Fistula Maturation
Part II

SKC In-service June 2015

Factors that influence fistula maturation

Post-Op

Pre-Op

Intra Op

Pre-Operative Assessment

- Physical exam
  - Venous evaluation - tourniquet and ruler method
    - Underestimates suitability of veins
  - Arterial evaluation
    - Allen test – evaluate patency of palmar arch
    - BP difference in extremities
      - <= 10mmHg normal
      - >= 20mmHg may suggest proximal arterial disease

Pre-Operative Assessment

- Ultrasound Exam (Vein mapping)
  - Can discover veins missed on exam
  - Improves chance of having a fistula placed
  - Arterial evaluation
    - Diameter > 1.6mm, without stenosis/calcification
  - Venous evaluation
    - > 2.5mm, no deeper than 0.5cm, 8-10cm straight segment
    - No central vein visualization

Pre-Operative Assessment

- Venography
  - Offers central vein evaluation
  - Contrast required, invasive

Patient Factors

- Worse odds: Women, African Americans, Hispanics, age older than 85 years, diabetes, peripheral vascular disease, congestive heart failure, other cardiac disease, and underweight
- Better odds: Hypertension, overweight, >12mo of nephrology care, all insurance except Medicaid, starting HD after 2005
- History of central venous catheters

- Even patients with the above factors can have a successful fistula placement!

Lilly et al. Am J Kidney Dis. 2012 Apr;59(4):541-9

Patient Training/Pathways to AVF/AVG:

VAC: teaching new patients "TLC"

Touch: thrill present/absent

Look: redness, swelling pus;
finger discoloration

Care: clean; loose clothing;
avoid compression, heavy
carrying, BP in arm

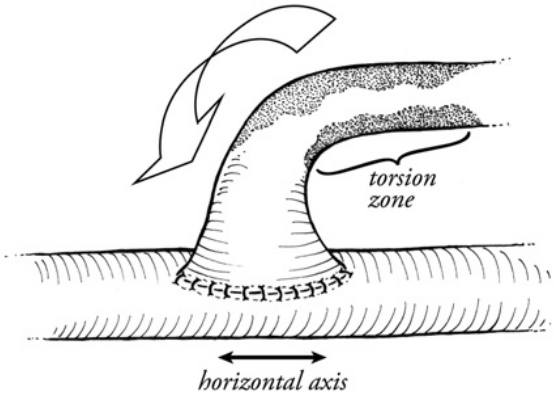
New: lower arm: squeeze ball
upper arm: elbow bends w/
light weight several times/day

