

# **CANNULATION FOR THE SKILLED CANNULATOR**

**Vascular Access Educator  
Group of BC  
FINAL May 6, 2008**

# Acknowledgement

Many of the slides in this presentation are used with permission from:

**Vascular Access Nursing Education Program  
Janet Graham, RN, MScN, CNeph(C)  
VA Coordinator, Ottawa Hospital**

***Development of these slides were sponsored by  
AMGEN***

# Match Cannulators & Accesses



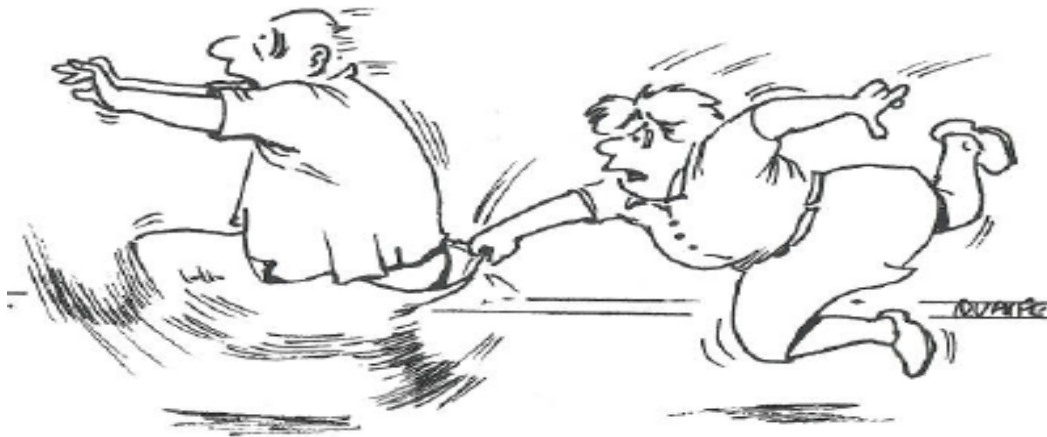
Skill Level of Cannulator	Access Rating Approved to Cannulate
Novice	<ul style="list-style-type: none"> <li>• Easy accesses:               <ul style="list-style-type: none"> <li>– <u>Established</u> accesses with no complications</li> <li>– AVFs in which buttonhole tracks are well established</li> </ul> </li> </ul>
Skilled	<ul style="list-style-type: none"> <li>• Moderately complicated accesses:               <ul style="list-style-type: none"> <li>• <u>New</u> accesses with no complications</li> <li>• <u>Established</u> accesses with one complication</li> <li>• AVFs in which buttonhole tracks are well established</li> </ul> </li> </ul>
Advanced	<ul style="list-style-type: none"> <li>• Complicated accesses:               <ul style="list-style-type: none"> <li>– <u>All</u> accesses (new &amp; established; with or without complications)</li> <li>– <u>Established</u> and <u>new</u> AVFs in which buttonhole tracks are already established or are being established</li> </ul> </li> </ul>



# Skilled Cannulators may....

- Cannulate new accesses with no complications
  - AVFs: 1<sup>st</sup> six weeks of cannulation
  - AVGs: 1<sup>st</sup> two weeks of cannulation
- Cannulate moderately complicated accesses
  - Accesses with one cannulation complication (e.g. difficult to palpate, deep, signs of edema, bruising or local infection)
- Cannulate buttonhole accesses with well established tracks
- Utilize portable ultrasound to assist cannulation

# CANNULATING NEW ACCESSES



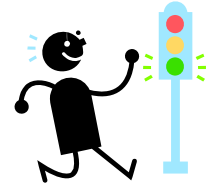
Come back here, Arnold!  
Stacey isn't needling today...



**BC Renal Agency**  
An agency of the Provincial  
Health Services Authority

*Cartoon licensed for use from Jazz Communications Ltd., publishers of The Lighter Side of Dialysis.. To order a copy or more information please visit [www.lightersideofdialysis.com](http://www.lightersideofdialysis.com) or call 1-866-239-3279.*

# When to Cannulate New Accesses



- AVFs:
  - After adequate time (minimum 4 wks – often longer)
  - Signs show maturation has occurred
  - Assessed by MD or VA RN as “ready to needle”
  - Attempted by skilled or advanced cannulator only
- AVGs:
  - No swelling in the access limb (minimum 2 wks)
  - Assessed by MD or VA RN as “ready to needle”
  - Attempted by skilled or advanced cannulator only
- Rationale:
  - Cannulation is a *learned* skill that improves with practice
  - Cannulation done too early or on a problem access site may damage or result in loss of the access

# Procedure for Cannulating New Accesses

- Same steps as for established accesses but possibly “trickier”
  - Physical assessment: LOOK! LISTEN! FEEL!
  - Cannulation:
    - Plan the site
    - Prepare the site
    - Insert the needles
    - Remove the needles

# Procedure for Cannulating New Accesses

- If patient is on heparin, contact MD to reassess heparin orders and heparin stop times (if protocols available, consult them). Reassess regularly during initial cannulations
- Use smallest available needle(s) for first several treatments; increase needle size gradually
- Start with slow pump speed for first several treatments; increase to target pump speed gradually
- If infiltrates, rest for 1 week; if infiltrates a 2<sup>nd</sup> time, rest for 2 weeks; if it infiltrates a 3<sup>rd</sup> time, refer to MD

# Cannulation Sequence: Fistulas with CVC in place

- If patient has AVF and CVC:
  - Place arterial needle in the fistula and use catheter for venous return for 3 treatments; reverse for 3 treatments
  - After 6 successful treatments, refer to MD for CVC removal

# Cannulation Sequence: Fistulas with CVC in place

Tx	1	2	3	4	5	6	7	8	9	10
Needle location	Arterial (CVC for venous)	Arterial (CVC for venous)	Arterial (CVC for venous)	Venous (CVC for arterial)	Venous (CVC for arterial)	Venous (CVC for arterial)	Arterial & venous	Arterial & venous	Arterial & venous	Arterial & venous
Needles	1	1	1	1	1	1	2	2	2	2
Needle gauge	17 or 16 g	Same as tx #1	Same as tx #1	Same as tx #1	Same as tx #1	Same as tx #1	Same as tx #1	Same as tx #1	Same as tx #1	Larger by 1 g until desired size
Max blood pump speed	250 (200 for children)	300 (250 for children)	300	250 (200 for children)	300 (250 for children)	300	Increase gradually to desired speed			

- For the first run, start with slow pump (50 ml/min) and increase 50 ml/min every 30 sec to 250 mL/min; if pump speed is not tolerated, reduce to 200 mL/min. Do not exceed rate of 300 ml/min for the first 2 weeks
- Arterial pressures should never be lower than -250 mmHg and venous pressures never higher than 250 mmHg

