CONTROVERSES ET ACTUALITÉS EN CHIRURGIE VASCULAIRE

CONTROVERSIES & UPDATES IN VASCULAR SURGERY

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MARRIOTT RIVE GAUCHE & CONFERENCE CENTER

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# SURGICAL VS PERCUTANEOUS ARTERIOVENOUS FISTULAE

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**Disclosure**

Speaker name:FRANCO  Gilbert

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- ☐ I have the following potential conflicts of interest to report:
- ☐ Consulting
- ☐ Employment in industry
- ☐ Shareholder in a healthcare company
- ☐ Owner of a healthcare company
- ☐ Other(s)
- ☒ I do not have any potential conflict of interest

# STATEMENT OF THE PROBLEM

- **AVF at wrist remains the first option for vascular access creation if likely to be successful**

  **Low incidence of thrombosis (0.2 events per patient per year) and Infection (2%)**

  **High early thrombosis and non-maturation rate ranging from 5 to 50%**

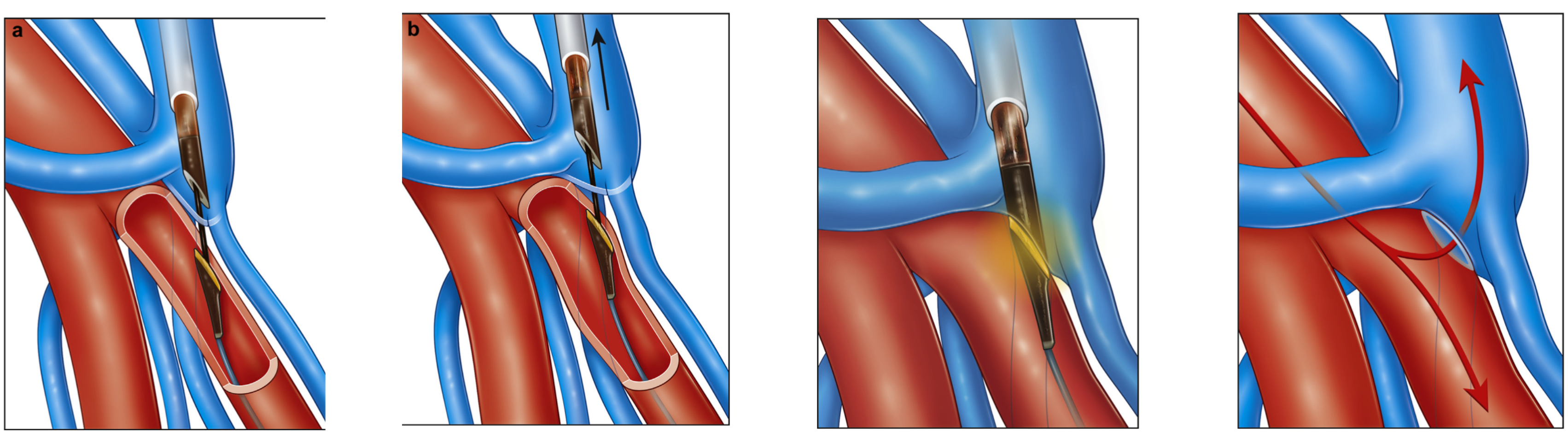
- **PERFORATING VEIN**

  **Valuable resource for the creation of a vascular access**

  **Surprisingly it doesn’t take any place in the recommendations of AVF creation**

**WHEREAS**

- **Easy to perform surgically or now better PERCUTANEOUSLY thanks to Ellipsys device**
- **Doesn't jeopardize any further surgery using the predilated veins if necessary: CV-BV -BR VEINS**



# ADVANTAGES OF RA- PERFORATING VEIN AVF

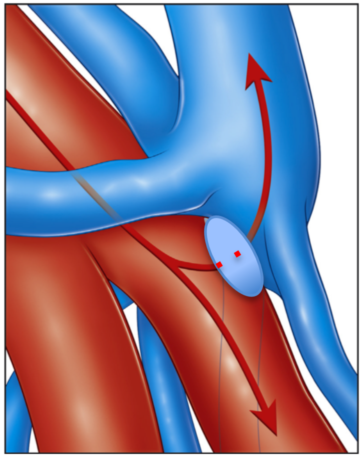
**Gracz fistula had bad reputation but has variants previously described**

- **No deep vein ligation**
- **Reduction of anastomosis size to the diameter of the perforating vein (3–5 mm)**
- **Anastomosis on the radial artery preventing high flow**
- **Reduction of the risk of steal syndrome**