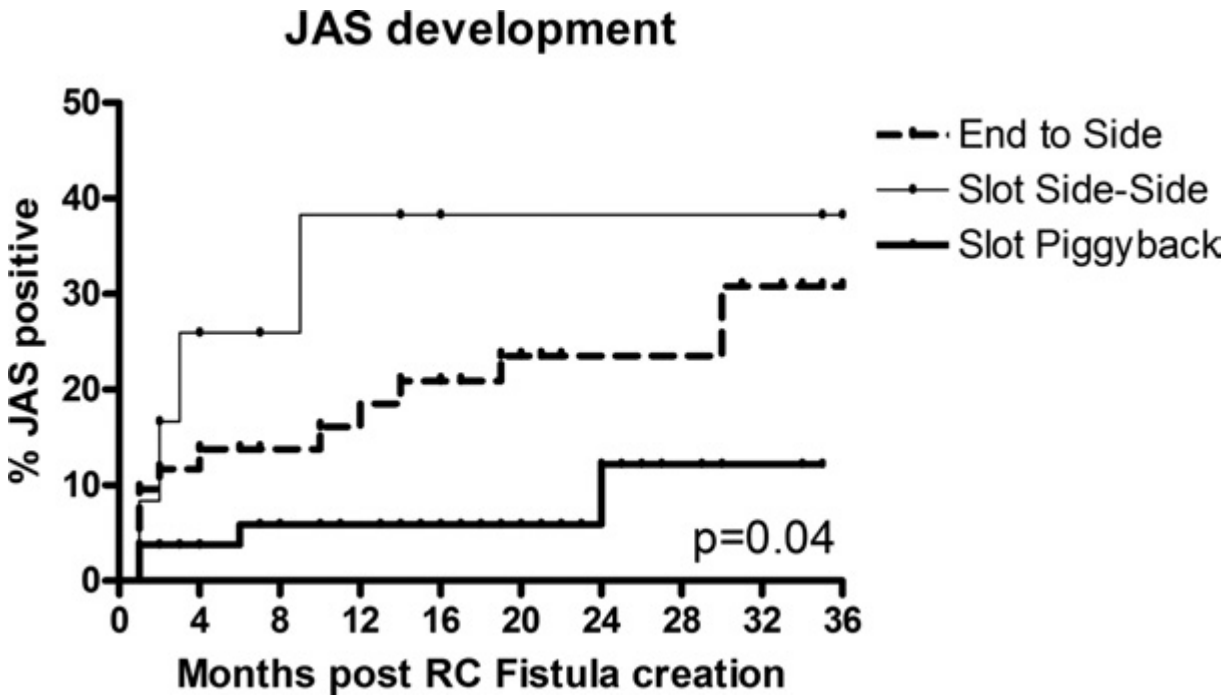
Provider factors

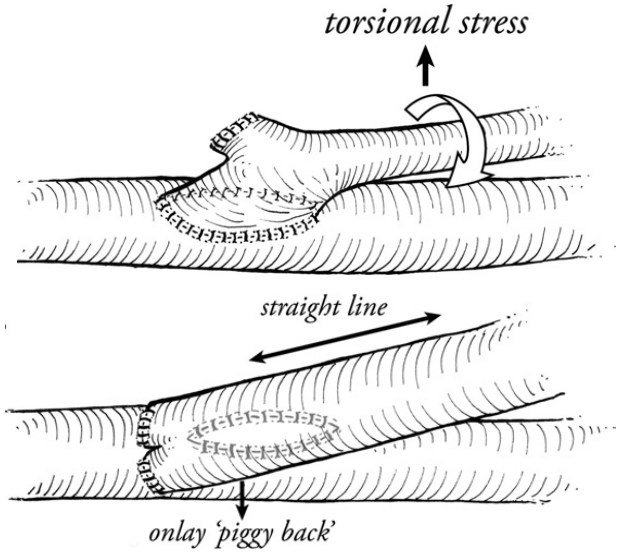
- Surgical expertise
- Interest in access placement
- Training in access placement
- Structured surgical programs and support staff for AVF creation

Intra-operative factors

- Handling of the tissues
- Suturing technique







Bharat et al. J Vasc Surg. 2012 Jan;55(1):274-80

Intra-operative blood flow

- Radiocephalic fistulas (N=58):
  - Functional vs non functional (230 vs 98 mL/min; P = 0.007)
  - Blood flow < 120 mL/min predictive of early failure in RCAVF
- All fistulas (N=70)
  - Functional vs. non-functional (573.6+/-103 mL/min vs. 216.8+/-35.8 mL/min; p<0.05)
  - Threshold of 140 mL/min for radiocephalic and 308 mL/min for brachiocephalic AVFs to predict maturation to a functional access

Saucy et al. Nephrol Dial Transplant. 2010 Mar;25(3):862-7

Berman et al. J Vasc Access. 2008 Oct-Dec;9(4):241-7

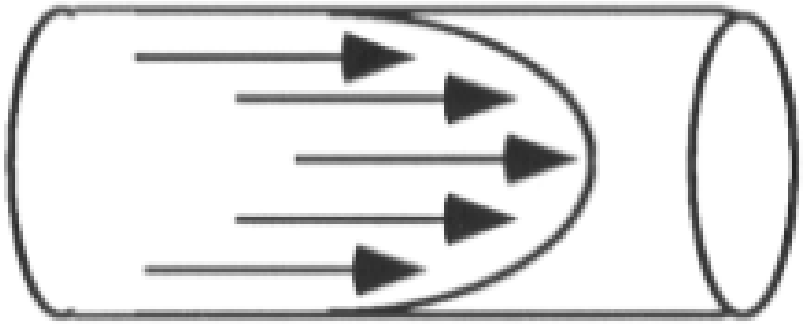
Other intraoperative factors

- Anastamotic angle
- Distance between artery and vein
- Correct selection of incision site
- Intraoperative vein mapping
- Use of tourniquet for the arteriovenous anastamosis
- Ligation of collateral vein branches

Huesynova et al. J Vasc Access. 2012 Apr-Jun;13(2):175-9

Post-operative factors

- Vessel response to sheer stress
  - Sheer stress is the difference between the velocity of the innermost portion of the vessel and the outermost boundary

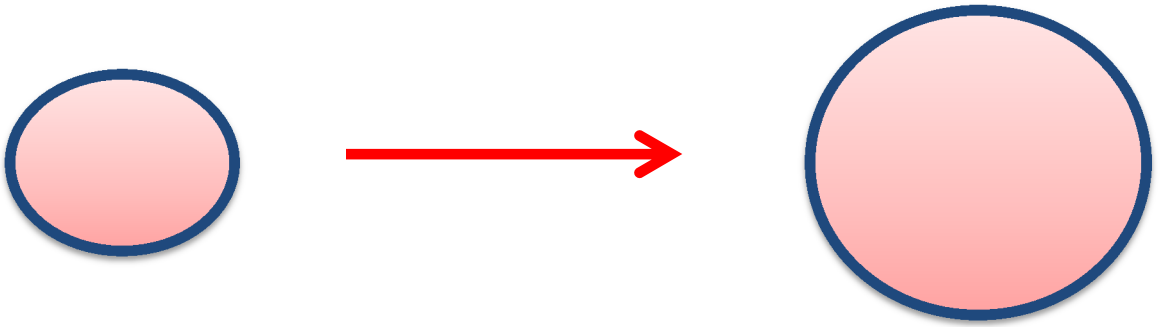


Sheer stress = $4\mu Q / \pi r^3$

Mechanical impact of sheer stress

After increase in flow, vessel will attempt to regulate the amount of sheer stress

