Anastomotic techniques reduce
1/ Juxta-anastomotic stenosis 2/ High flow ?

YES ....BUT

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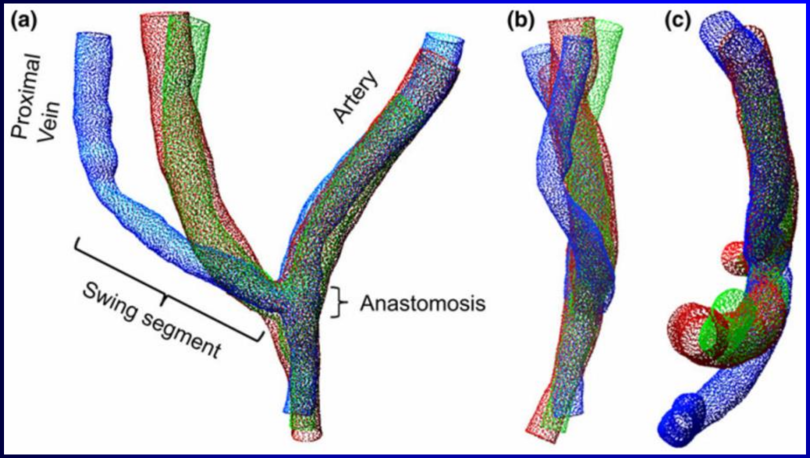
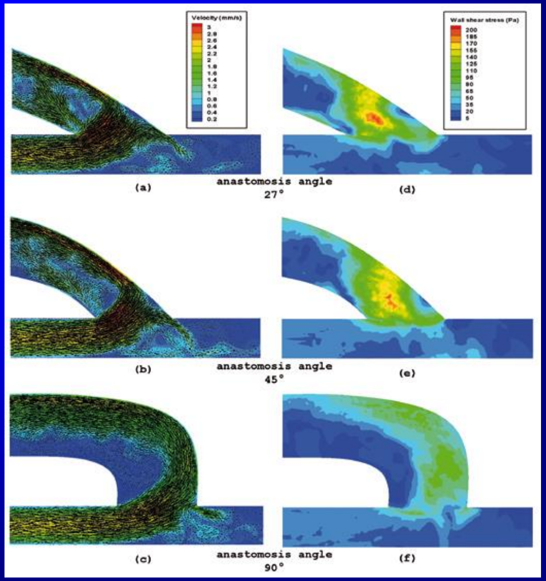




Controversies & Updates in Vascular Surgery
Paris, January 23, 2015

Introduction

60% failure to maturation

43% - 65% juxta-anastomotic stenosis major cause for early AVF failure and arrested maturation

Intimal hyperplasia

- Geometry of the AVF
- Hemodynamical changes due to increase flow and "shear stress"
- Remodeling process
- Patient factors

Critical point : juxta-anastomotic segment

Sivanesan et al. Sites of stenosis in AV fistulae for haemodialysis access. Nephrol Dial transplant 1999

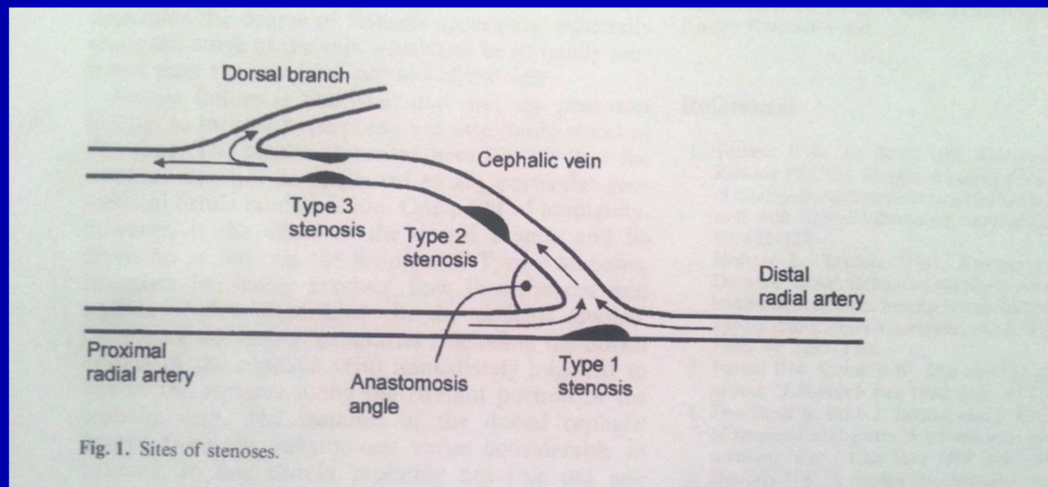


Fig. 1. Sites of stenoses.

Type I : at the anastomosis (12/25)

Type II : on the courvature of the vein “swing segment” (5/25)

surgical technique, anatomical conditions

Type III : where the veine straightens out (17/25)

Critical point : juxta-anastomotic segment

Bharat et al. A novel technique of vascular anastomosis to prevent juxta-anastomotic stenosis following AV fistula creation. J Vasc Surg 2012

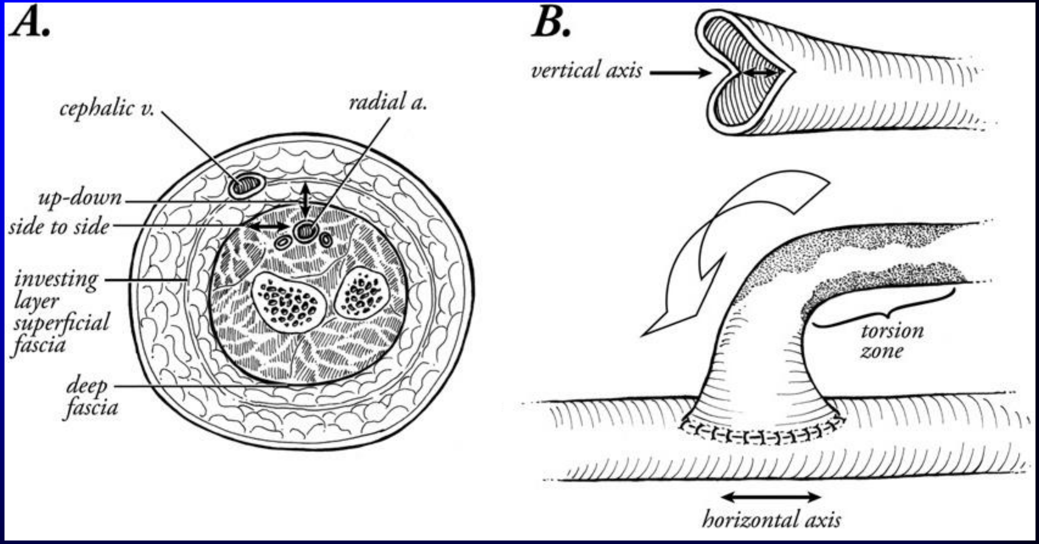
"torsional stress zone" within 1 to 4 cm from the anastomosis