# Cannulation Sequence: Grafts & Fistulas with no CVC

Tx	1	2	3	4	5	6	7	8	9	10
Needle location	Arterial & venous	Arterial & venous	Arterial & venous	Arterial & venous	Arterial & venous	Arterial & venous	Arterial & venous	Arterial & venous	Arterial & venous	Arterial & venous
Needles	2	2	2	2	2	2	2	2	2	2
Needle gauge	17 or 16 g (2 needles)	Same as tx #1	Same as tx #1	Larger by 1 g	Same as tx #4	Same as tx #4	Increase gradually to desired gauge			
Max blood pump speed	250 (200 for children)	300 (250 for children)	300	300	300	300	Increase gradually to desired speed			

- For the first run, start with slow pump (50 ml/min) and increase 50 ml/min every 30 sec to 250 mL/min; if pump speed is not tolerated, reduce to 200 mL/min. Do not exceed rate of 300 ml/min for the first two weeks
- Arterial pressures should never be lower than -250 mmHg and venous pressures never higher than 250 mmHg

# Desired Blood Pump Speed & Needle Gauge

Once cannulation has been established, correlate needle gauge, blood pump speed, and clinical condition (Kt/V or PRU)

Desired Blood Pump Speed	Recommended Needle Gauge	
	AVF	AVG
<300 mL/min	17 g	17 g
300 – 350 mL/min	16 g	16 g
350 – 450 mL/min	15 g	15 g
>450 mL/min	14 g	15 g



# CANNULATING COMPLICATED ACCESSSES



*Cartoon licensed for use from Jazz Communications Ltd., publishers of The Lighter Side of Dialysis.. To order a copy or more information please visit [www.lightersideofdialysis.com](http://www.lightersideofdialysis.com) or call 1-866-239-3279.*

# Procedure for Cannulating Complicated Accesses

- Procedure is the same as for easy accesses but cannulation can be “trickier”
- Consult MD or VA Coordinator if:
  - Difficult to cannulate
  - Unable to achieve a BPS of  $>300$  mL/min by week 3 or  $<350$  mL/min in established HD in 2 consecutive runs
  - Low arterial or high venous pressure on 3 consecutive runs
  - Unexplained, prolonged bleeding ( $>10$  – 15 min) from cannulation site on 3 consecutive runs
  - Signs of access complications

# Tips for Success with Complicated Accesses

- Wrap patient limb in warm blanket prior to cannulating (to achieve vasodilation)
- For fistulas, if access is hard to feel, apply a tourniquet (for vasodilation)
- If access is hard to feel, use a stethoscope or doppler to listen for bruit & to ensure you are above the vessel. Needle where the sound is loudest
- Use a wet needle. Attach syringe with 5cc NS to the needle and flush saline through to the end of the needle prior to inserting (to prevent clotting)
- If cannulation problems occur, go back to small needle size. Increase needle size slowly

# Tips for Success with Buttonholes (AVFs)

- Stabilize with tourniquet during needle insertion (stabilization & vasodilation)
- Needle should slide in easily once you have punctured the skin in an established buttonhole
- When inserting the needle, if more than a moderate amount of pressure is required and no blood has flashed into the tubing, remove the needle and exchange for a sharp one
- If patient has high access flows with thick vessel walls, the track may close off and you may need to use a sharp needle

# Access Complications

AVFs		AVGs
Early Failure	Late Failure	
Inadequate vein or artery used for creation	Stenosis: arterial or venous	Steal syndrome
Juxta-anastomotic venous (JAV) stenosis	Thrombosis	Ischemic monomelic neuropathy
Accessory veins	Aneurysm	Graft stenosis (venous)
Inflow stenosis within arterial system	Infection	Pseudoaneurysm
	Ischemic steal syndrome	Thrombosis



# Early Fistulae Failure

- Inadequate vein or artery used for creation
- Juxta-anastomotic venous (JAV) stenosis\*
- Accessory veins\*
- Inflow stenosis within arterial system

\* To be discussed in next section

# Early Fistula Failure: Juxta-anastomotic Venous (JAV) Stenosis

Normal	JAV Stenosis
Thrill continuous & felt at the anastomosis	Thrill only felt in systole
Pulse easily compressible	Strong pulse felt at anastomosis only; disappears quickly at site of stenosis
	Often felt as severe dip in vein or shelf in vein
	Above area of stenosis, pulse is weak and vein may be small or difficult to palpate <sup>1</sup>

<sup>1</sup>Ball LK. *Nephrol Nurs J* 2005;32:611-17.

# Stenosis at Arterial Anastomosis of Brachiocephalic AV Fistula



© Janet Graham

# Early AV Fistulae Failure: Accessory Veins

- Visually examine fistula
- If veins not visible, fistula can be occluded distal to arterial anastomosis
- If thrill over anastomosis does not disappear, accessory veins may exist below area being occluded
- Continue procedure up vein to evaluate if accessory veins exist further on



Accessory veins © Janet Graham

# Later Fistula Failure

- Stenosis: arterial or venous\*
- Thrombosis\*
- Aneurysm\*
- Infection\*
- Ischemic steal syndrome\*

\* Discussed in next section

# Later Fistula Failure: Venous Stenosis or Occlusion

- Most common location is at arterial anastomosis
- Cause-Theory:
  - Manipulation and mobilization of vein at time of surgery
  - Trauma and stretching of vein during surgery
- Presents as:
  - Arterial insufficiency-arterial pressure > limiting flow
  - “Spasm”
  - Small underdeveloped fistula

# Later Fistula Failure: Venous Stenosis or Occlusion

- Stenosis may occur anywhere along vein
- Causes:
  - Repeated needling causing scar tissue
  - Site of previous intravenous or phlebotomy causing scarring of vein
  - Site of previous hematoma
  - Central stenosis from current or past central catheter, PICC catheter insertion or pace maker (can present as swelling of arm or breast)
  - Deep vein thrombosis unrelated to central catheter insertion
  - Increased turbulence from arterialization of a vein (theory)

Roy-Chaudhury P, et al. *J Am Soc Nephrol* 2006;17:1112-27.

# Later Fistula Failure: Venous Stenosis or Occlusion

## Normal Mature Fistula

- Soft pulse
- Easily compressed
- Collapses partially or completely when arm or leg elevated

## Venous Stenosis

- Firm and pulsatile proximal to stenosis
- Portion of vein peripheral to stenosis stays distended and central portion of vein collapses
- Aneurysmal dilatations often appear below stenotic site

Beathard G. *Fistula First National Vascular Access Improvement Initiative. A Practitioner's Resource Guide to Physical Examination of Dialysis Vascular Access.* November 2003.