Sheer stress = $4\mu Q / \pi r^3$



Biological impact of sheer stress in arteries

↑ Sheer stress

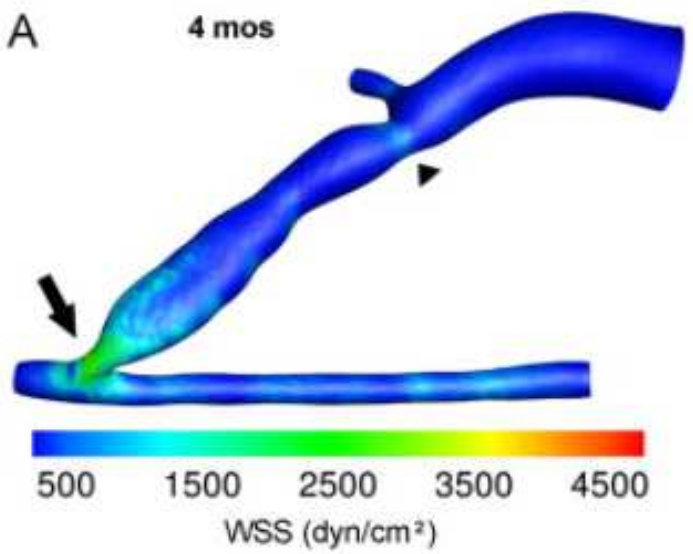
Increased survival of endothelial cells
Endothelial cells align with the flow
Increased secretion of vasodilators: NO, prostaglandins
Inhibition of platelet aggregation (also NO, prostaglandins)
Regression of neointimal hyperplasia

Vessel dilation and reduction of sheer stress

Veins: Less well known, medial hypetrophy occurs ? (may be independent of sheer stress)

Biologic reasons for failure of maturation

- Failure of arterial dilation
- Failure of venous dilation
- Excessive venous neointimal hyperplasia (inward remodeling)



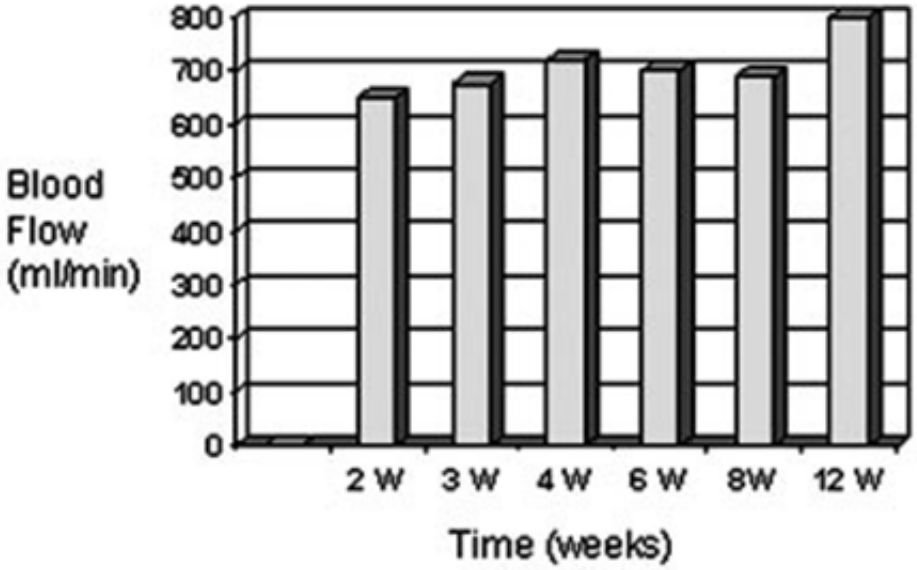
He et al. J Biomech. 2013 Jan 4;46(1):165-9.