End-to-side anastomosis "torsional stress zone" created by the three-dimensional vein movement

1) Superficial to deep (up to down)

2) Side to side (lateral to median)

3) Horizontal axis to vertical axis (vein cut end is vertical axis and the arteriotomy is horizontal axis)

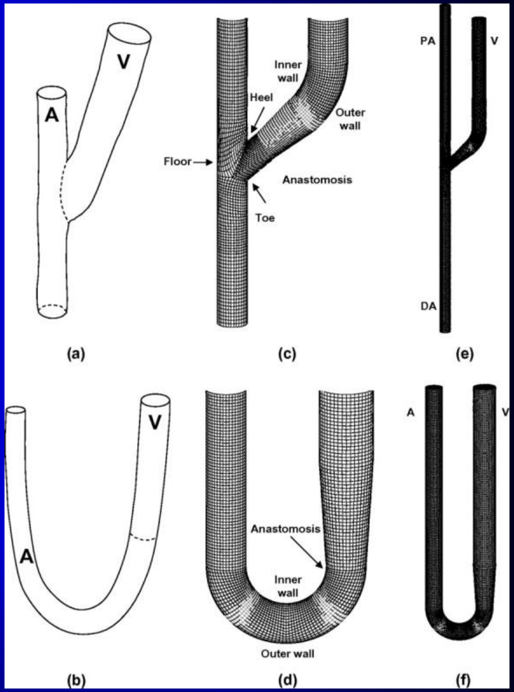


Type of anastomosis

End-to-side : "torsional stress zone" created by the three-dimensional vein movement

End-to-end :"additional torsion point on the arterial side"

Stanziale et al. Hemodial Int 2010



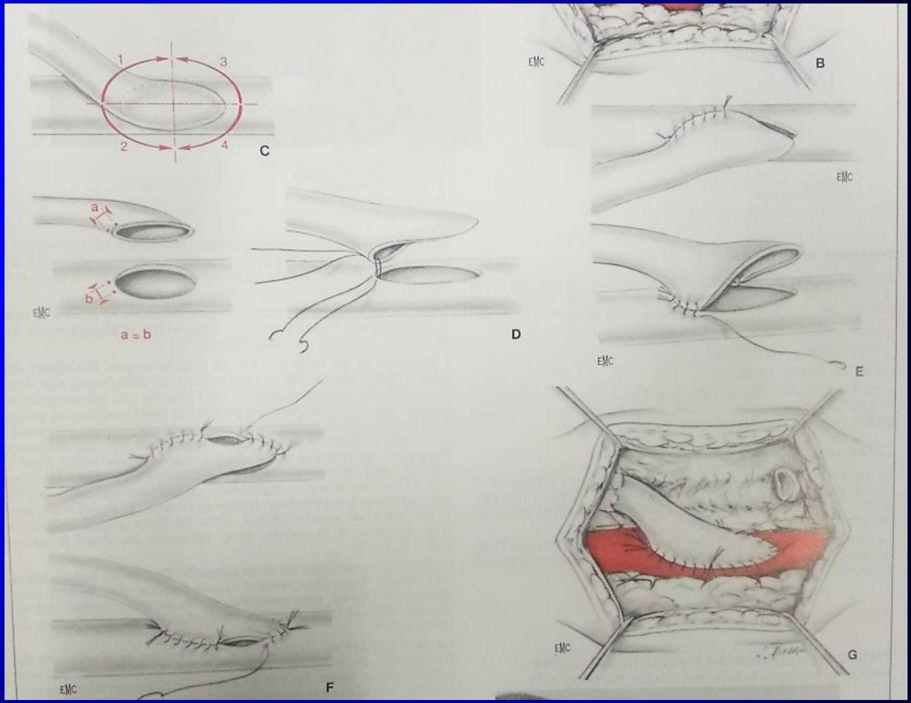
Stenosis : 21.4% end-to-end vs 2.5% end-to-side

Thrombosis : 10% end-to-end vs 4.1% end-to-side

Technique of anastomosis

Fassiadis et al. Semin Diak 2007

Torsional strain tends to be the greatest when branch points are used to create an anastomotic hood. It can be reduced by spatulating the vein



Type of suture

running suture

separate stitches

Critical points : heel and tip of the anastomosis

Length and angle of anastomosis

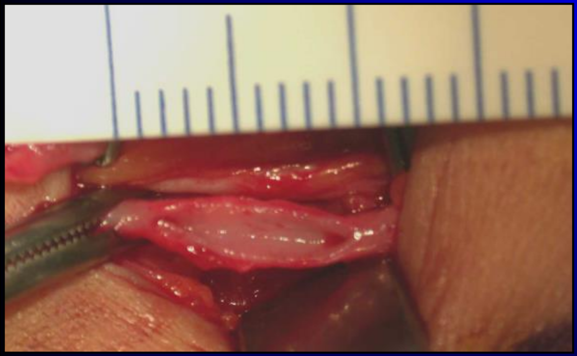
AVF at the wrist

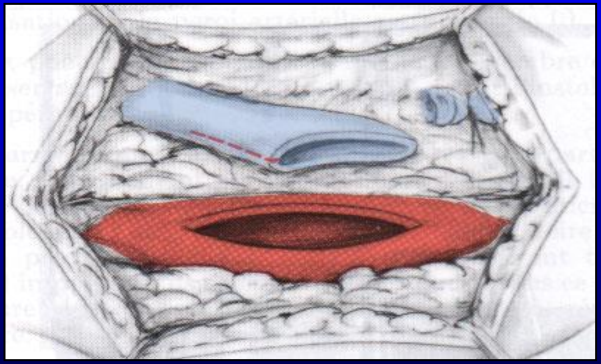
Ideal length : 10 mm

7 mm : elliptic shape after maturation = 10 mm

Shape : spatulated anastomosis

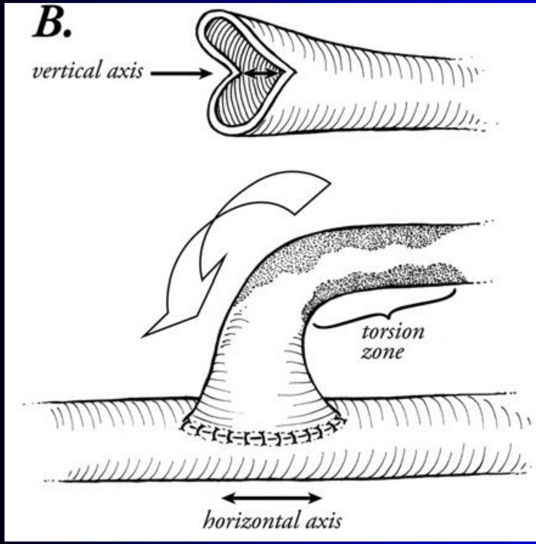
Ideal angle : 30°- 45° based on anatomical conditions : vessel wall alignment

