CHAPTER 2

ARTERIOVENOUS ACCESS FAILURE, STENOSIS AND THROMBOSIS

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INTRODUCTION

Vascular access related complications can lead to patient morbidity and reduced patient quality of life. Some of the common arteriovenous access complications include failure to mature, stenosis formation and thrombosis.

Definitions

| Primary Failure (failure to mature) | • An arteriovenous access that either gets thromboses before its use on dialysis or lacks suitability for use on dialysis.  
• There are no universal definitions  
• Most incorporate early thrombosis, inadequate maturation or lack of ability to be cannulated and used successfully for dialysis over a sustained period of time (usually 3 or 4 weeks) |
| Primary Patency (unassisted patency) | • The interval from time of access creation until the first access thrombosis or any intervention to maintain or restore access blood flow\textsuperscript{1, 2}.  
• Calculated either from the time of creation (in which case, failures include primary failures) or from first use |
| Secondary Patency (assisted patency or cumulative patency) | • The time from access creation until access abandonment\textsuperscript{1, 2}.  
• Calculated either from the time of creation (in which case, failures include primary failures) or from first use |
AV FISTULA PRIMARY FAILURE

• Definitions of fistula maturation and primary failure vary greatly
• The definition usually relates to anatomical changes (size and flow), the ability to cannulate the fistula for hemodialysis and whether interventions were required to promote maturation of the fistula
• Clinical studies use more objective definitions of primary failure as seen in previously cited NIH fistula maturation study
• Regardless of the definition used, it is very important to understand exactly how maturation (lack of primary failure) was defined in studies when interpreting risks and counselling patients
• A good estimate of fistula primary failure is reported in a meta-analysis by Al-Jaishi et al showing an overall risk of fistula primary failure is ~23% which increases to 37% in the elderly
PREDICTORS OF PRIMARY FAILURE

- Patient factors that predict primary failure include:
  - Age, sex, race, diabetes, history of coronary artery disease, peripheral vascular disease, obesity and location of the fistula
  - Risk predication model for fistula failure, developed and validated by Lok et al 2006, included: patient age ≥ 65 years old, peripheral vascular disease, coronary artery disease and race
  - Caution should be exercised when applying risk models as widespread applicability is limited
- Surgical factors that may impact primary failure rate are:
  - Extent of surgical training
  - Type of anaesthesia
  - Anastomosis angle
# Prevention of Fistula Primary Failure

<table>
<thead>
<tr>
<th>Prevention of fistula primary failure</th>
<th>Health care processes</th>
<th>Medical interventions</th>
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<tbody>
<tr>
<td></td>
<td>• Preoperative: Vein preservation programs prior to access placement such as “Save my Veins” and “Vein Preservation” <a href="http://www.bcrenalagency.ca/documents/presentation-vein-preservation-ckd-patients">http://www.bcrenalagency.ca/documents/presentation-vein-preservation-ckd-patients</a> • Postoperative standardized care, specifically with surgeon can prevent failures</td>
<td>• Currently no proven pharmacological therapies, • Clopidogrel ↓ risk of early fistula thrombosis from 19.5% to 12.2% but not overall suitability for dialysis • Antiplatelet agent at time of creation a consideration to reduce early thrombosis and intervention</td>
</tr>
<tr>
<td>Management of primary failure</td>
<td>• Endovascular or surgical manipulations of stenosis can facilitate maturation as per Beathard et al who reported 98% -100% immediate success rates with eventual fistula use in 92%</td>
<td>• New types of anastomotic connectors, hybrid grafts, sirolimus and paclitaxel coated materials, bioengineered vessels are in development</td>
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KEY RELEVANT AV ACCESS PATENCY RATES

AV Fistulas

• Primary patency rates of fistula vary - from 60% at one year to 51% at two years (primary failure rate included) or 67% at one year and 51% at two years (excluding primary failure rate)
• The secondary patency rates for AVF are much higher at 82% at one year and 73% at two years