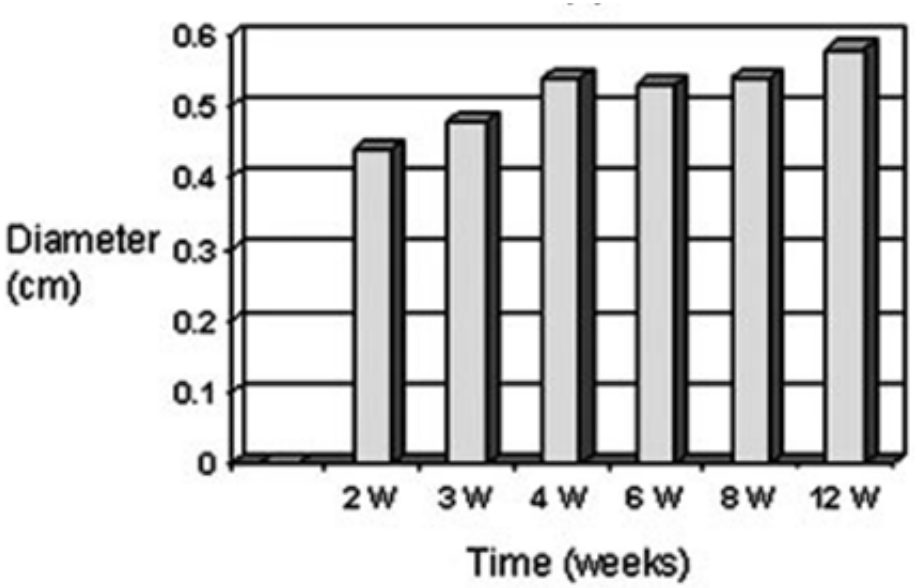
Bottom line

1. AVF needs adequate blood flow to support dialysis

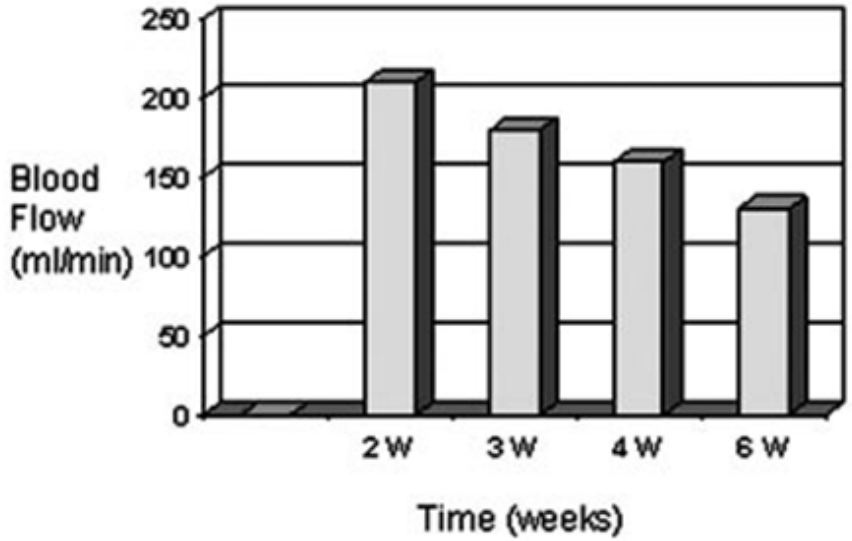
2. AVF needs adequate diameter to support needle placement

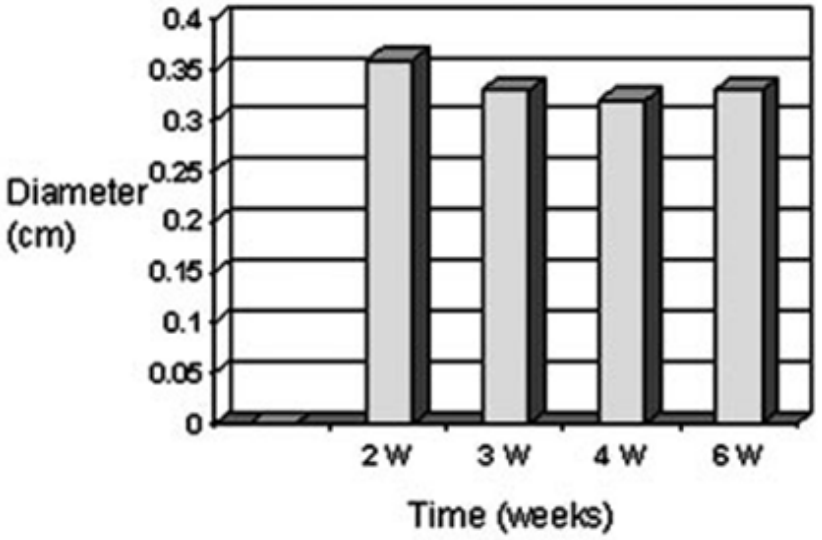
Healthy, maturing fistula:





Fistula with maturation failure:





Asif et al. Clin J Am Soc Nephrol 1: 332–339, 2006

AV Fistula Maturation

- Fistula becomes suitable for cannulation, develops:
  - adequate flow
  - wall thickness
  - diameter

- Rule of 6's: mature fistulae:
  - have a blood flow greater than 600 mL/min
  - are a minimum of 6 mm in diameter with discernible margins when a tourniquet is in place
  - are less than 6 mm deep
  - are evaluated for non-maturation 4–6 weeks after surgical creation if it does not meet the above criteria

National Kidney Foundation. *Am J Kidney Dis.* 2006;48(suppl 1):S1-S322.

AV Fistula Maturation

AVF Assessment for Maturation

Patient Access AVF

Assess for maturation 4th week - ultrasound

Signs of maturing e.g.
>1" in length
BF > 200ml/min
< 6mm deep

No → Call surgeon for intervention within 1 business day – notify nephrologist

Yes

Assess Maturation -6 weeks
Vein diameter > 6mm
Blood flow > 600 ml/min
<6mm from skin surface

Yes → Access ready for use @ 6 weeks

No → Call surgeon for intervention within 1 business day – notify nephrologist

Call for order to use access

Use AVF using access guidelines

Access Guidelines

AVF – Week 1
17 gauge needles for both A&V or
17 gauge needle for arterial needle– catheter for venous return
Qb @ 250
3 tx x 2 needles – assess for catheter removal

Week 2
16 gauge 1" needles both A & V
Place 2" apart – placement can be either direction – venous antegrade
Rotate sites
Qb 300 ml/min
If still 2 needles- assess catheter removal

Week 3 & ongoing
Increase blood flow to MD order
Adjust needle gauge to blood flow rates
Adjust heparin off time to MD order

Blood flow rates to needle gauge
200 – 250 ml/min = 17 gauge
250 – 350 ml/min = 16 gauge
350 – 450 ml/min = 15 gauge