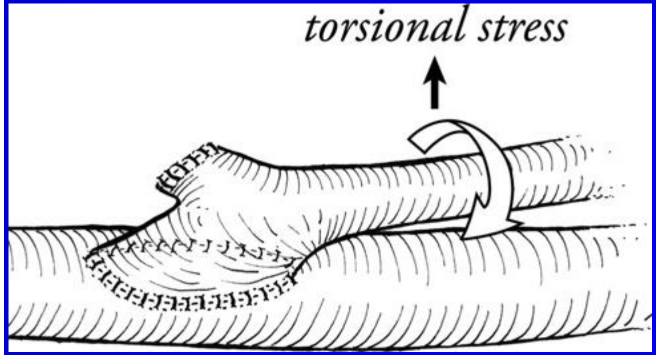


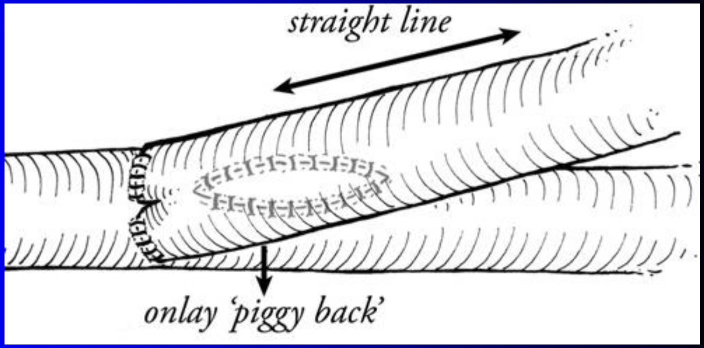


Length and angle of anastomosis

A novel technique of vascular anastomosis to prevent juxta-anastomotic stenosis following AV fistula creation. Bharat et al. J Vasc Surg 2012







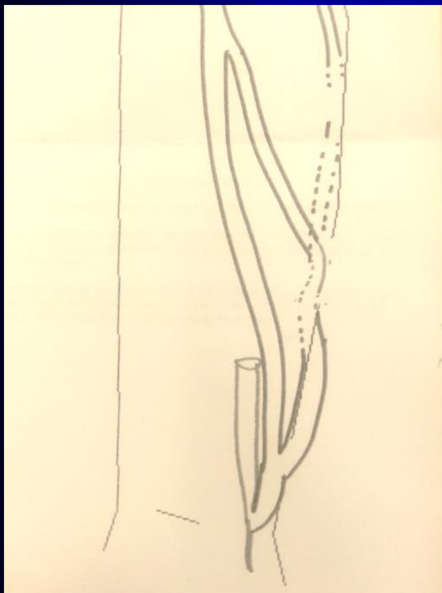
Traditional end-to-side technique

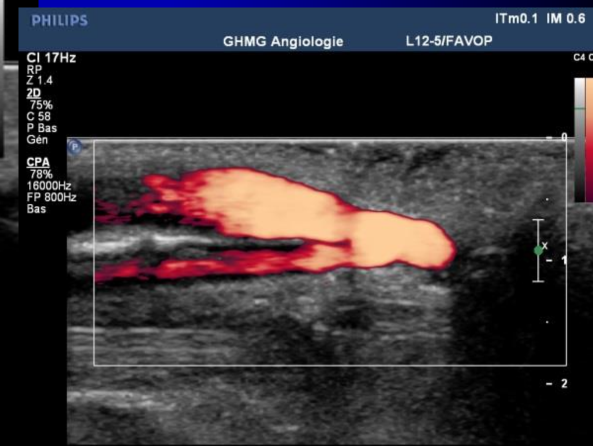
SLOT straight-line onlay technique

pSLOT "piggy back" straight-line onlay technique

pSLOT eliminating the torsional component and maintaining proper vessel alignement, resulted in significant reduction of juxta-anastomotic stenosis