**This configuration is ACHIEVED with P.AVF**

**↓**

**Better survival rate EXPECTED**

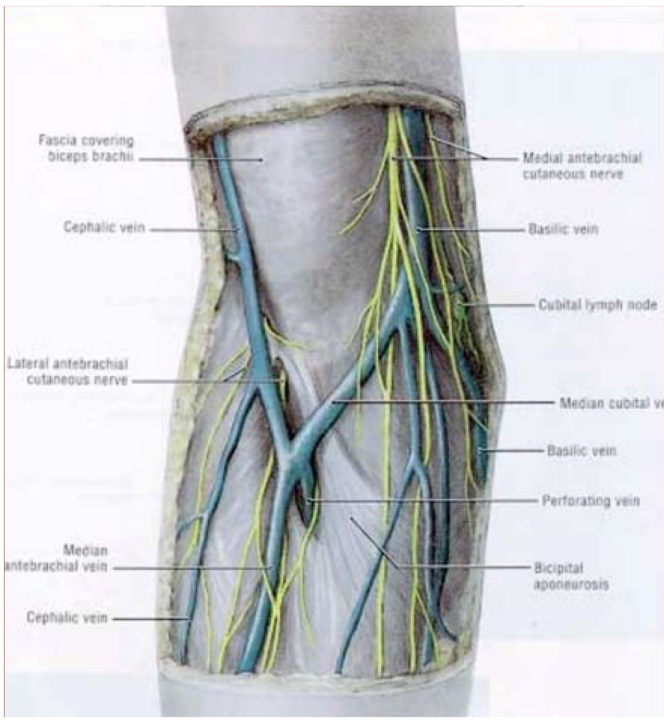


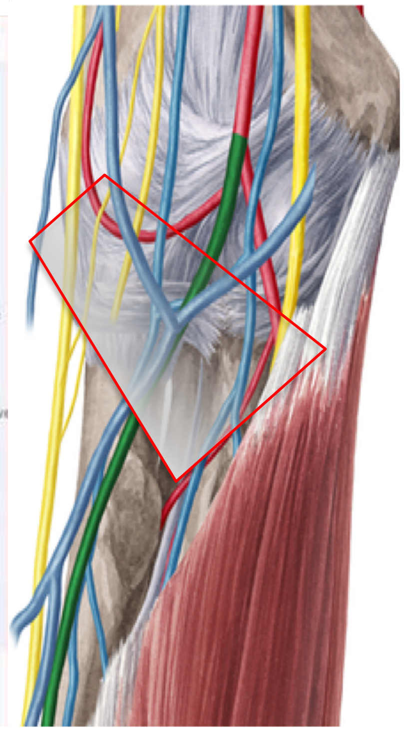

**Konner K.** Tailoring the initial vascular access for dialysis patients. *Kidney Int ,2002*

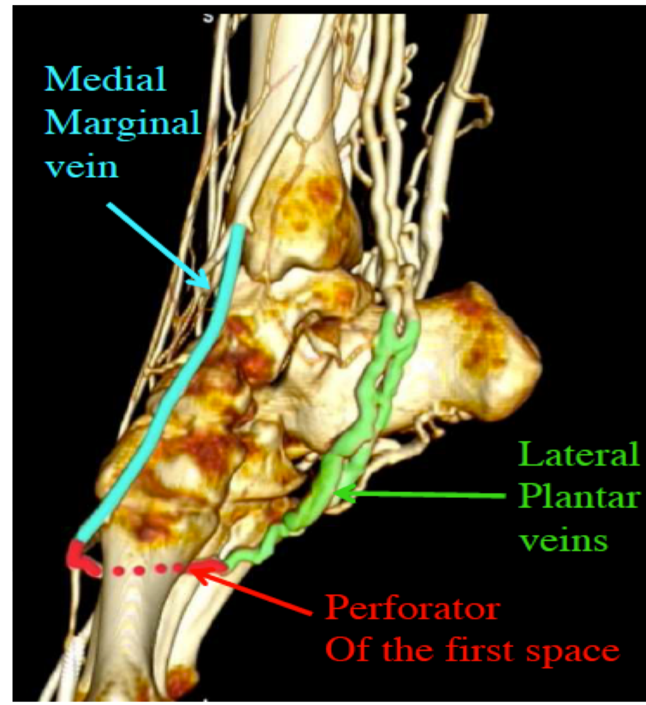
**Weyde W**. Radial artery-perforating vein fistula for hemodialysis. *Am J Kidney, 2007*

# PERFORATING VEIN

**There are only two perforating veins whose flow goes usually:**
**from deep to superficial veins and could run in the both direction**