AV Grafts

• Primary patency rate for grafts is < fistula
• Grafts tend to have more interventions in order to maintain their survival
• Cumulative patency rates for graft range widely in the literature from 57% to 82%
• PTFE forearm grafts have lower cumulative patency vs upper arm grafts
• Table 1 outlines patency rates for AV Grafts and Fistulas
# COMPARISON OF AVF vs. AVG SURVIVAL

<table>
<thead>
<tr>
<th>Reference</th>
<th>AVF</th>
<th>AVG</th>
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<th>AVG</th>
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**Notes:**
- **Primary Failure (Access never used)**
- **Primary unassisted patency (time without thrombosis or needing intervention)**
- **Secondary or Cumulative patency (time from creation until abandonment)**
- **Median, or % at Time Point**

  - 1* year = 71%
  - 2* year = 57%
  - First access = 7.4 months+
  - Subsequent access = 7 months+
  - First access = 15 months+
  - Subsequent access = 9 months+

  - 2.2 years HR for benefit over AVF = 0.57 before 1.2 years than the same as AVF after 2 years

  - 1 year = 71%
  - 2 year = 63%
  - 1 yr+++ = 50%
  - 18 mos+++ = 26%
  - 1 year = 46%
  - 1 year = 22%
  - 1 year = 54%
  - 2 year = 51%
  - 100 days
  - 91 days
  - 231 days
  - 355 days
  - 1 year = 52%
  - 1 year = 79%
AV ACCESS (PERIPHERAL VEIN) STENOSIS

- Peripheral vein stenosis is the primary cause of fistula and graft thrombosis
- Stenosis is initiated by endothelial cell injury often caused by shear stress from turbulent blood flow, mechanical trauma from venipuncture or angioplasties

Clinical Features:
- In a newly created fistula, maturation failure and sometimes thrombosis occurs as a result of an inflow or outflow stenosis.
- Depending on the site of the stenosis, the fistula may have physical exam findings as described in Table 2:

Table 2: Physical Examination of fistula

<table>
<thead>
<tr>
<th>Site of Stenosis</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Inflow</td>
<td>• Water hammer pulse at site of stenosis</td>
</tr>
<tr>
<td></td>
<td>• Weak pulse beyond area of stenosis</td>
</tr>
<tr>
<td></td>
<td>• Decreased in transmission of the pulse to the fingertip at anastomosis with occlusion of outflow vein (Augmentation test)</td>
</tr>
<tr>
<td>Outflow</td>
<td>• Fistula does not collapse with arm elevation (Arm Elevation test)</td>
</tr>
<tr>
<td></td>
<td>• Localized attenuated thrill at site of stenosis</td>
</tr>
<tr>
<td></td>
<td>• Bruit may have loss of diastolic component and increase in pitch with severity of stenosis</td>
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<tr>
<td></td>
<td>• Whistling sound heard only during systole with severe downstream stenosis</td>
</tr>
</tbody>
</table>
AV ACCESS (PERIPHERAL VEIN) STENOSIS

Treatments Options

Angioplasty

• First line treatment of stenosis should be percutaneous angioplasty
• High and ultra high pressure balloons improve immediate success rate in recurring lesions but have higher risk of vein rupture
• Cutting balloons provide similar patency rates but ↑ risk of venous rupture and dissections
• Drug-eluting balloons provide antiproliferative medication (paclitaxel) to entire area of stenosis and may have higher 6 mo. patency rates but long term data lacking

Stents

• Stents are only recommended when the stenotic lesion has failed conventional angioplasty with a significant amount of recoil post-plasty and if surgery is not an option
• Concerns include: possible vein depletion with reduced options for future surgeries, limited area of cannulation and possible stent migration or stent fracture

Surgery

• Resistant lesions should be revised surgically
AV ACCESS THROMBOSIS

Untreated stenosis will lead to thrombosis
There are two types of thrombosis that can occur: soft, friable clot that disintegrates and a firm fibrin plug
- Increased risk of access thrombosis for both fistula and graft include:
  - Systemic factors such as hypotension, higher hemoglobin target, and hypercoagulability
  - Patient factors such as sex (female) and diabetes increase risk of fistula thrombosis as well
  - 25% increased risk of thrombosis associated with hematoma from a needle complication