Technique of anastomosis





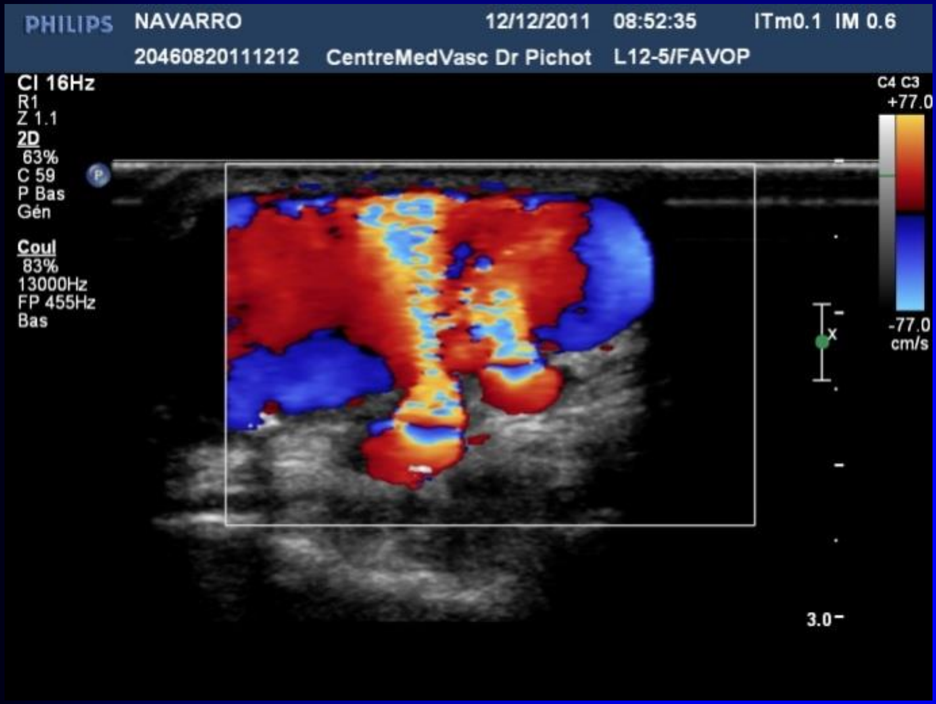
Lack of maturation:
Radiocephalic AVF

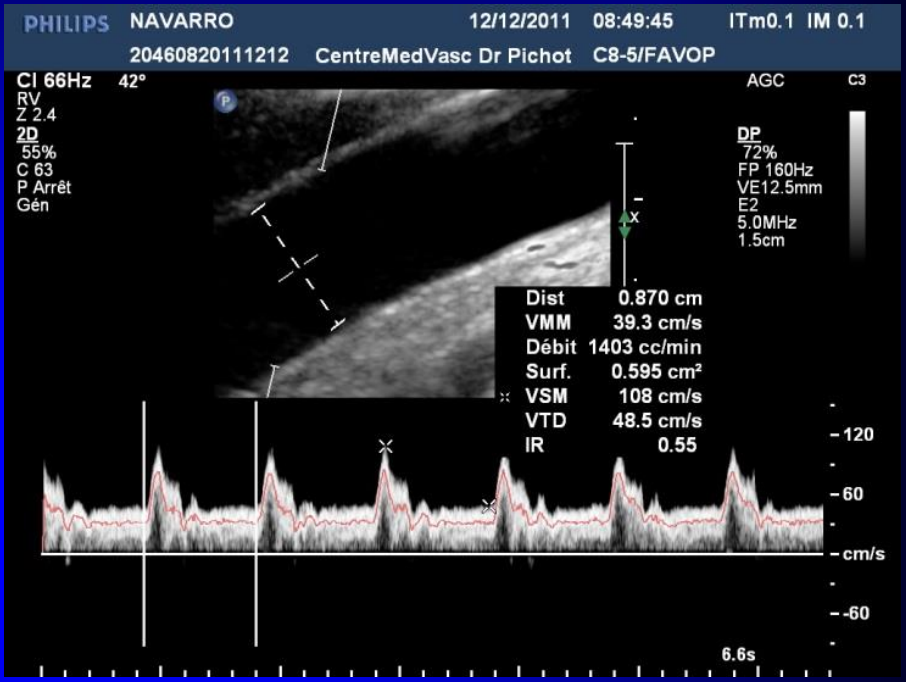
low flow 300 ml/min

stenosis of the radial artery at the heel

thrombosis of the distal radial artery

Technique of anastomosis





“atypical” configuration of a radiocephalic AVF with “normal” flow

Length and angle of anastomosis

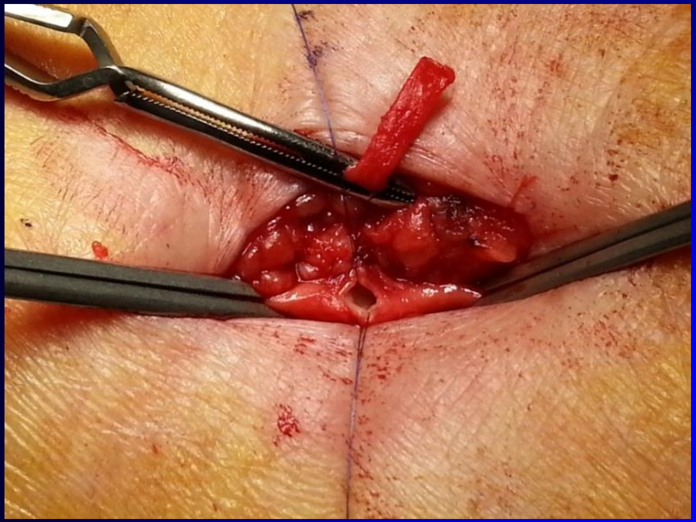
Elbow AVF

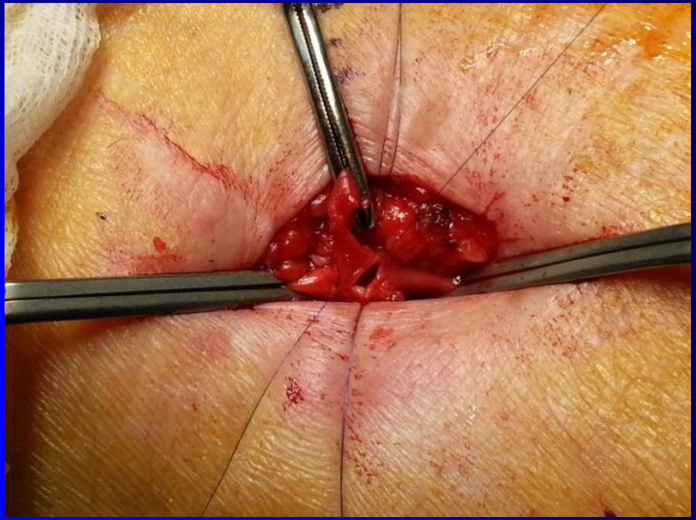
Ideal length : 5-6 mm

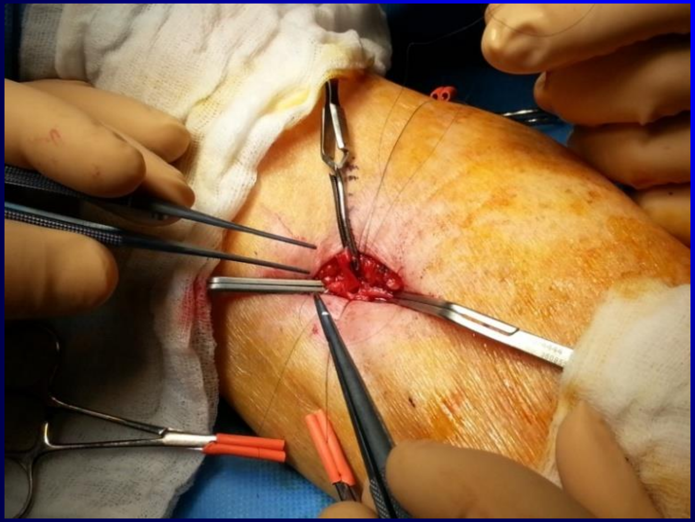
Non spatulated shape

Ideal angle: based on anatomical conditions : 25°- 90°

Brachio-cephalic AVF

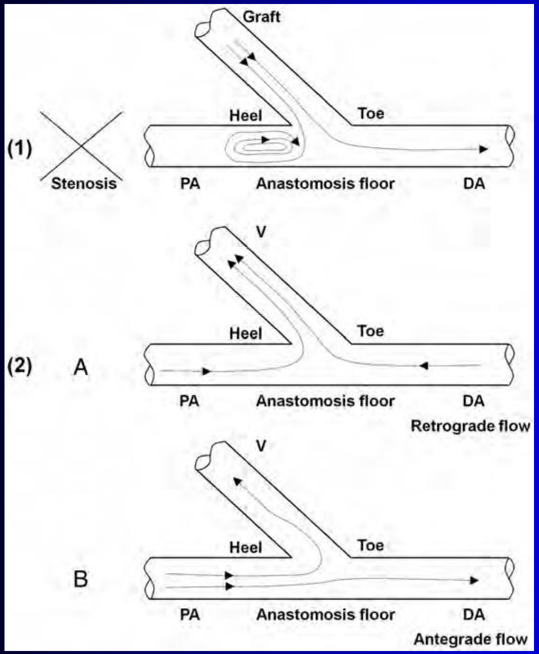


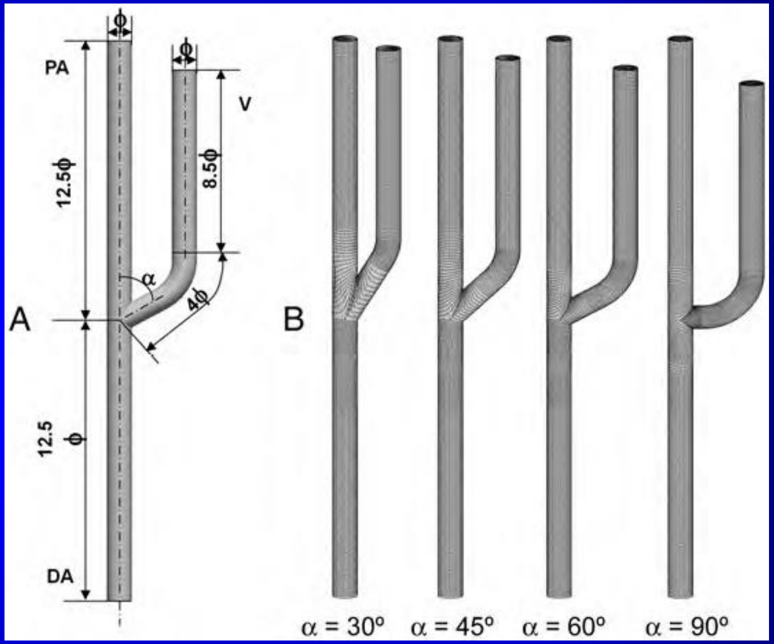




Geometry of anastomosis

Ene-Iordache et al. Effect of anastomosis angle on the localization of disturbed flow in "side-to-end" fistulae for haemodialysis access; Nephrol Dial Transplant 2013





