveillance

1. Based on intra access static pressure measurement:
   A. Automated VAPR trending (Vasc-Alert)
   B. Sten-Tec Gauge
   C. Derivation of ‘pressure from flow’ using The *Blue Dop* device

2. Magnetic Linear Actuator- for access geometry and flow
Early Intervention

- Based on findings of monitoring and surveillance (But only in presence of clinical issue)

- Endovascular intervention: Generally preferred
  - Balloon Angioplasty +/- stent placement for stenosis
  - Percutaneous or surgical thrombectomy
  - Coiling for accessory veins

- Surgical revision
Juxta-anastomotic Stenosis

Fistula

Radial Artery

Juxta-anastomotic stenosis

Anastomosis
Juxta-anastomotic Stenosis - Post Angioplasty
Role of Surgical Intervention: Neo-anastomosis
Angioplasty - Pros And Cons

- Improves AVF patency, but not permanently
- Does not improve survival of AVF
- Incremental cost

But -
  - What about clotted AVF at 6 am?
  - What about the quality of life of the patient, the nurse and the nephrologist?
Angioplasty Is Not Perfect

- Causes endothelial injury, usually complicated by recurrence
- Invasive, can have complications
- Requires use of IV contrast, though most procedures can be done with small amount

- Decision to intervene needs to be individualized carefully
- Surgical intervention should also be considered in cases of recurrent stenosis
Accessory Veins

- Accessory vein
- Radial Artery
- Anastomosis
- Fistula
- Accessory vein
Coils For Accessory Veins
Accessory Veins - Post Coiling
Thrombectomy
Central Vein Stenosis
Recurrent Stenosis in a Month-Stent was deployed

AV Access Occlusion Risk

- AV accesses are complicated by stenosis and occlusion
- Methods to improve access patency remain unclear
- Antiplatelet drugs have been used to improve access patency, with conflicting results
Initial Outcomes of Antiplatelet Therapy

- The Antiplatelet Trialists Collaboration analyzed results of 60 RCTs of antiplatelet therapy (n~ 8000)
- Aspirin alone or aspirin plus dipyridamole reduced risk of coronary or peripheral artery occlusion
- Analysis included 400 dialysis patients with a shunt or fistula
  - Occlusion was 17% with antiplatelet therapy versus 39% in controls

Dialysis Access Consortium AVF Study

- Clopidogrel vs. Placebo were studied in new AVF and maturation rates were analyzed
- Clopidogrel reduced the risk of early fistula thrombosis but did not increase the proportion of fistulae that became suitable for use
- Findings did not support routine Clopidogrel use to prevent early failure of new fistulae

- Fact remains: A high proportion of new fistulas do not mature adequately for use

Dember et al. JAMA 2008
Clopidogrel Failed: Lessons Learned

- There are many determinants of fistula maturation:
  - vascular function
  - vascular anatomy and
  - surgical technique
- Better targets for interventions to improve fistula outcomes are needed
- Be cautious when relying upon surrogate outcomes

Dember et al. JAMA 2008
DAC Graft Trial

- Dipyridamole in new grafts (N=84) had previously shown a reduced rate of thrombosis vs. Placebo (RR 0.35, p=0.02)

DAC Hypothesis:
Extended release dipyridamole in the form of Aggrenox® (ERDP/ASA) will inhibit stenosis and prolong primary unassisted patency of new grafts

Sreedhara et al, Kidney Int 45:1477, 1994
Dixon et al, NEJM 360:2191-201; 2009
DAC Graft Trial: Conclusions

- Absolute difference of 5% in \( I^0 \) outcome at 1 year
- Median primary unassisted patency increased from 4.3 to 5.8 months with ERDP/ASA treatment
- No difference in cumulative patency

High Failure Rate of 77% at 1 year

Dixon et al, NEJM 360:2191-201; 2009
REVIEW

Medical Adjuvant Treatment to Improve the Patency of Arteriovenous Fistulae and Grafts: A Systematic Review and Meta-analysis

N.C. Tanner, A.F. da Silva

Eur J Vasc Endovasc Surg (2016) 52, 243-252
Conclusion:

This systematic review has not demonstrated a beneficial effect for any adjuvant treatment to increase the patency of AVF or grafts in the short term, except ticlopidine which has been taken off the market.
Antiplatelet Agent After Access Intervention

• Retrospective study (n=96) of patients with access failure
• Underwent ultrasound-guided intervention by interventional nephrologists in Tokyo
• Compared antiplatelet and non-antiplatelet groups
• Incidence of access failure was significantly lower in the antiplatelet group
• Multivariate analysis revealed a lower risk of access failure after access intervention in antiplatelet group

Mizuno et al. Renal Replacement Therapy (2018) 4:43
SUMMARY

- Monitoring with physical exam compliments surveillance
- It is important to continue diligent clinical monitoring which is nearly as efficacious, economical and effective
- Newer data suggests improvement in access outcomes with surveillance and intervention
- No definite evidence exists to suggest that it prolongs access life
SUMMARY

- There is evidence of benefit in improving patency of AV grafts, but not AV fistula or catheters
- There is a risk of bleeding complication, especially high for dual antiplatelet therapy that should not be used
- Judicious use of single antiplatelet agent may be desirable in patients with AVG
Thank You
"We'd now like to open the floor to shorter speeches disguised as questions."