# Later Fistula Failure: Venous Stenosis or Occlusion

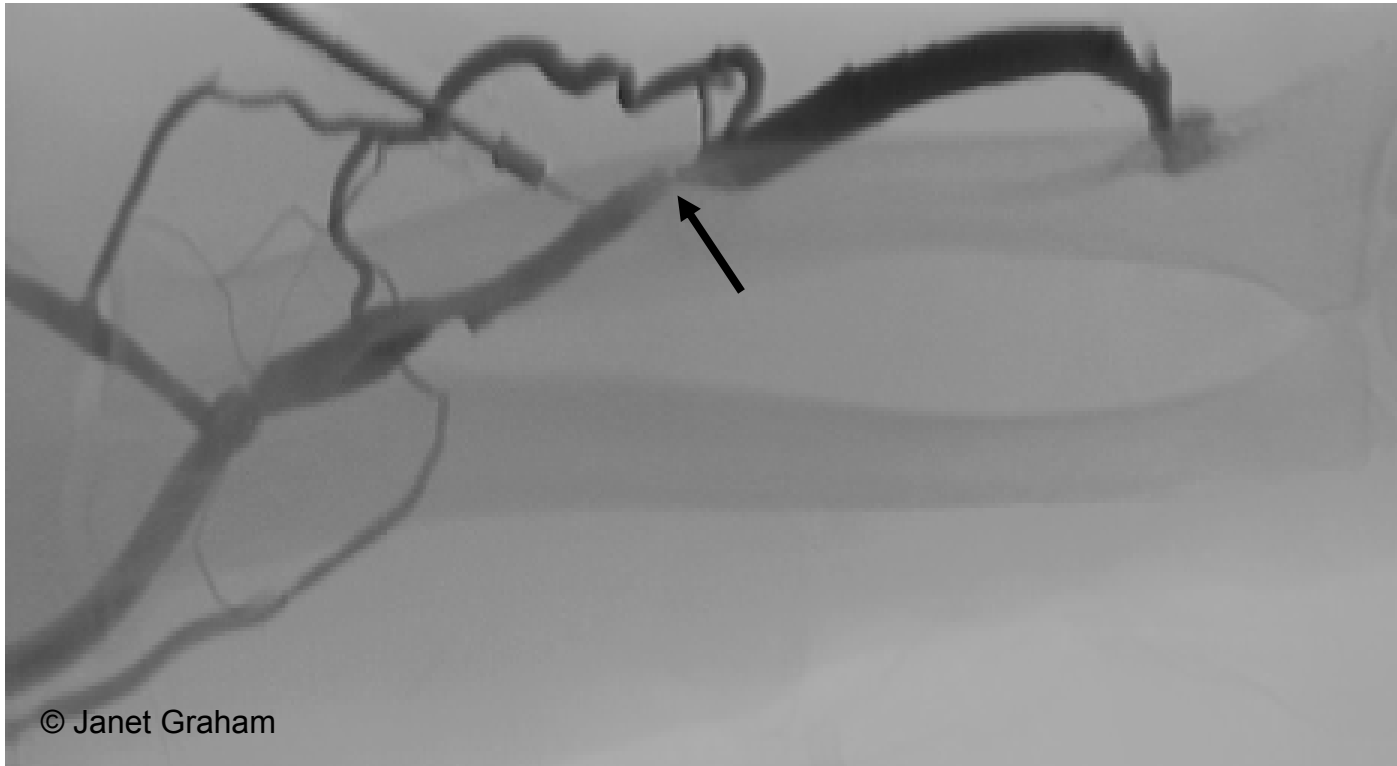
<b>Parameter</b>	<b>Normal</b>	<b>Stenosis</b>
Thrill	-Only at arterial anastomosis	-At site of stenotic lesion
Pulse	-Soft, easily compressible	-Water hammer
Bruit	-Low pitched -Continuous -Diastolic and systolic	-High pitched -Discontinuous -Systolic only

# Diagnosis of Stenosis or Occlusion in Fistula

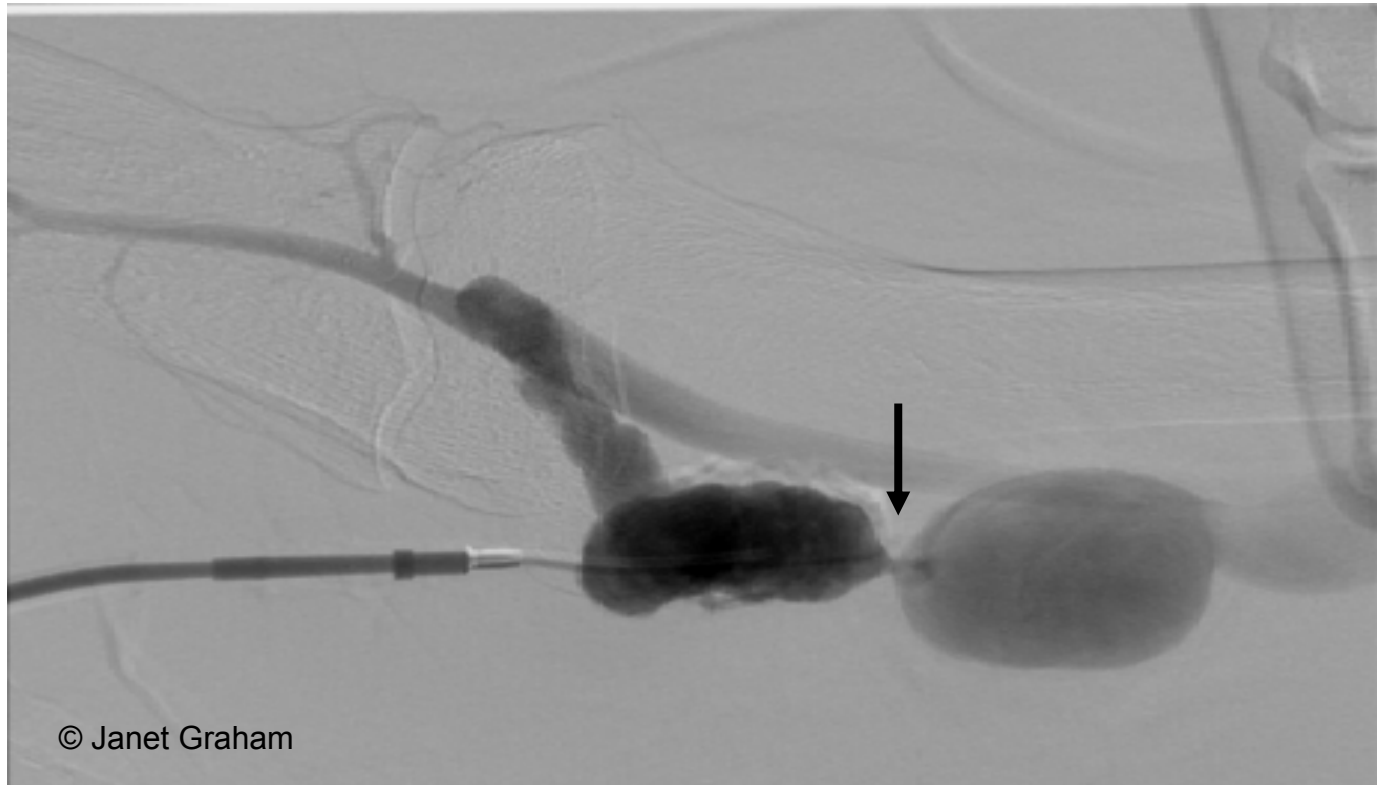
## Fistulogram

- Puncture fistula with small gauge needle
- Inject contrast
- Visualize fistula from arterial anastomosis to central veins
- Reflux of contrast into artery during injection necessary to examine arterial anastomosis and arterial limb