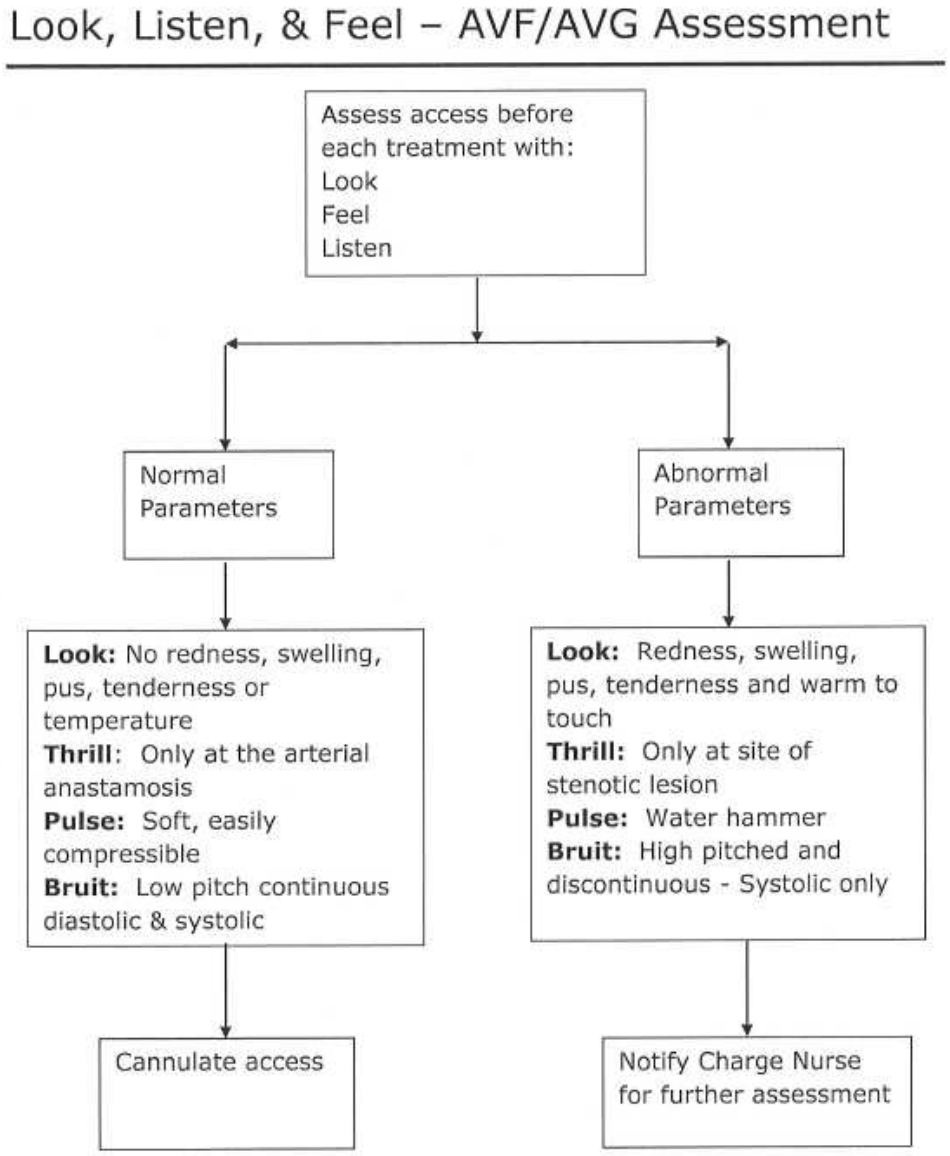
Access Maturation:

What should the caregiver find with a good fistula?

- meets criteria for initial use
- vessel walls firm to touch
- very few/no prominent collaterals
- continuous low-pitched bruit
- strong bruit/thrill at arterial anastomosis