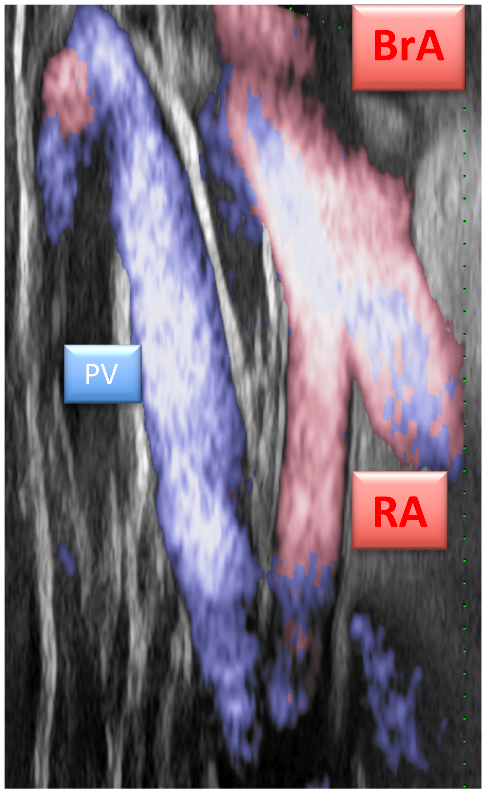





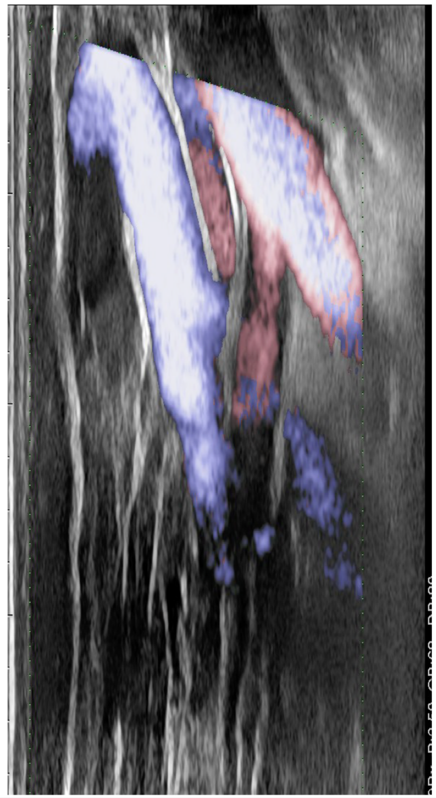

Ante cubital fossa

Back of the foot

# ANATOMY of ANTECUBITAL FOSSA




Longitidinal scan :
Radial artery and Perforating vein are close to each other




Junction of the veins and distribution of different ascending blood streams are displayed  thanks to rock and roll maneuver, sligt lateral motion of the probe

# HEMODYNAMIC AND AVF

- **FLOW LEVEL and FLOW DISTRIBUTION**
- **RESISTANCE**
- **WALL SHEAR STRESS**
- **STEAL**

# HEMODYNAMIC and POISEUILLE'S LAW

$\Delta P = 8\mu . l . Q / \pi . r4$ or $Q = \pi . r^4 . \Delta P / 8\mu . l$

- $\Delta P$ is the pressure drop
- L is the length of conduit
- μ is the dynamic viscosity
- Q is the volumetric flow rate
- r is the radius

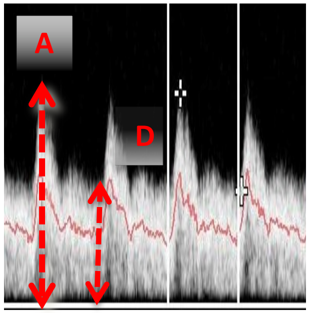
Volume flow is directly proportional :

- to the pressure gradient between its ends
- to the fourth power of its internal radius
- inversely proportional to its length and viscosity

Classically Poiseuille'S law is invoked to explain what happens in fistulas
Radius, Length ,Pressure gradient, viscosity are the different actors but importance of each one is overestimated and numerical application is inaccurate because it does not take into account microcirculation

# Resistance Index(RI) :In vivo resistance

- **Resistance is the force that opposes to flow**
- **RI measured with PW Doppler gives an USEFULL evaluation of total in vivo resistance**




A:SYSTOLIC VELOCITY
D:DIASTOLIC VELOCITY

→

RI= A—D/A
0,5<RI<0,6

- **Poiseuille's equation indicates that a 50% reduction in radius should increase resistance 16-fold**

$$R=8\mu.l.\ Q\ /\ \pi.r4$$

- **And decrease in the same proportion the flow**
- **No one has ever seen such a reduction in flow**
- **In this case the total resistance increases by 15% according with resistance index**

**BECAUSE**

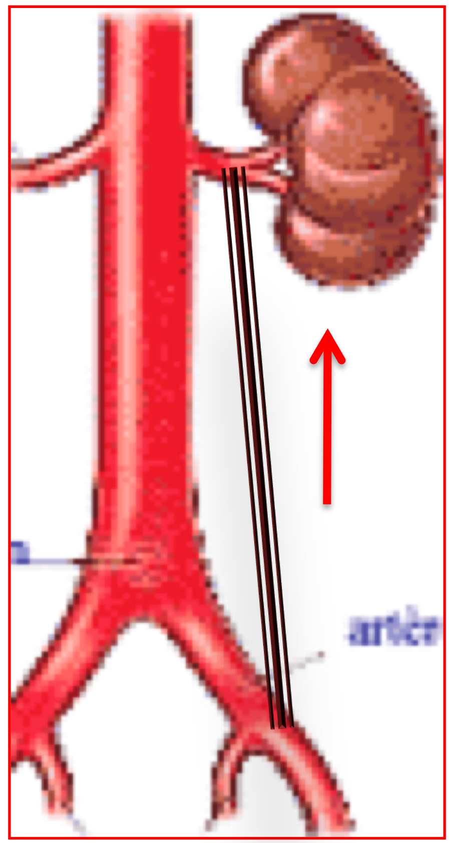
- **Large vessels resistance represent only a small part of total resistance**
- **Microcirculation comprises about 70% of the total resistance**