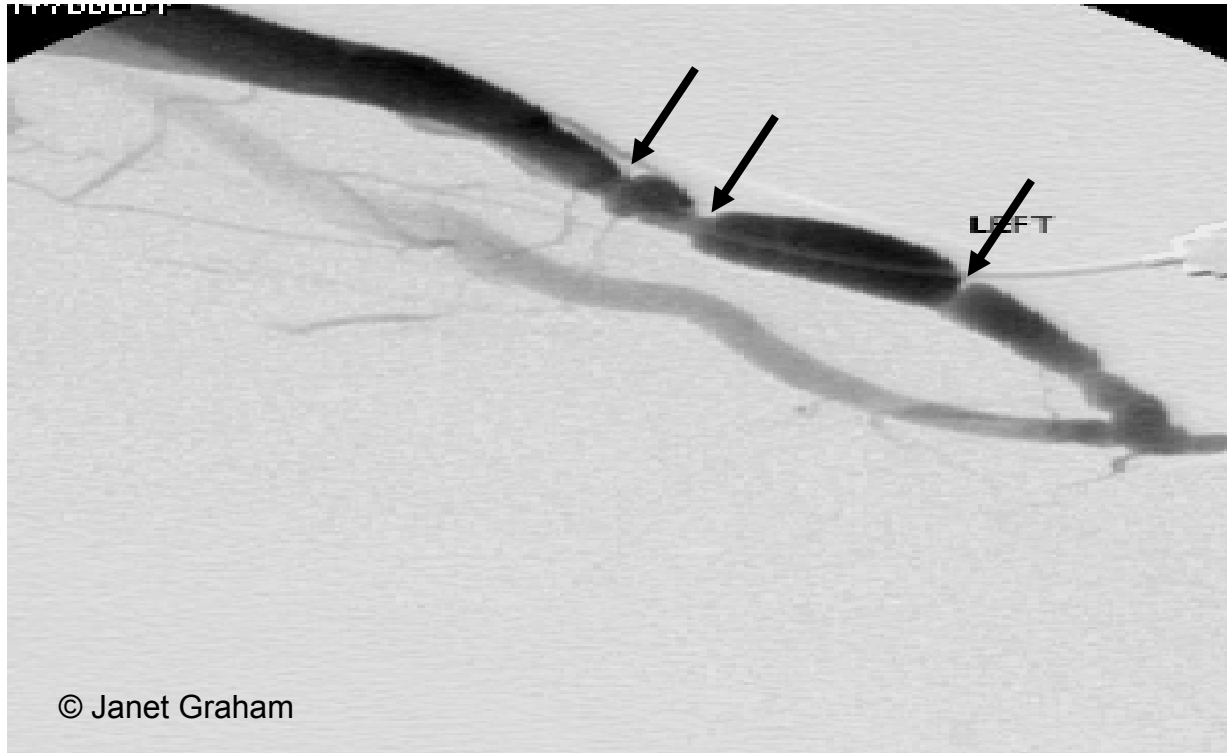
# Stenosis in the Cephalic Vein of a Radiocephalic AV Fistula



# Stenosis in Basilic Vein Between Aneurysmal Dilations



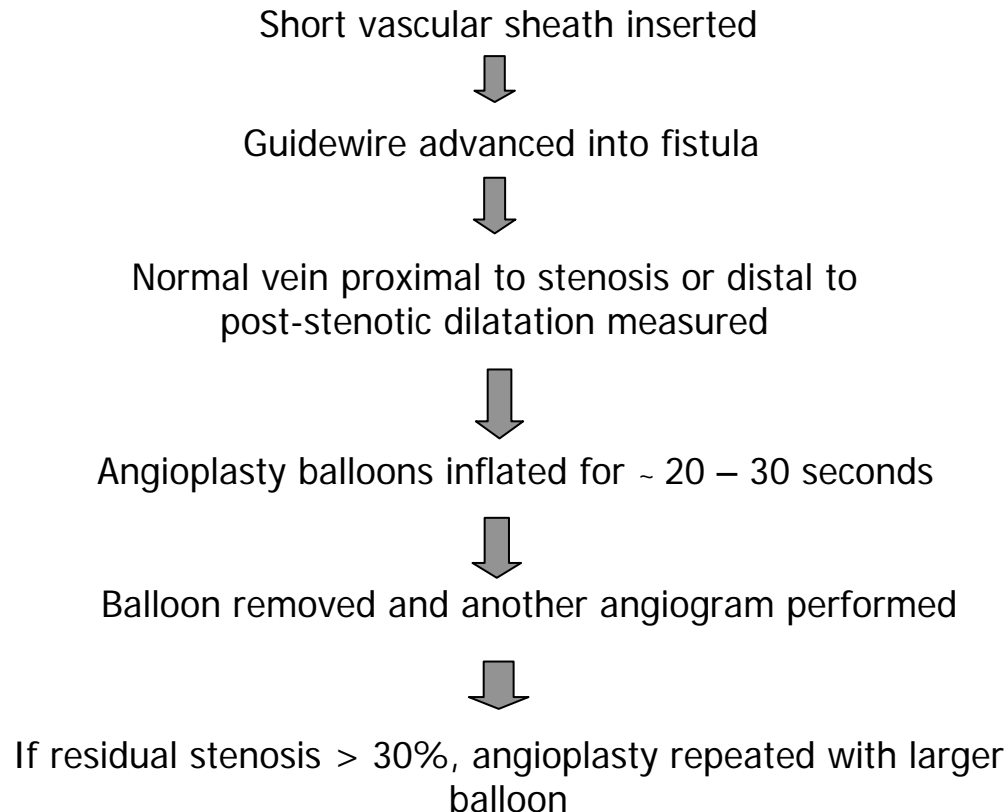
# Multiple Areas of Stenosis in Radiocephalic Fistula