M. Moya, MD

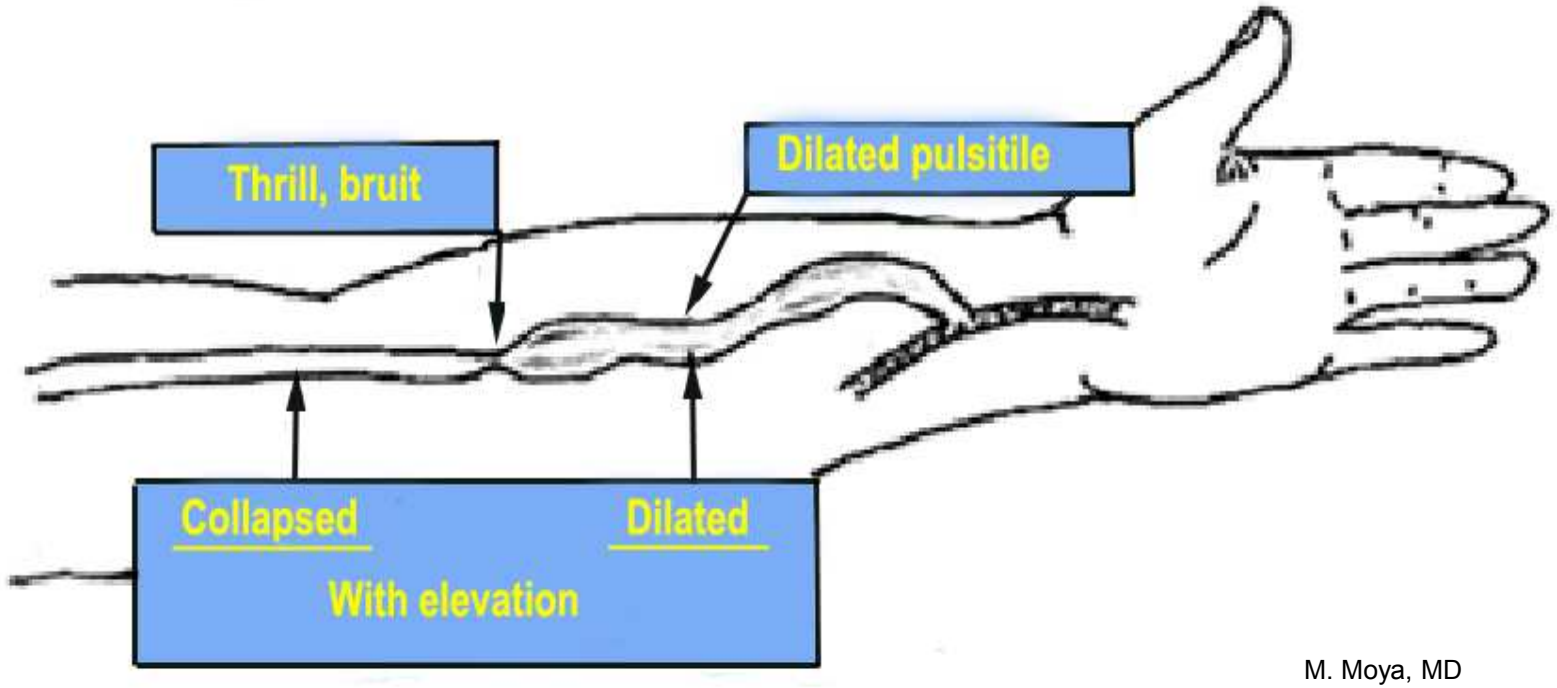
Every Caregiver's Task



Detecting Fistula Outflow Stenosis

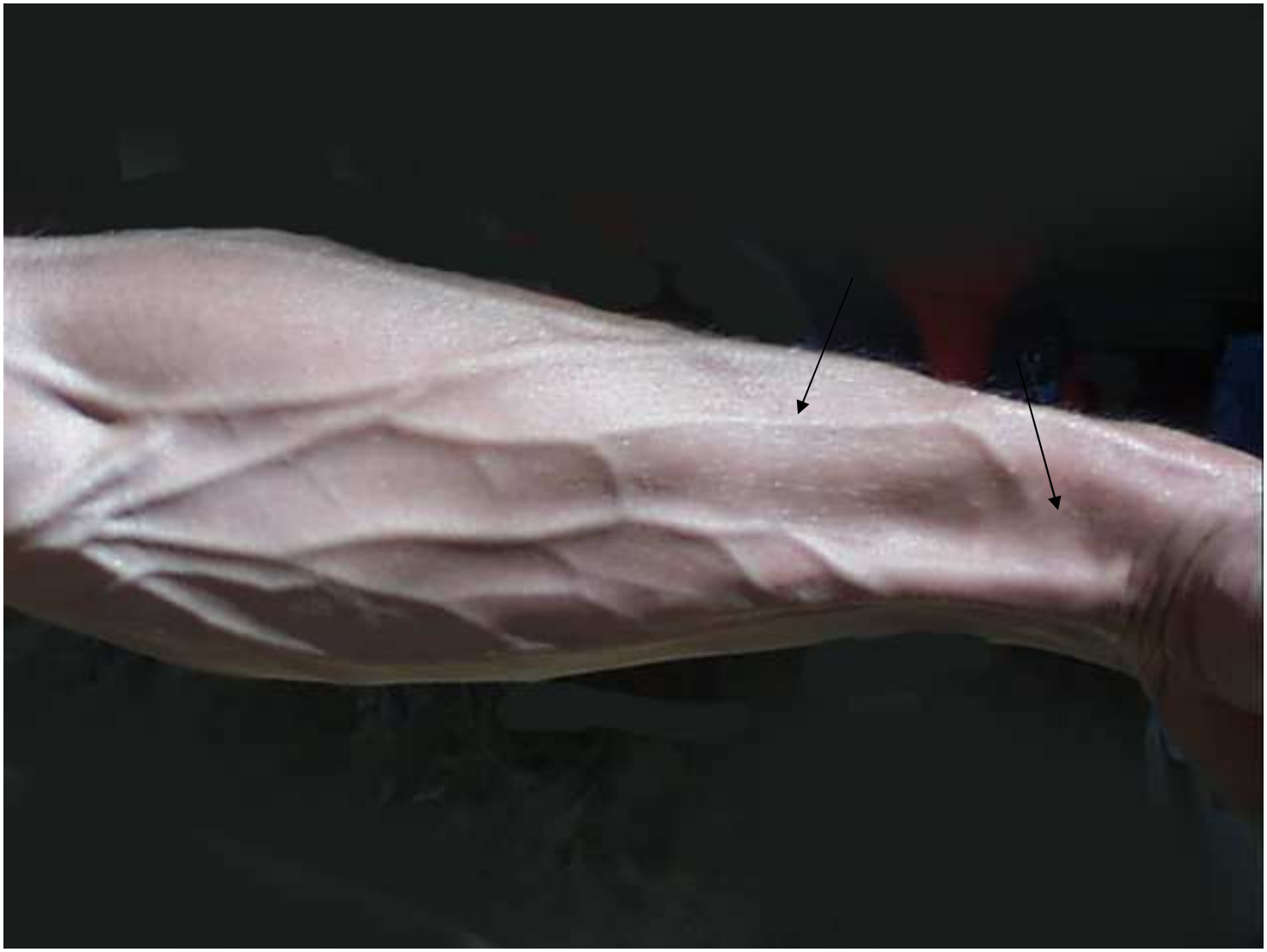
Normal fistula
- soft with a continuous thrill
- easily compressible with instant pressure increase
- with arm raised - collapses, becomes flat