# ↘ RESISTANCE → VOLUME FLOW ↗

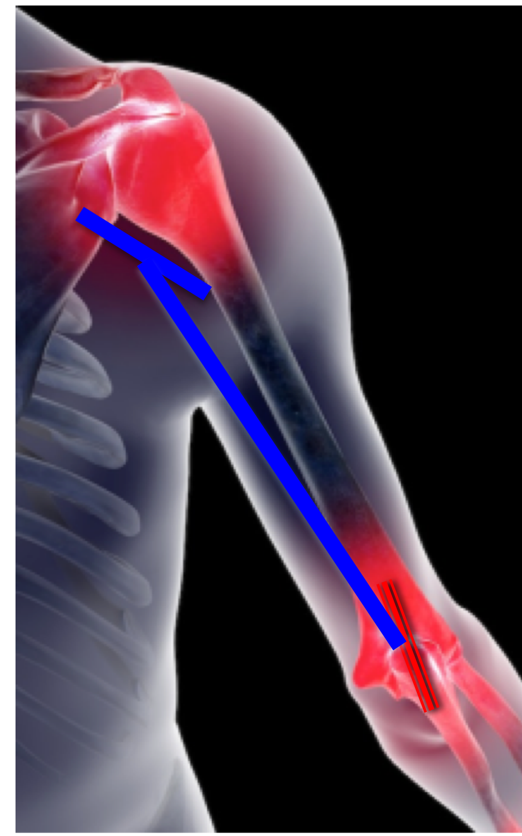
**Resistance is the force that opposes the Flow: most important Flow contributor**

| RI:1 100-200 ml/mm | RI:0,7 300-400 ml/mm | RI:0,5 800-1 L ml/mm |
|---|---|---|

FEMORO POPLITEAL GRAFT



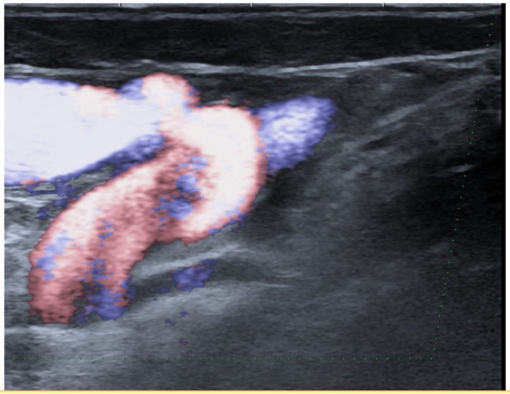
ILIO RENAL GRAFT



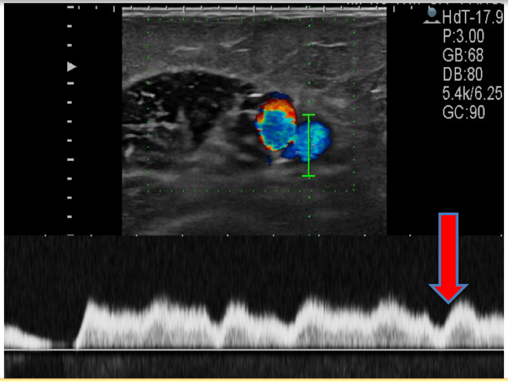
BRACHIO AXILARY GRAFT

These three comparable by-passes illustrate that resistance and microcirculation level are the dominant component of flow regulation. Anastomoses area, ⃠of graft and donor arteries are similar, their flow rate ranges from 1 to 8 while the RI varies in the opposite direction.

# FOREARM AVF :FLOW DIVERSION



RETROGRADE FLOW IN PERFORATING VEIN




BRACHIAL VEINS:
EFFECT OF AVF COMPRESSION ↘ VELOCITY

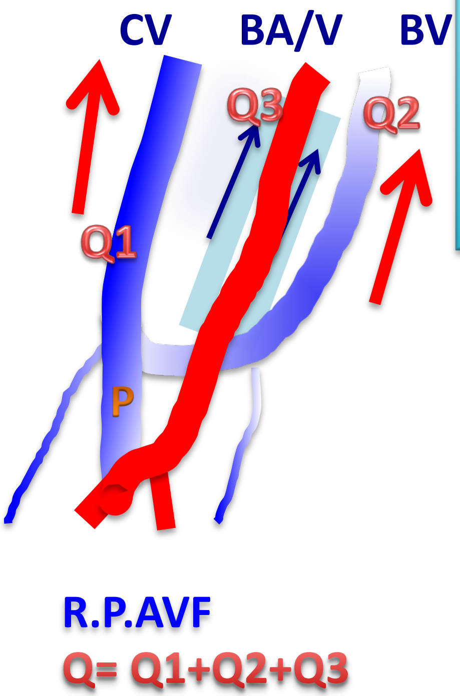
**PERFORATING LIGATION:**

- ↗ SUPERFICIAL VOLUME FLOW
- ↘ STEAL
- ↗ DIGITAL PRESSURE

Jennings, W.C *Arch Surg*. 2006
Moini, M. *J Vasc Surg*. 2008

| AVF | Patients | AGE | Q ml/mm | Ø RA mm | RI | Δ.P mmHg | % Flow Inversion PV |
|---|---|---|---|---|---|---|---|
| RC AVF | 32 | 68 | 919 | 4,3 | 0,52 | 27 | 98% |