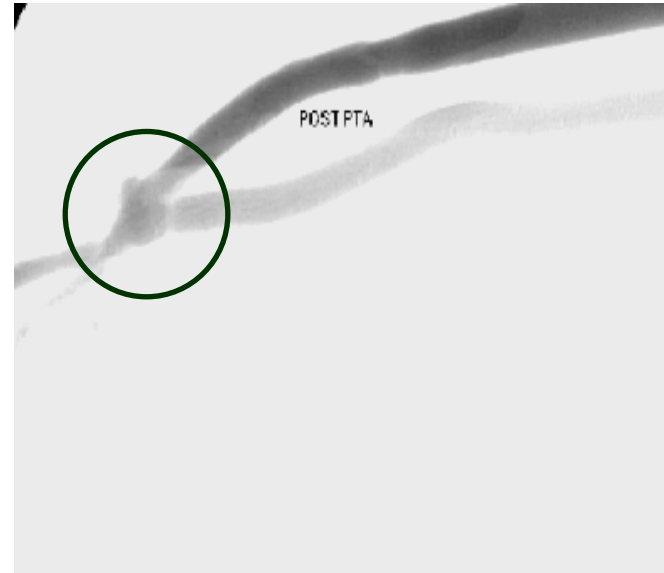
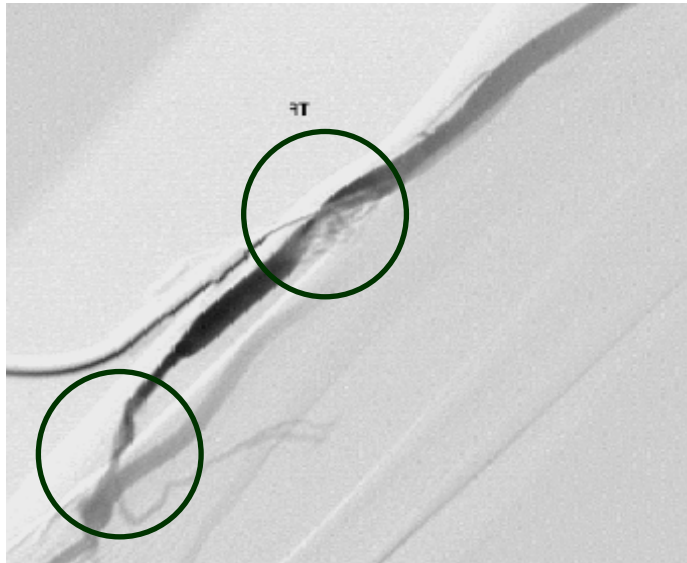
# Management of Stenosis in AV Fistulae

- Venous stenoses do not respond as well to angioplasty as arterial stenoses
- Guidelines recommend treatment of stenosis  $\geq 50\%$  reduction of normal vessel diameter accompanied by hemodynamic, functional or clinical abnormality

# Management of Stenosis in AV Fistulae with Angioplasty



# Pre- and Post-angioplasty of Severe Stenosis above Arterial Anastomosis in Radiocephalic Fistula



Areas of arterial anastomosis © Janet Graham

# Later Fistulae Failure: Thrombosis

- In most patients, thrombosis is the final complication after a period of AV fistula dysfunction
- Treatment should start as early as possible
  - Delay may increase risk of progressive growth of thrombus and future thrombotic events
  - Early intervention increases chance that same AV fistula can be used for future dialysis

# Treatment of Thrombosed AV Fistulae

## Three options available:

- Surgical thrombectomy +/- revision
- Mechanical thrombectomy +/- angioplasty
- Pharmacomechanical thrombectomy with angioplasty

# Should a Thrombosed AV Fistula be Salvaged?

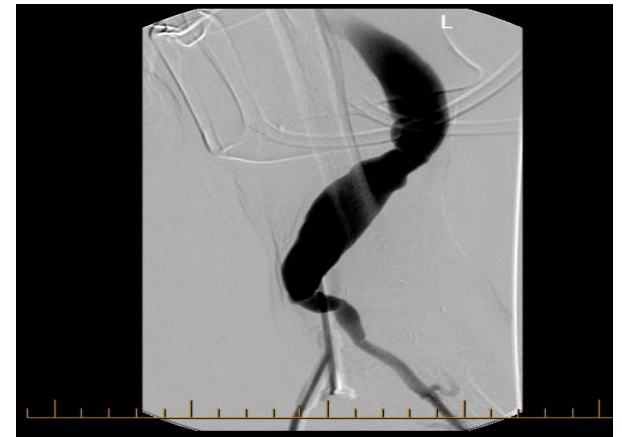
- What caused the thrombosis?
- Does the fistula have a history of previous angioplasties?
- Is there history of central vein stenosis?
- If present, what size are the aneurysmal dilatations?
- What portion of the vein remains patent?

# Challenges of Thrombectomy

- Fistulae are thin walled
- Can be difficult to locate anastomosis and remove clot due to irregular anatomy
- Stenosis can be in artery or anywhere along vein, including central veins
- Stenosis is usually very severe
  - fistulae can remain patent under low flows
- Collateral veins can cause confusion when identifying main vein
- Large volume of clot may be present in aneurysmal dilatations

# Later Fistulae Failure: Aneurysm Formation

- Localized dilation of vein
- Over time, flow in fistula increases and vein enlarges
- Can develop upstream from venous stenosis



# Later Fistulae Failure: Pseudoaneurysm Formation



# Later Fistulae Failure: Aneurysm Formation

- **Requires close monitoring for:**
  - Thinning of skin over fistula, often white and shiny
  - Ulceration or non-healing needle sites
  - Evidence of bleeding or difficulty with prolonged bleeding from a particular needle site
- **Often the only treatment is surgery**

Beathard G. Fistula First National Vascular Access Improvement Initiative. A Practitioner's Resource Guide to Physical Examination of Dialysis Vascular Access. November 2003.

# Later Fistulae Failure: Infection

- Relatively rare
- May occur post-operatively over incision lines
- In mature fistulae, may present as:
  - perivascular cellulitis with localized erythema
  - swelling or tenderness, or as infected aneurysms
  - abscesses from infected needle sites

Beathard G. *Fistula First National Vascular Access Improvement Initiative. A Practitioner's Resource Guide to Physical Examination of Dialysis Vascular Access.* November 2003.

# Later AV Fistulae Failure: Ischemic Steal Syndrome

- Assess both hands and all digits for
  - skin temperature
  - gross sensation
  - signs of skin breakdown, tissue necrosis or infection
  - range of motion
  - presence and quality of radial and ulnar pulses
  - numbness/tingling

Beathard G. *Fistula First National Vascular Access Improvement Initiative. A Practitioner's Resource Guide to Physical Examination of Dialysis Vascular Access*. November 2003;  
Malik J, et al. *J Nephrol* 2003;16:903-7.

# Later AV Fistulae Failure: Ischemic Steal Syndrome



# Graft Complications

- Infection\*
- Steal syndrome\*
- Ischemic monomelic neuropathy\*
- Graft stenosis (venous)\*
- Pseudoaneurysm\*
- Thrombosis\*

\* = To be discussed in next section

# Infection: Assessment

## Superficial

Pustules (previous cannulation sites)

Cellulitis

Inflammation

+/- Pain

Warmth, fever

## Deep

Erythema

Swelling

+/- Pain

Warmth

Elevated WBC count

# Infection: Assessment & Treatment

## Assessment

- Infections may feel warm, but skin over functioning graft always warmer than normal
- Post-operatively: erythema, swelling and/or evidence of a hematoma may be confused with infection due to invasive tunneling

## Treatment

- Antibiotics and may require surgical removal

# Steal Syndrome: Assessment

- Mild to severe numbness
- Tingling of hand
- Increased coolness of hand and digits
- Pale appearance of hand and digits
- Cyanosis
- Mild to severe pain of hands and digits

Beathard G. *Fistula First National Vascular Access Improvement Initiative. A Practitioner's Resource Guide to Physical Examination of Dialysis Vascular Access.* November 2003.