"among the four geometries we considered in this study, the smaller angle (30°) would be the preferred choice that minimize the development of neointima"

Geometry of anastomosis

Numerical model study of flow dynamics through an end-to-side anastomosis: choice of anastomosis angle and prosthesis diameter. Pousset et al. Ann vasc surg 2006

Angle of anastomosis : 18°, 25°, 35°, 45°

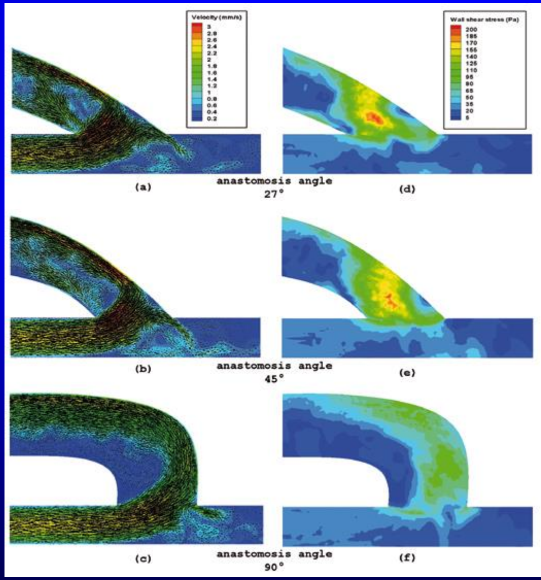
Prosthesis diameter : 4, 5, 6 mm

“the angle of anastomosis that minimize wall shear stress was 18°. ….these findings suggest that surgeons should choose as acute angle of anastomosis as possible.

Geometry of anastomosis

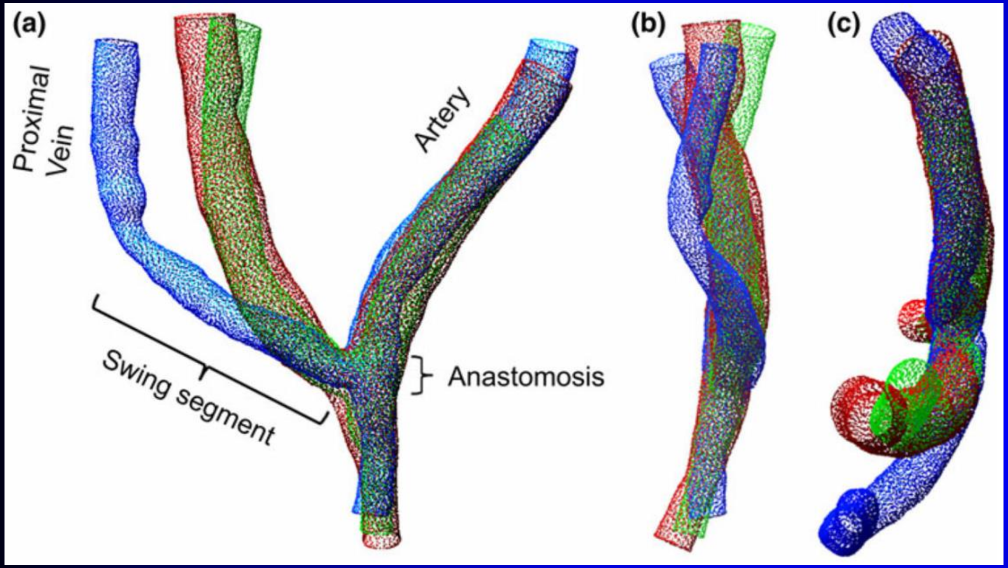
Hemodynamic impact of anastomosis size and angle in side-to-end arteriovenous fistulae: a computer analysis. Van Canneyt et al. J Vasc Access 2010

When the anastomosis angle exceeded 58°, the proximal arterial inflow was not sufficient to deliver enough flow, leading to distal arterial flow reversal.