Stenotic fistula
- increased pulse and firm pressure to touch
- distended
- when arm is raised:
  distal to lesion – distended
  proximal to lesion - collapsed



M. Moya, MD

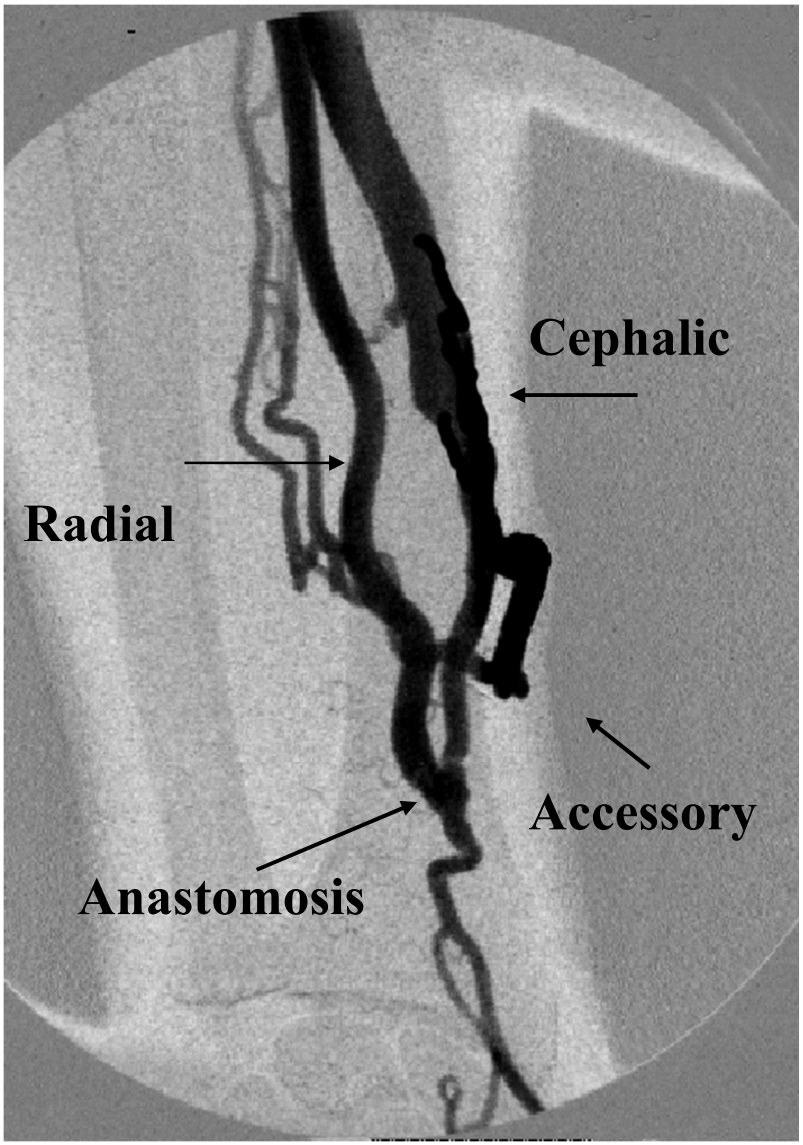
Access exam: radiocephalic fistula



What's wrong here? What is to be done?