# Ischemic Monomelic Neuropathy: Assessment

- Profound weakness of hand
- Severe pain and numbness
- Unable to feel palpation to hand, fingers
- No appearance of ischemia to hand
- Hand warm
- Radial and ulnar pulses same as in other hand

**This clinical presentation requires immediate surgical intervention**

Beathard G. *Fistula First National Vascular Access Improvement Initiative. A Practitioner's Resource Guide to Physical Examination of Dialysis Vascular Access.* November 2003.

# Graft Stenosis or Occlusion: Assessment

## Normal

- Easily compressible pulse
- Continuous thrill palpable at arterial anastomosis
- Low-pitched bruit continuous throughout systole and diastole and decreases as move up arm

## Stenosis

- As stenosis increases, pulse in graft stronger and pitch of bruit increases
- Second thrill heard downstream from arterial anastomosis
- Thrill can be palpated at site of stenosis
- High-pitched bruit heard only in systole: severe stenosis
- Swelling of upper or lower arm and/or hand or breast: central stenosis
- Collateral veins in chest wall: central stenosis

# Graft Stenosis or Occlusion: Assessment

- Most common location is at venous anastomosis
- Cause-Theory:
  - Neointimal hyperplasia – smooth muscle proliferation and accumulation of extracellular matrix at site of venous anastomosis
- Presents as:
  - Increased venous pressure that can be flow limiting

Roy-Chaudhury P, et al. *J Am Soc Nephrol* 2006;17:1112-27;  
Beathard G. *Fistula First National Vascular Access Improvement Initiative. A Practitioner's Resource Guide to Physical Examination of Dialysis Vascular Access*. November 2003.

# Graft Stenosis or Occlusion: Assessment

- May occur throughout graft or draining veins
- Causes:
  - Repeated needling causing damage to AV Graft
  - Central stenosis from current or previous central catheter, PICC catheter or pace maker, which can present as swollen arm or breast
  - Previous venipuncture or intravenous of draining vein

Roy-Chaudhury P, et al. J Am Soc Nephrol 2006;17:1112-27.

# Graft Stenosis or Occlusion: Diagnosis

## Angiography

- Puncture graft with small gauge needle
- Inject contrast
- Visualize graft from venous anastomosis to central veins

# Stenosis in Draining Vein of AV Graft

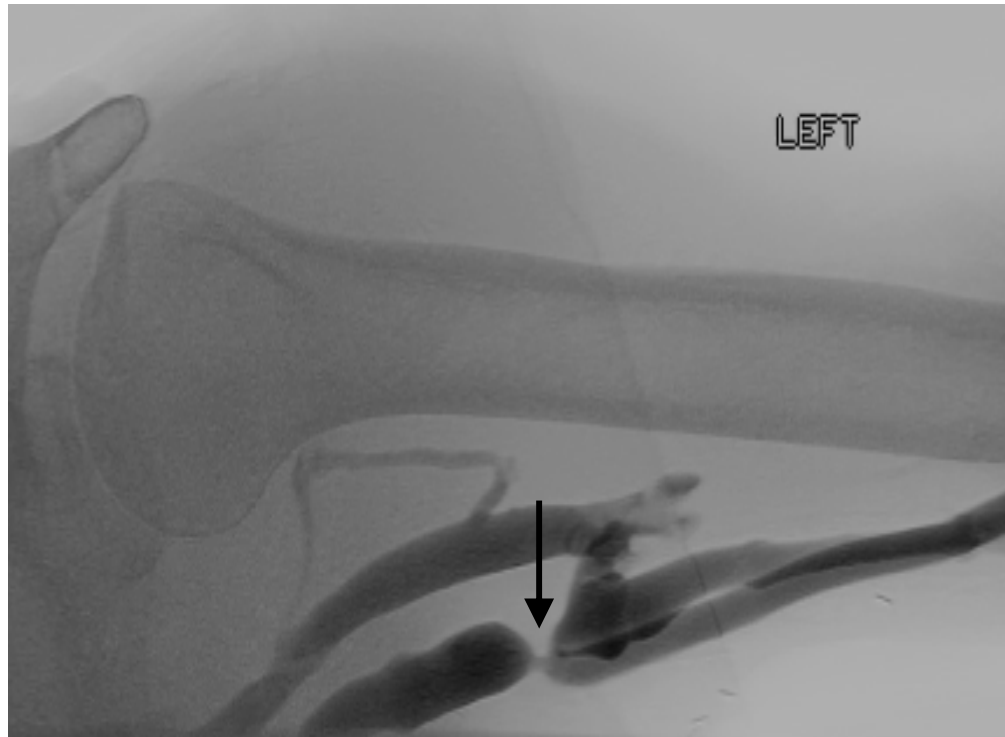


AV graft © Janet Graham



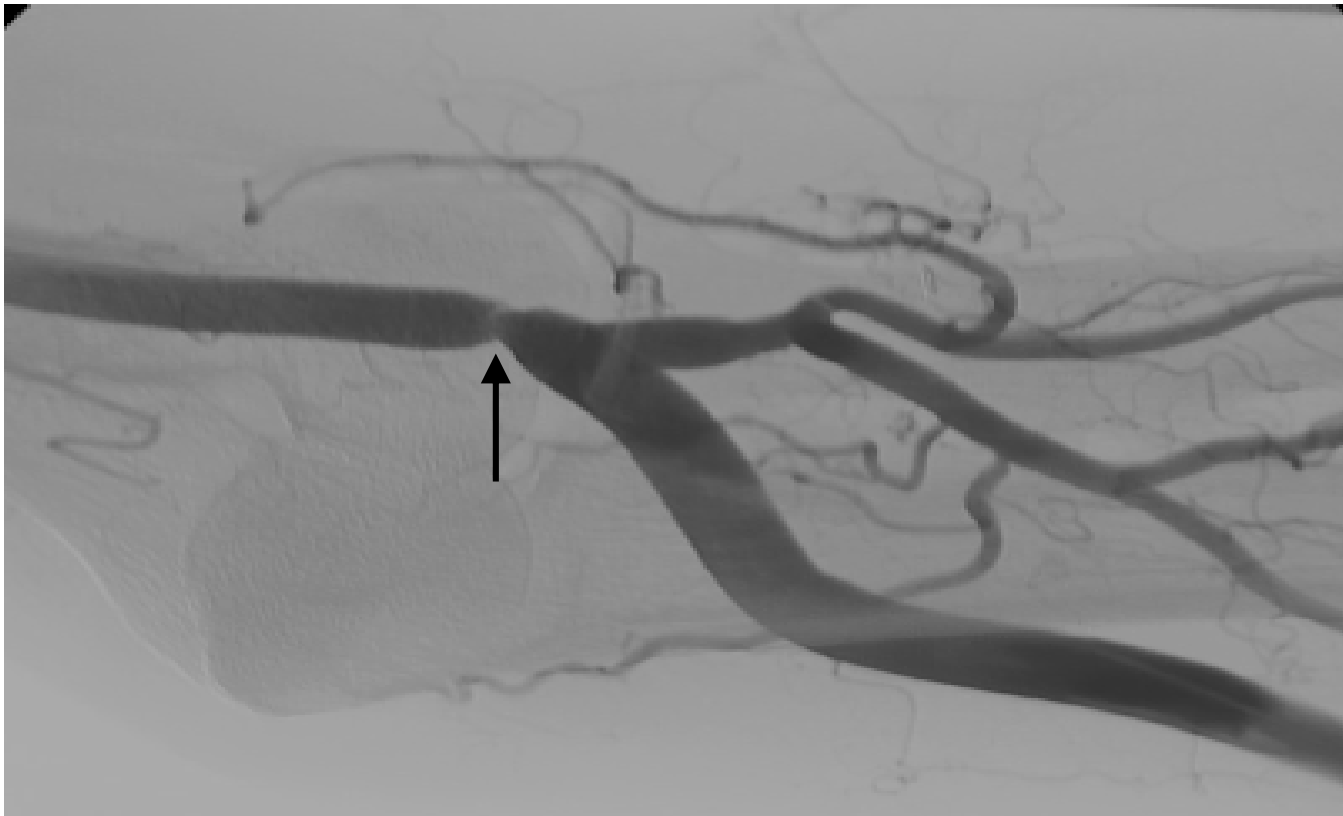
Stenosis in draining vein © Janet Graham