Remodeling in AVF

Sigovan et al. Vascular remodeling in autogenous arterio-venous fistulas by MRI and CFD. Ann Biomed Eng 2013



Vascular geometries from 5 days (blue), 1 month (green) and 3 months (red) after placement of a brachio-cephalic fistula

Technique of anastomosis and high flow

Diameter of artery +++

vein

anastomosis

22 patients

Mean flow: 2.8 L/min (1,9-3,8 L/min)

Diameter of brachial artery (n=15) : 8,5 mm (6-11 mm)

Technique of anastomosis and high flow

Diameter of anastomosis

wrist : 10 mm

elbow : 5 mm

Ideal length : 75% of diameter of the artery

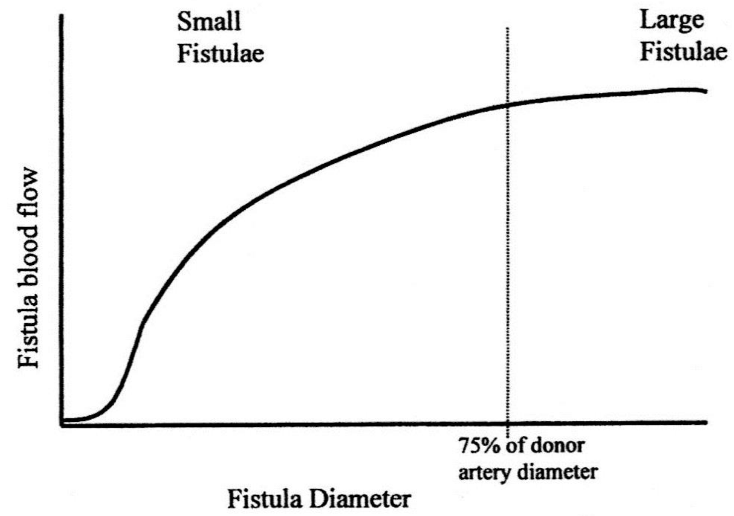
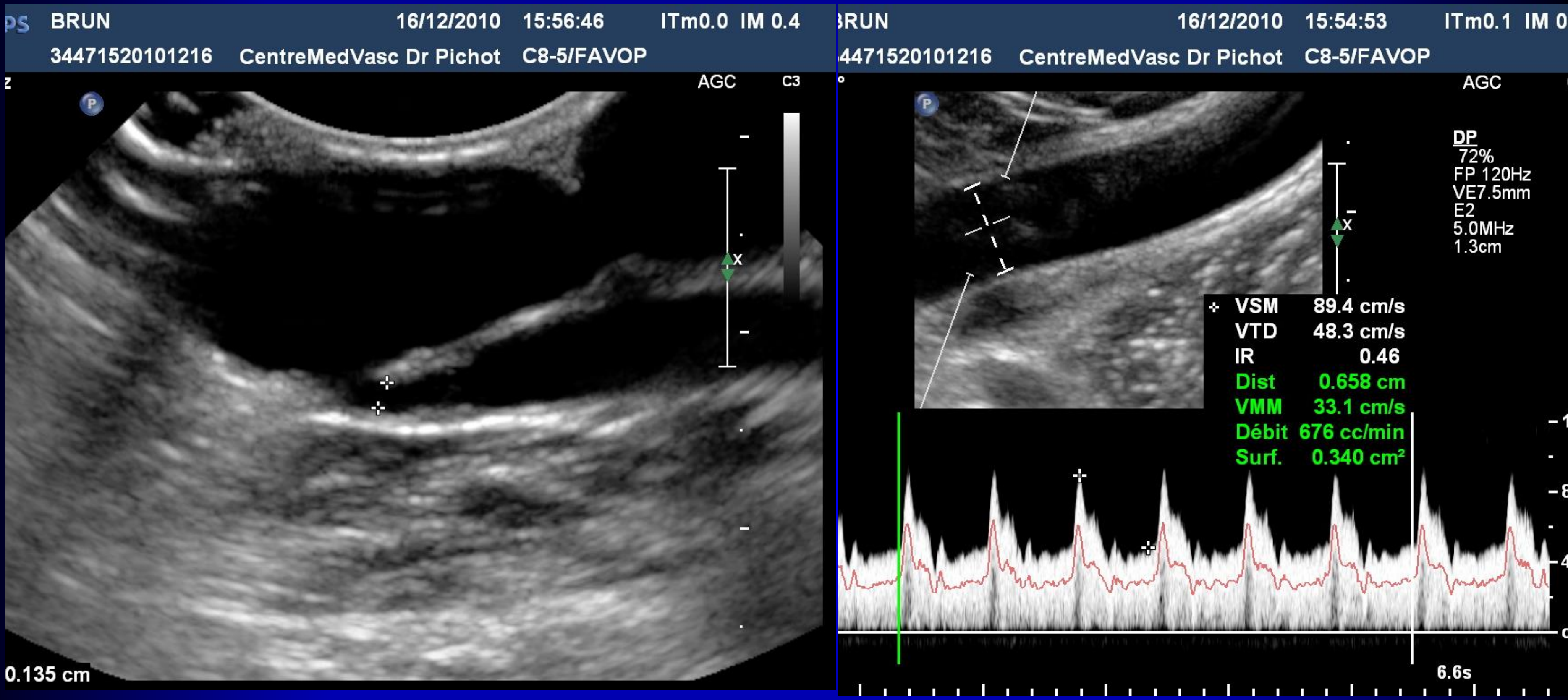


Figure 2. Sigmoid curve reflecting the flow through an arteriovenous fistula as a function of fistula diameter. Blood flow in small fistulas (20% to 75% of the donor artery diameter) is directly proportional to fistula diameter. Blood flow in large fistulas is independent of the fistula diameter and depends more on the resistance of the inflow artery, the peripheral circulation, and the collateral network.