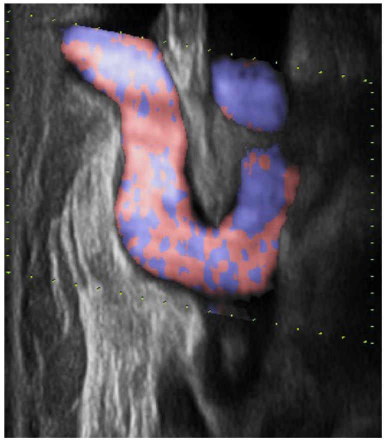
# REGARDING FOREARM.AVF/P.AVF

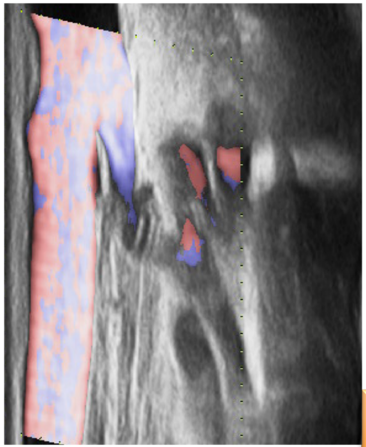


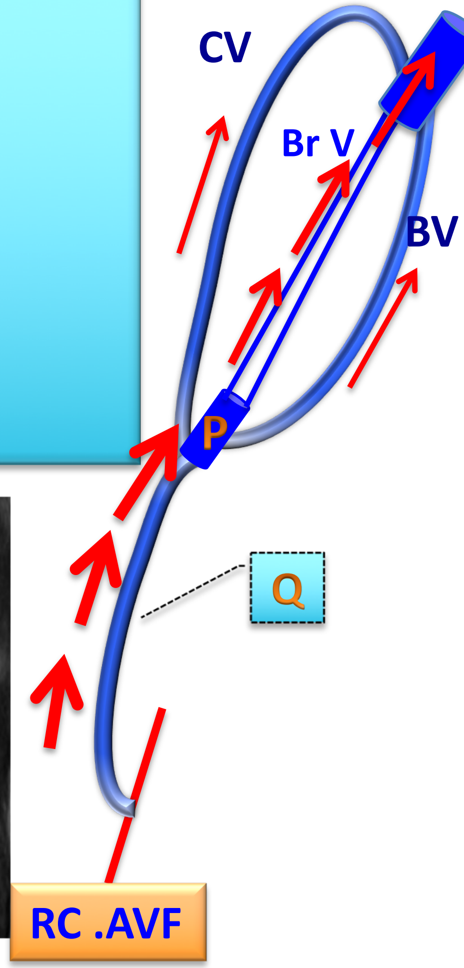

- Flow direction in the perforator is reversed in forearm AVF
- Flow diversion towards the brachial veins

**CONTRARY TO**

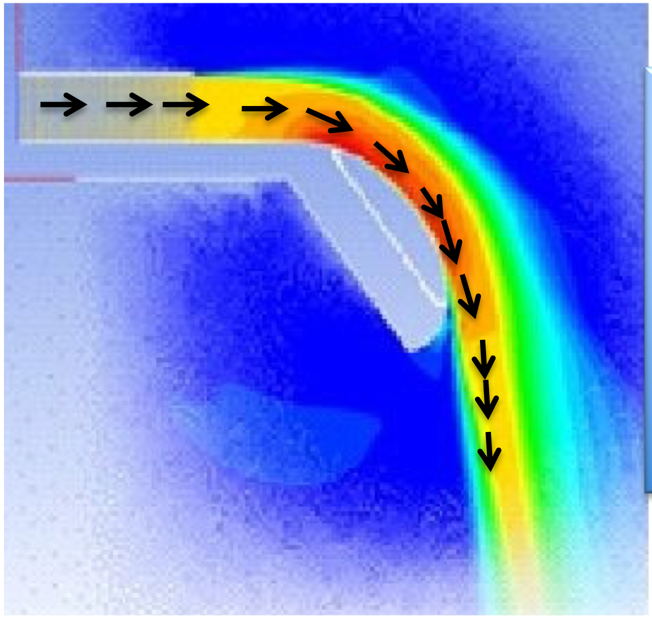
- P.AVF flow remains in the physiological direction
- Flow within brachial vein is very fewly increased







# COANDA'S EFFECT



**COANDA's effect or driven jet**

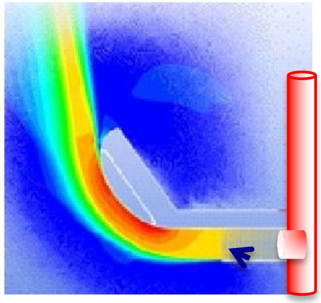
is the tendency of a fluid jet to stay attached to a convex surface and "the tendency of a jet of fluid emerging from an orifice to follow an adjacent flat or curved surface and to entrain fluid from the surroundings so that a region of **lower pressure develop.**