# Stenosis in Draining Basilic Vein of AV Graft



© Janet Graham

# Stenosis at Venous Anastomosis of AV Graft



© Janet Graham

# Graft Stenosis: Treatment

- Venous stenoses do not respond as well to angioplasty as arterial stenoses
- Guidelines recommend treatment of stenosis  $\geq 50\%$  reduction of normal vessel diameter accompanied by hemodynamic, functional or clinical abnormality
- Prospective surveillance plus correction improves patency and reduces incidence of thrombosis

Jindal K, et al. *J Am Soc Nephrol* 2006;17:S16-23;

National Kidney Foundation. KDOQI Clinical Practice Guidelines and Clinical Practice Recommendations for 2006 Updates: Vascular Access. *Am J Kidney Dis* 2006;48(suppl 1):S1-S322.

# Graft Stenosis: Angioplasty

Short vascular sheath inserted



Guidewire advanced into graft



Normal vein proximal to stenosis or distal to post-stenotic dilatation measured



Angioplasty balloons inflated for ~ 20 – 30 seconds



Balloon removed and another angiogram performed



If residual stenosis > 30%, angioplasty repeated with larger balloon

# Pseudoaneurysm: Assessment

- Palpation: dip or missing piece of graft felt
- Appears pulsatile
- Only thin skin and thin layer of fibrosed subcutaneous tissue at defect site
- Over time, graft will dilate at defect site and form pseudoaneurysm

Beathard G. *Fistula First National Vascular Access Improvement Initiative. A Practitioner's Resource Guide to Physical Examination of Dialysis Vascular Access.* November 2003.

# Pseudoaneurysm: Assessment & Treatment

## Assessment

- Monitor poorly healed needle sites
- Will grow in size
- Can ulcerate and bleed spontaneously
- If thrombosed, clot can adhere to inside of pseudoaneurysm

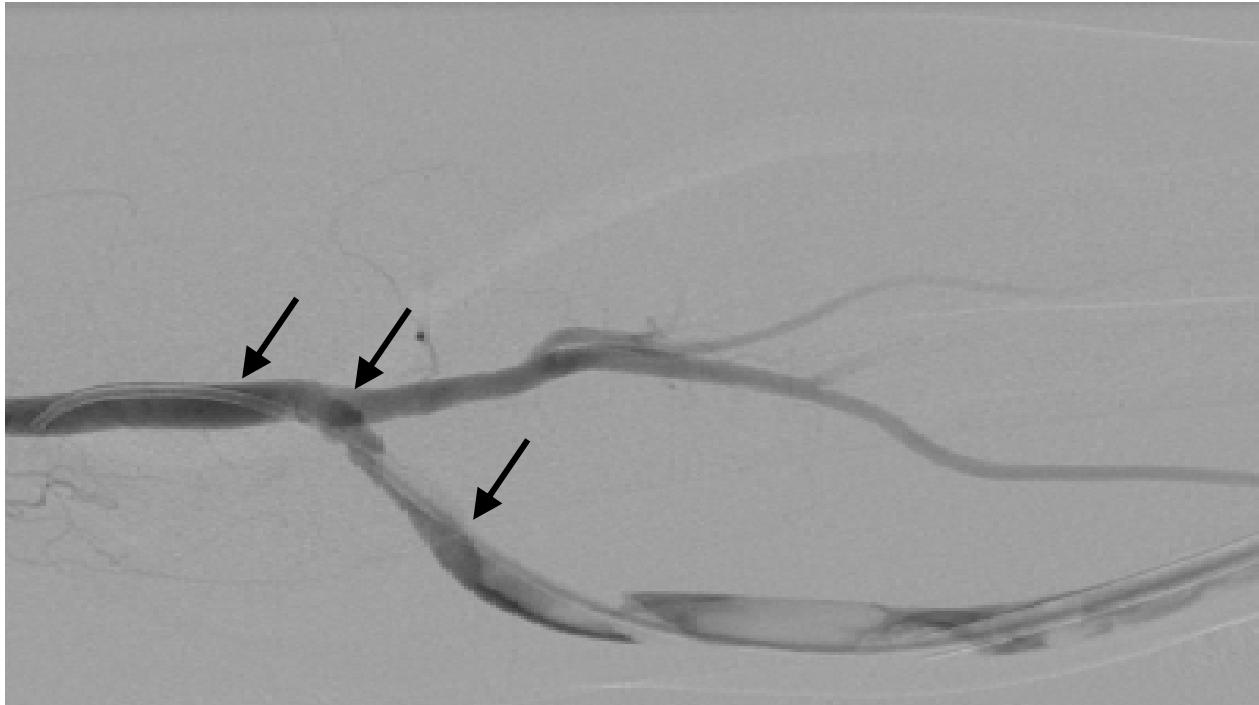
## Surgery required when:

- Palpation of aneurysms twice “normal” diameter of graft
- Thin, shiny areas on graft that appear red
- Unhealed needle sites
- Necrotic areas

# Thrombosed Grafts: Treatment

- Surgical thrombectomy +/- revision
- Mechanical thrombectomy
- Pharmacomechanical thrombectomy

# Thrombosis in AV Graft



© Janet Graham

# USING PORTABLE ULTRASOUND TO ASSIST WITH CANNULATION



*Cartoon licensed for use from Jazz Communications Ltd., publishers of The Lighter Side of Dialysis.. To order a copy or more information please visit [www.lightersideofdialysis.com](http://www.lightersideofdialysis.com) or call 1-866-239-3279.*