Clinical Features
- A history of recent onset of difficulty needling, a significant drop in access flow, a new onset of low access flow or significant recirculation all may be clues to an impending fistula thrombosis
- Physical exam of thrombosed fistula or graft = reduced thrill along with absent or abnormal bruit. Ultrasound confirms presence of thrombus and low flow state
- Treatment should be initiated as soon as possible
AV ACCESS THROMBOSIS

Treatment Options

Surgery

• Established technique for salvage of thrombosed access
• Involves the use of a Fogarty thrombectomy combined with retrograde manual removal of clot
• Success rates for surgical thrombectomy range from 70 – 94 %, 12 mo patency ranging from 68-88% for either fistula or graft
• Both fistula and graft thrombosis should be treated within 48h in order to avoid placement of a catheter

Endovascular intervention

• Involves chemically or mechanically disrupting and removing the thrombus, then correcting underlying lesion
• Thrombolytic such as tPA typically used
• Following mechanical/thrombolysis an angioplasty is done to correct underlying stenosis
• Success rates for endovascular approach range from 80-90%
AV ACCESS THROMBOSIS

Prevention: Role of arteriovenous access monitoring & surveillance

• Regular physical exam and clinical monitoring and assessment for AV access stenosis is recommended as standard care
• Assess at each dialysis treatment: **LOOK, LISTEN** for bruit and **FEEL** for thrill
• Goal of monitoring and surveillance is to identify early access dysfunction and correct prior to access thrombosis or loss
• Ideal surveillance method includes accurate, noninvasive and economical evaluation of access anatomy (eg., stenosis) and function

Access surveillance:

• Involves the use of tools like dynamic or static venous pressure monitoring and access flow measurements.
• Detects underlying fistula and graft stenosis
• Does not predict graft thrombosis. Does predict fistula thrombosis
• Improves fistula survival but not graft survival

Prevention: Role of antiplatelet and anticoagulation medication

• Meta-analysis demonstrates protective effect of Antiplatelet agents (ASA, ticlopidine and clopidogrel) from early thrombosis and loss of patency in AVF but not grafts
CENTRAL VEIN STENOSIS

- Manifestations of central vein stenosis can appear when a patient has an ipsilateral access that drains into the side of the central vein stenosis
- Common signs: venous hypertension, arm and hand swelling, dusky, rubor (red colour) of hand and dilated veins on the arm and or chest
- Risk factors for development thought to be related to history of catheter, pacemaker or PICC insertion but cases of central vein stenosis do occur in absence of these risk factors

The treatment of choice:
- percutaneous angioplasty with long term patency requiring repeated interventions
- The role of stenting is not clear and should be reserved for lesions that have significant elastic recoil or for lesions that recur within three months of treatment
- Asymptomatic lesions do not require intervention and should be monitored

SEE CENTRAL VEIN STENOSIS – CHAPTER 6 Section 3
SUMMARY OF RECOMMENDATIONS

• Primary failure is a common complication for fistula; rates vary widely

• Interventions aimed at reducing the risk of primary failure include, promoting early vein preservation, consideration of antiplatelet agents to reduce early thrombosis and intervention with endovascular or surgical techniques to facilitate maturation

• Peripheral venous stenosis is the most common cause of fistula and graft dysfunction which may lead to access thrombosis

• First line treatment of stenosis should be balloon angioplasty

• Stent placement in the peripheral vein is not recommended

• Resistant lesions should be revised surgically when the lesion is not amenable to angioplasty (long lengths of stenosis or significant elastic recoil)
SUMMARY OF RECOMMENDATIONS

• Access clinical monitoring using history and physical exam is the standard of practice for arteriovenous access
• Access surveillance involves the use of tools like dynamic or static venous pressure monitoring or access flow measurements
• Intervention based on surveillance leads to < thrombosis in fistula (at the expense of increased interventions) and appears to prolong survival
• Intervention based on surveillance does not prevent thrombosis or prolong survival in grafts
• Thrombosed arteriovenous access is a medical emergency and a salvage attempt should be made as soon as possible in order to avoid catheter placement and admission