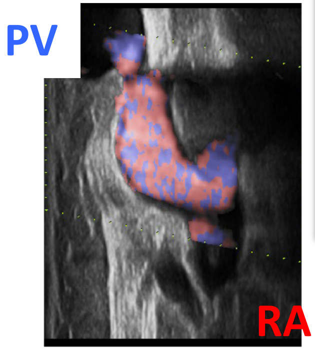
**This continues until a point where the velocity of the flow drops**

**Makes the planes can take off**

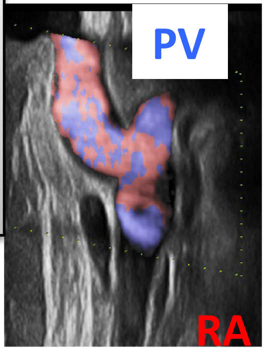
- **Makes we can pour a cup of tea without loosing any drop**

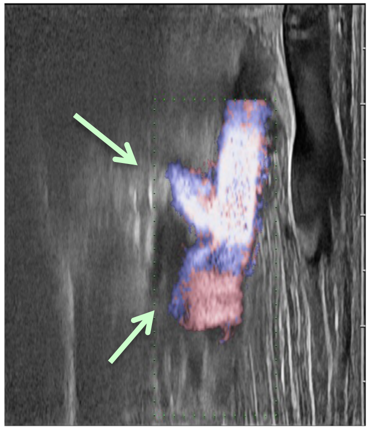
# SUPERFICIAL/DEEP FLOW CONTROL

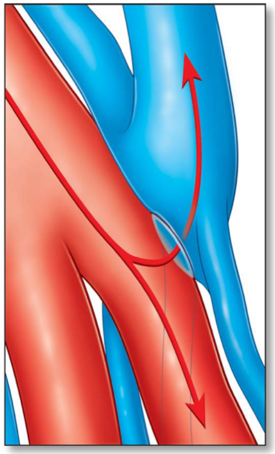


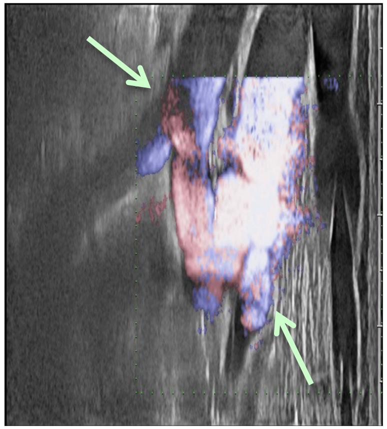



P.AVF is a Side to Side AVA but functioning nearly as End to Side AVA:
Valves below AVF prevent retrograde flow in deep forearm veins
COANDA's effect and physiological flow direction preserved in perforator control low flow level within brachial veins