# Portable Ultrasound Use

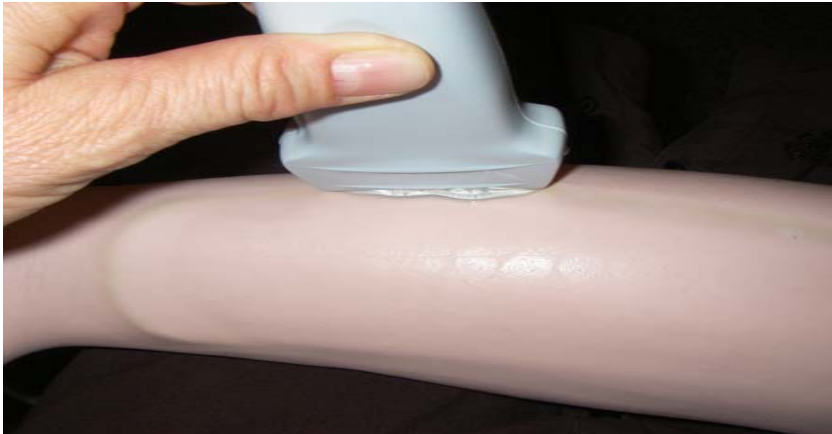
## Before Cannulation

- To determine the depth & direction of the vessel
- To identify areas of the vessel that are straight for threading the needle its full length
- To draw the location of the vessel on the patient (to make it easier for other nurses; may also photograph location & put in chart)

## After Cannulation

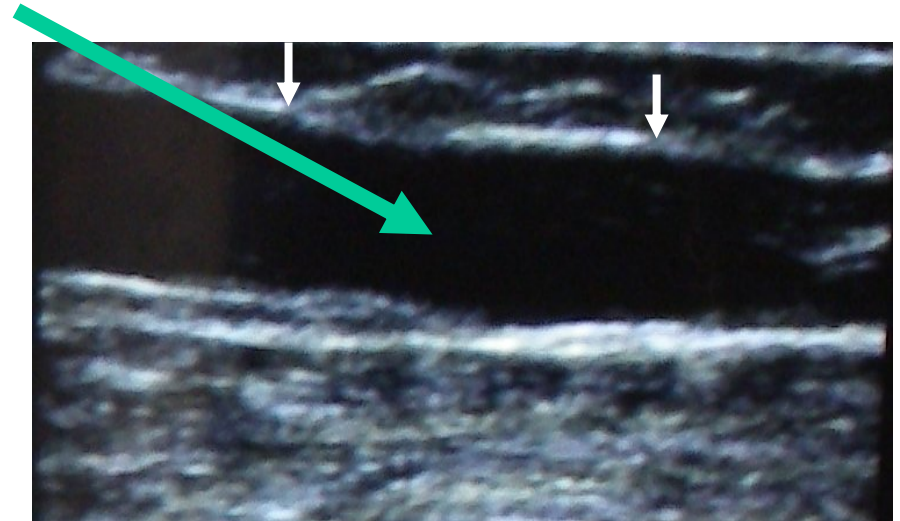
- To determine the position of the needle (is it straight & deep enough? Is it in the wall of the vessel?)

# Ultrasound Enables Lengthwise Mapping

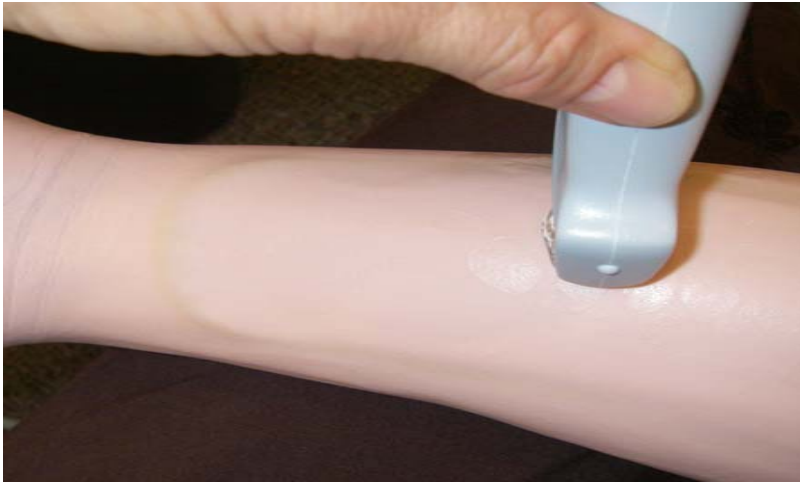


This picture shows there is an area of the access that is straight enough for a fistula needle to be threaded completely.

Note downward trend of vessel indicated by white arrows that show distance from skin to the vessel. This suggests fistula needle should not be flattened out too much, assuming needle is being directed according to angle of the green arrow

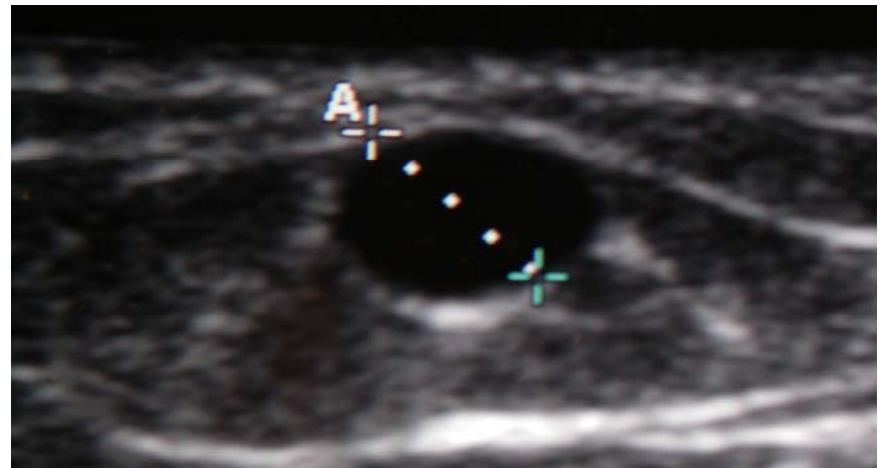


# Ultrasound Enables Crosswise Mapping



The dotted lines below show the diameter of the vessel, while the white arrow shows the depth. The diameter is approximately 0.6 cm and the depth is approximately 0.25 cm.

As fistula needles are 2.5 cm long, a diameter of 0.6 cm makes it possible to get the needle well into the fistula before flattening out and threading.



# Ultrasound Enables Marking the Location of the Vessel



Black dots may be used to show the location of the vessel (to ensure aneurysm is not being needed). Sharpie black felt pens work well & do not wash off.

# Tips for Success Using Ultrasound

- Use lots of warm lubricant (warm lubricant encourages vasodilation)
- Don't press down too hard with the ultrasound (or it flattens the vessel and makes it harder to find)
- Face the dot on the ultrasound probe toward the patient's head