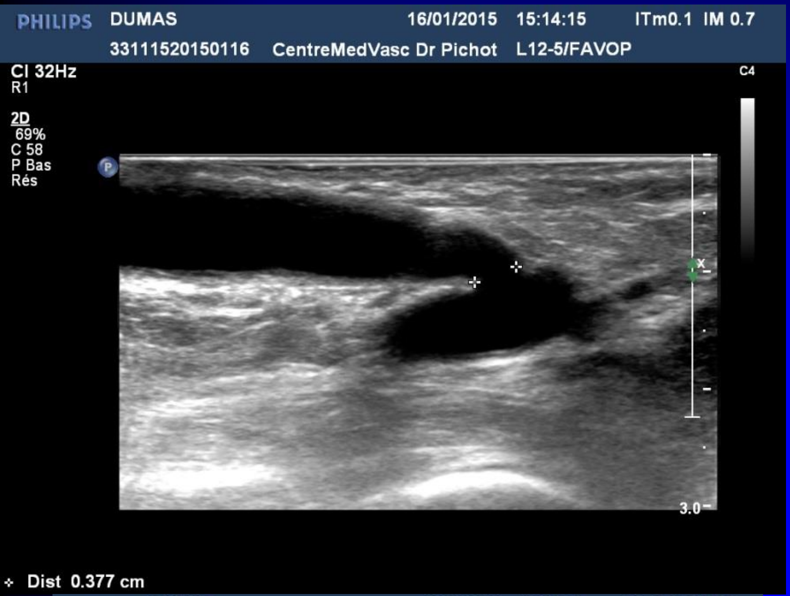
Wixon 2000

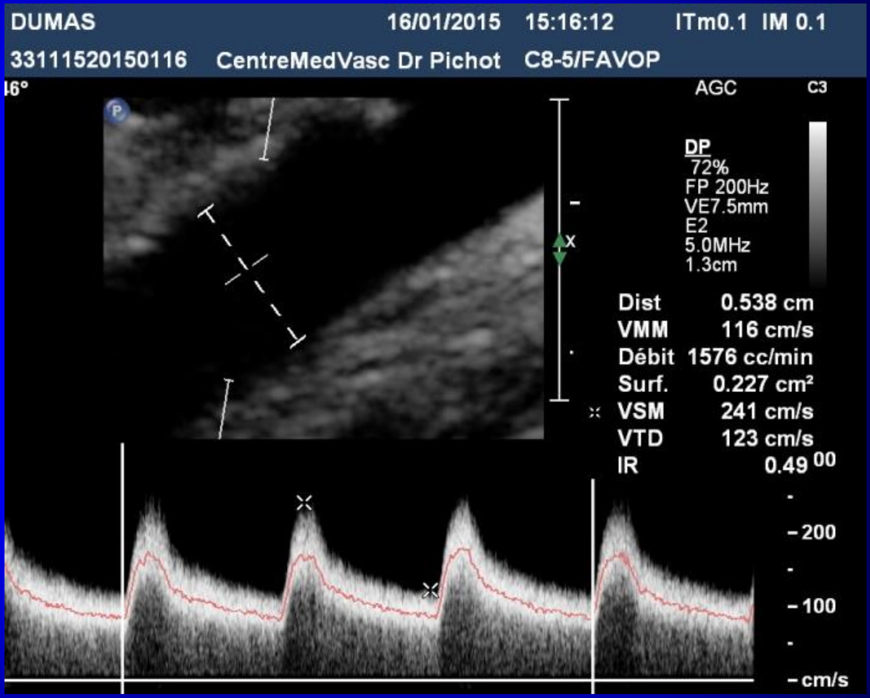
Technique of anastomosis and high flow



Small anastomosise 1.3 mm; "normal" flow 670 ml/min

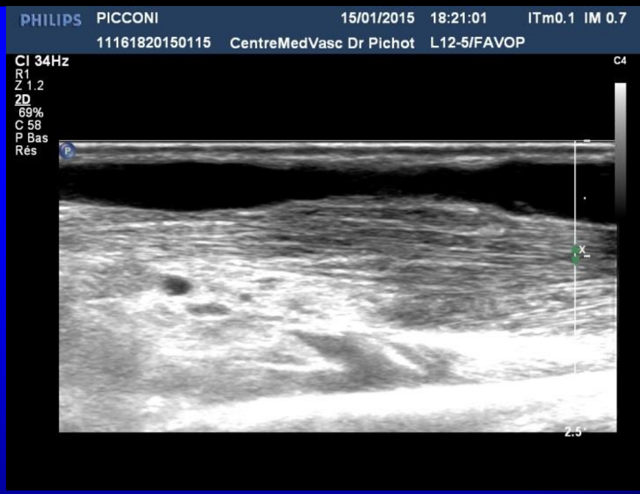
Technique of anastomosis and high flow





Small anastomosis 3.7 mm :
"normal" flow 1500 ml/min

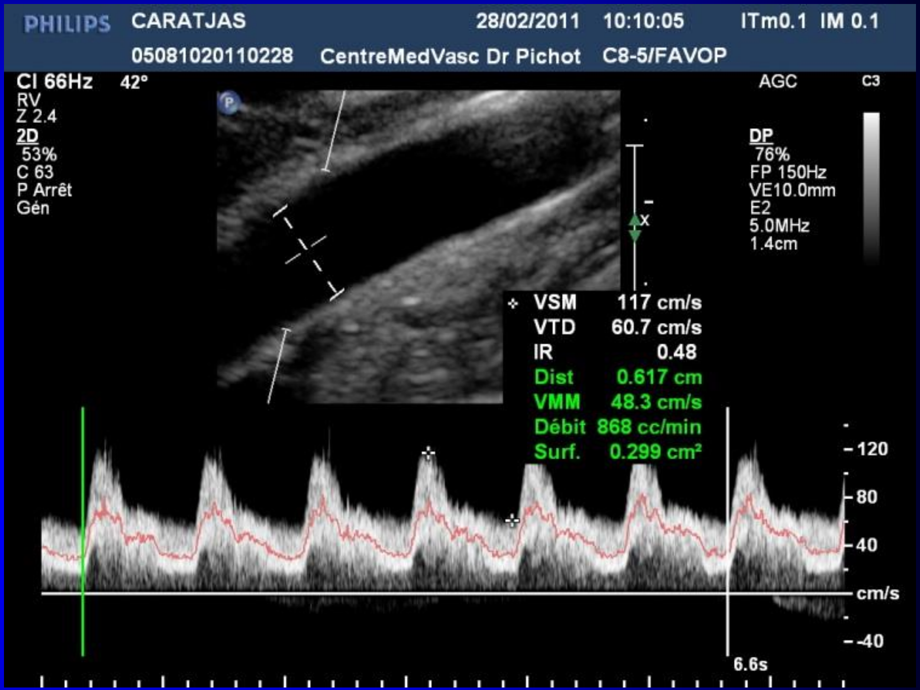
Technique of anastomosis and high flow



Anastomosis : 8 mm
Flow : 380 ml/min
Diameter of radial artery : 5 mm

Stenosis of the outflow vein

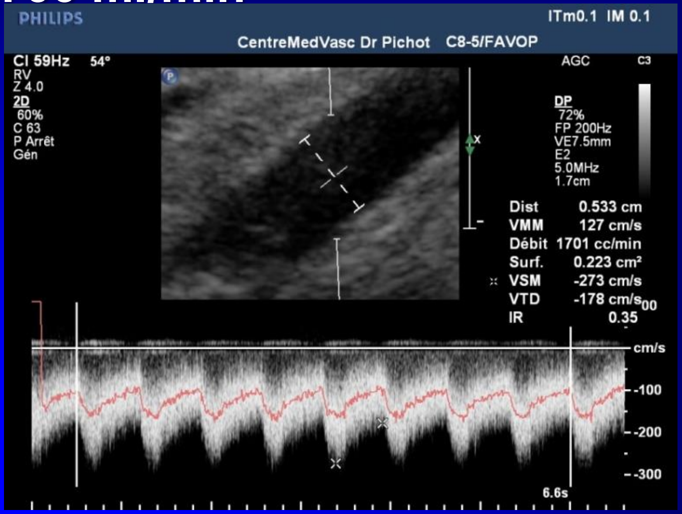
Technique of anastomosis and high flow



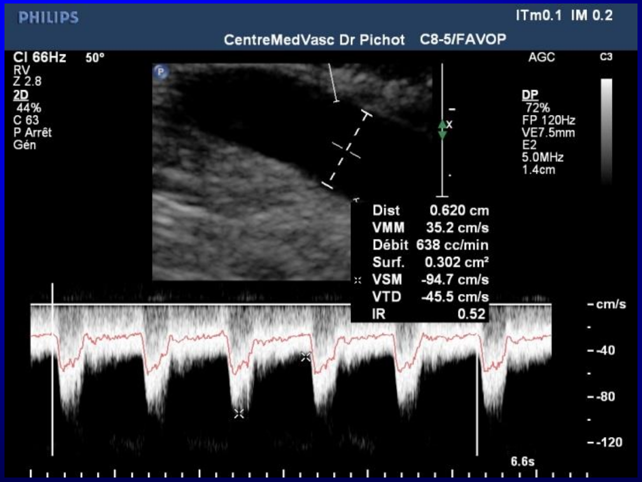
Small anastomosis : 1.9 mm:
Normal flow : 800 ml/min

Technique of anastomosis and high flow

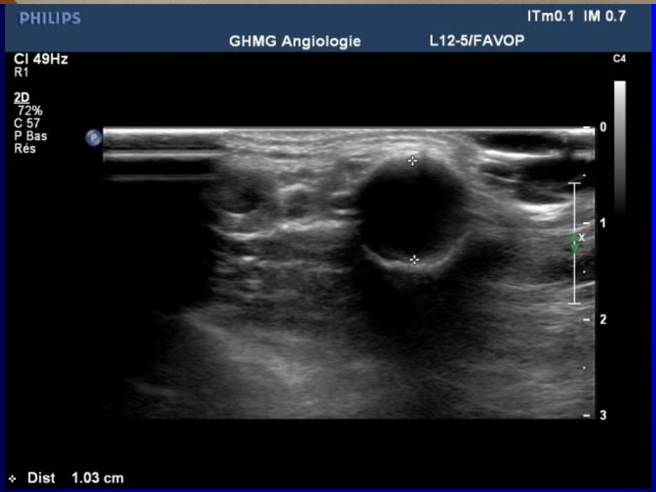