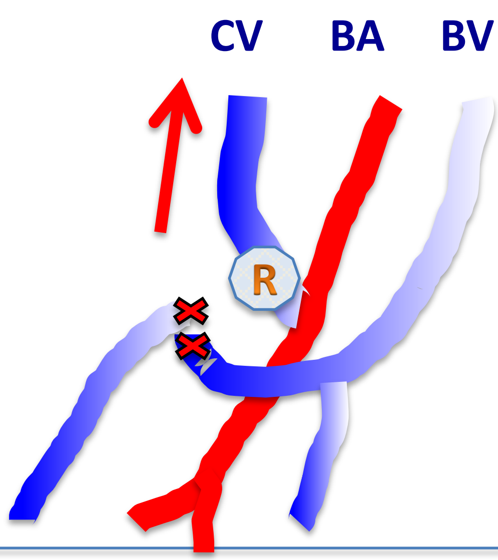



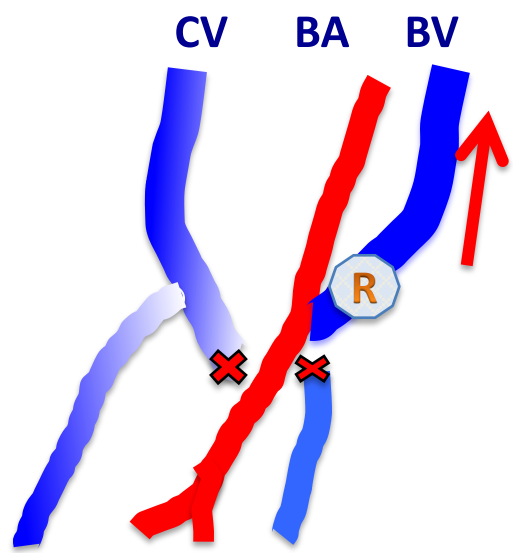


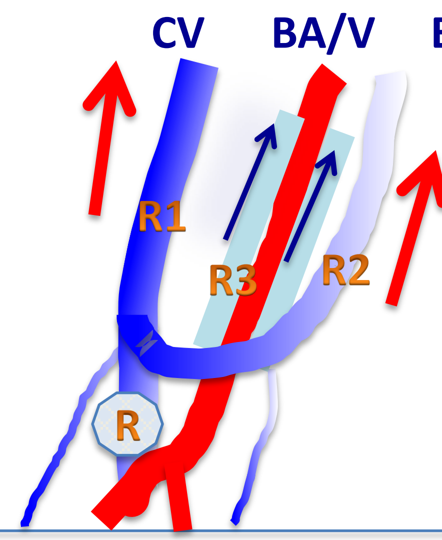


# ELBOW FISTULAS

P.AVF :Total resistance is less than the resistance of any of the single vein




**Brachio-Cephalic AVF**

**Brachio-Basilic AVF**

LIGATIONS FORCE THE FLOW TOWARD ONE SINGLE VEIN

Forces are concentrated in a single vessel

**RESISTANCES are in SERIES :R**

≠

**Radio-Perforating AVF**

FLOW IS IDEALLY DIVIDED INTO THREE STREAMS

Forces are better distributed

**RESISTANCES are in Parallel**

R= R1.R2.R3/R2R3+R1R3+R2R1

**Strain and Stretch ↗**

**Strain and Stretch ↘**

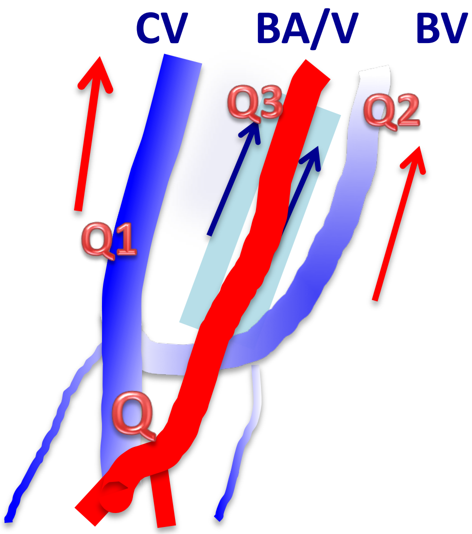
# WSS and AVF

- AVF has behaviour of capacitor repeatedly charged and discharged and wall vein stretched and un-stretched
- At equal volume flow rates :

  Division into 2 or 3 streams decreases Volume Flow and WSS in each vein ,beneficial to NO production

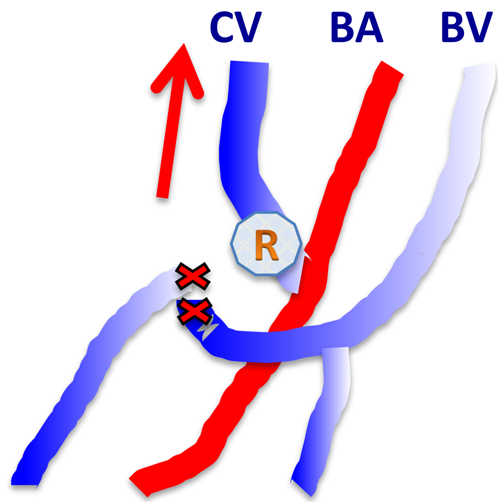
  Load and distension of each branch is decreased (P.AVF)

  Reduction of turbulences downstream the needle and ↓risk of NIH




R.Perf.AVF

Q= Q1+Q2+Q3



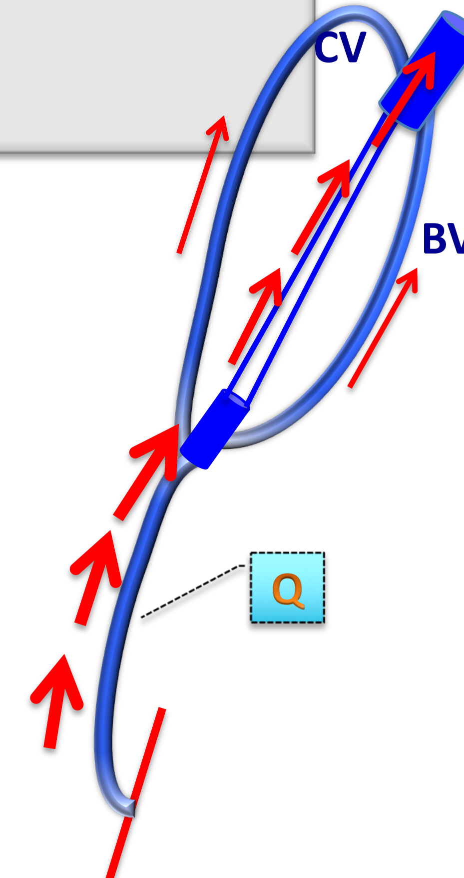

Br .Cep.AVF

WWS is frictional force applied by pulsatile blood flow against the vessel wall :

$\tau(\text{dynes/cm2}) = \mu \Upsilon = \mu[8.V/d]$

μ :viscosity. ϒ:shear rate

V: velocity .d: diameter

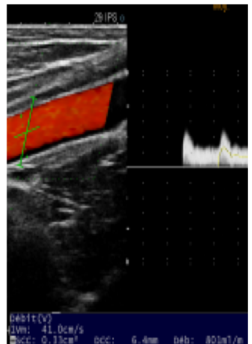



RC .AVF

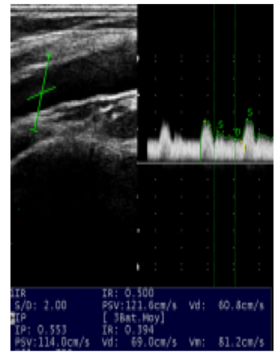
# MEASUREMENTS :RC AVF/P.AVF

- VOLUME FLOW
- [RI/PI]
- Ø RA
- ØPERFORATING
- Ø DRAINAGE VEINS
- Ø BRACHIAL VEINS
- AVA AREA
  - Short axis
  - Long axis