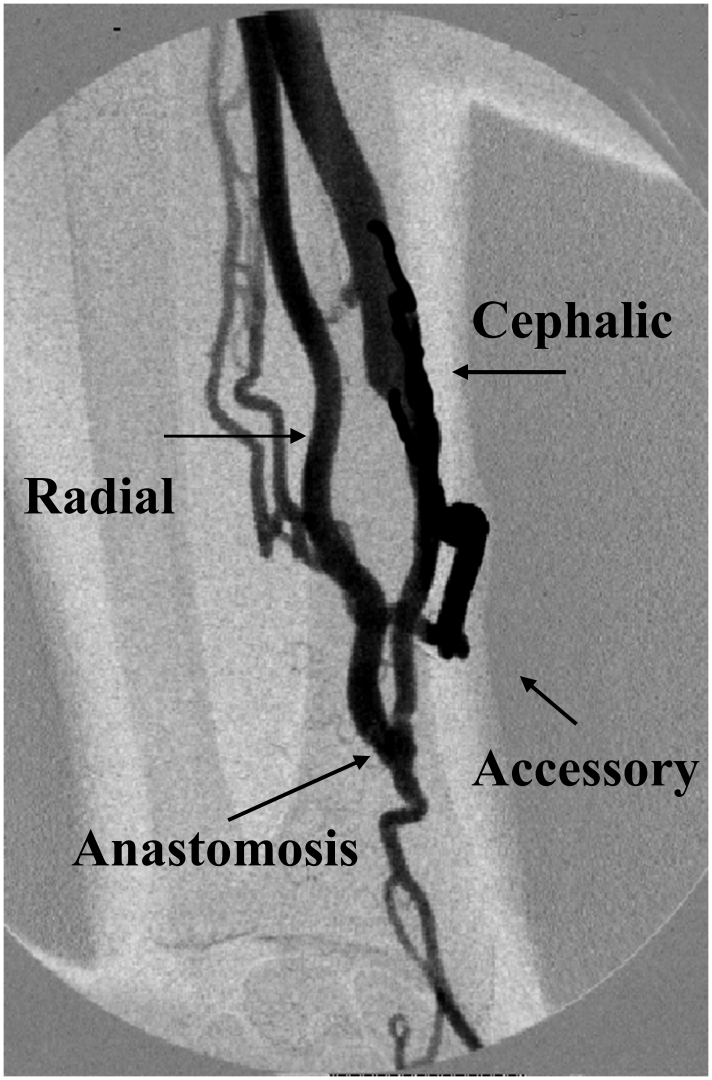
adapted from M. Moya, MD

What is the problem?



adapted from M. Moya, MD

How was this fixed?



M. Moya, MD

Native Radio-Cephalic AVF

M. Moya, MD

Access Exam: Unilateral Edema

http://www.homedialysis.org/

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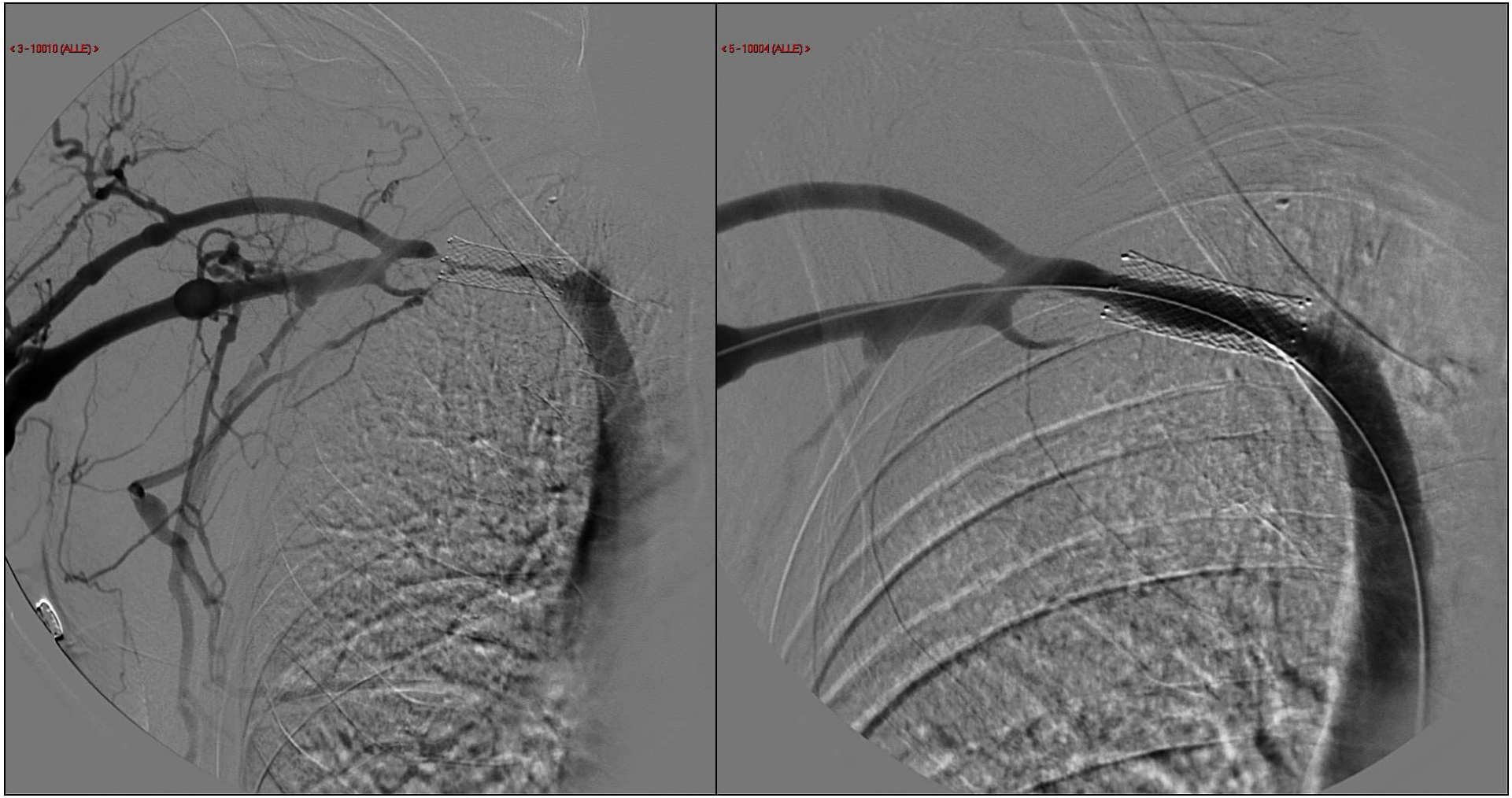
Central Stenosis



Conclusions

- Recognize patients at high risk for AVF maturation failure
- Assess fistula at 4-6 weeks for appropriate increase in flow and diameter
- Consider intervention or revision early if not meeting goals
- All care providers are responsible for ensuring that fistulas mature in a timely fashion!