Small anastomosis 2.6 mm ; high flow 1700 ml/min

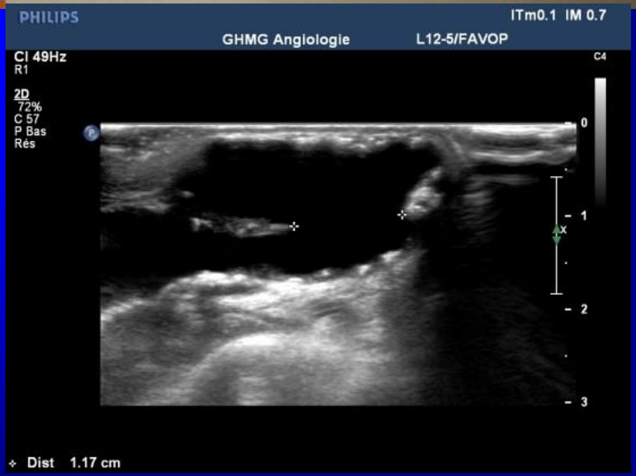


Small anastomosis 2.5 mm; normal flow 630 ml/min



Technique of anastomosis and high flow

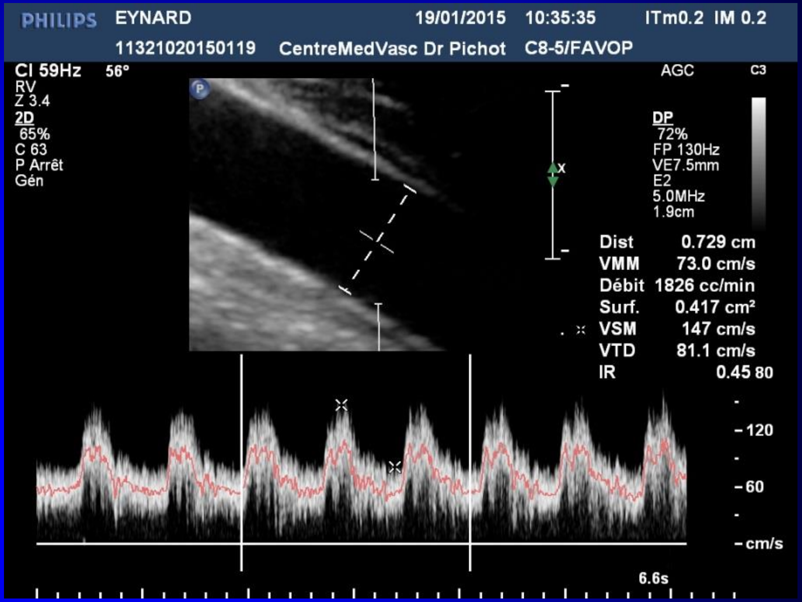




Anastomosis length : 11 mm

“High” flow : 2000 ml/min

Technique of anastomosis and high flow



Large anastomosis 25 mm; high flow 1800 ml/min

Conclusions

Anastomotic techniques determine the initial “geometry” of the anastomosis and peri-anastomotic segment and will partially impact the risk of stenosis

The risk of stenosis is modulated by the maturation and remodeling process leading to hemodynamical and morphological changes

The “geometry” of the AV anastomosis and peri-anastomotic region has a little impact on high flow