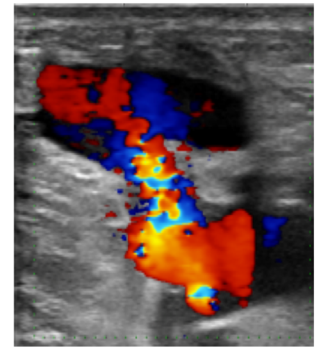
- DEPTH
- STENOSIS?
- DIGITAL PRESSURE



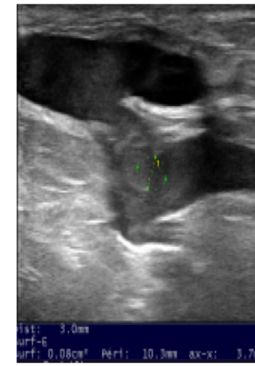
Q

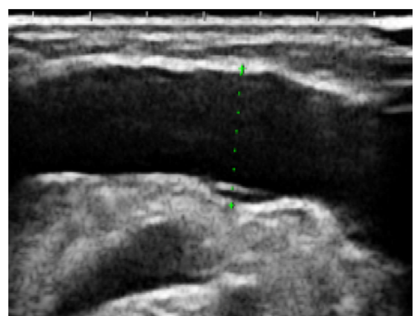


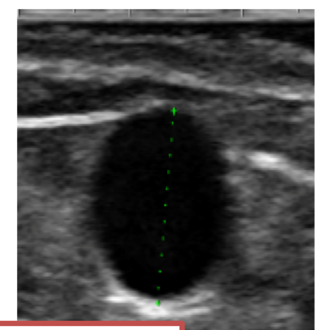
[RI/PI]



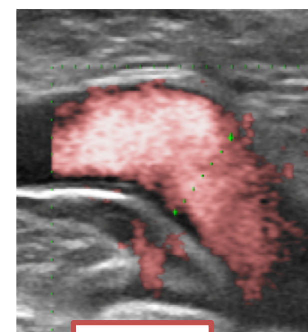
AAV







DRAINAGE VEIN



PERF

| AVF | Patients | AGE |
|---|---|---|
| RC AVF | 32 | 68 |
| P.AVF | 31 | 62 |

# MAIN PARAMETERS

## Q –RA-AVA-RI-FLOW DIRECTION

| | sRCAVF | pAVF | P-value (t-test / RR*) |
|---|---|---|---|
| **Q ml/min** | 919 (620-1220, SD:170) | 859 (410-1340, SD: 216) | 0.2 |
| **Ø RA mm** | 4.3 (2-8, SD: 1.4) | 4 (2-6.1, SD: 0.8 | 0.3 |
| **RI** | 0.52 (0.4-0.7, SD: 0.11) | 0.57 (0.43-0.78, SD: 0.07) | 0.07 |
| **AVA mm$^2$** | 43 (18-77, SD: 16) | 16 (6-58, SD: 9) | **0.002** |
| **FLOW DIRECTION INVERSION in DCV** | 98% | 0% | RR: 61 (CI:3.9-597 – **p:0.003**) |

**Table 1.** Summary of results of main duplex scan parameters in sRCAVF and pAVF
Q: Volume flow. RA: radial artery. RI: resistance index. AVA: area of arteriovenous anastomosis.
**SD**: standard deviation. sRSAVF. DCV: Deep communicating vein: Radiocephalic arteriovenous fistula. pAVF percutaneous arteriovenous fistula.
*t-test used for comparison of means and RR for DCV flow inversion

# DIGITAL PRESSURE

| | sRCAVF | pAVF | P-value |
|---|---|---|---|
| **DP/IL mmHg** | 101(66-140, SD:19) | 108 (52-133, SD: 19) | 0.1 |
| **DBI/IL mmHg** | 0.77 (0.4-1, SD: 0.15) | 0.75 (0.3-1, SD: 0.14) | 0.3 |
| **DP/CL** | 127 (90-170, SD: 20) | 126 (50-153, SD: 21) | 0.3 |
| **DBI/CL** | 0.98 (0.7-1.3, SD: 0.13) | 0.87 (0.3-1, SD: 0.14) | 0.1 |
| **Δ.P mmHg** | 27 (0-86, SD: 24) | 19 (1-41, SD: 12) | 0.07 |

**Table 3.** Summary of digital pressure measurements in SRCAVF and pAVF
**DP/IL:** digital pressure ipsilateral **DBI/IL:** digital brachial index ipsilateral
**DP/CL:** digital pressure controlateral **DBI/CL:** digital brachial index controlateral
**Δ.P:** pressure drop between ipsi and controlateral side. sRCAVF: Radiocephalic arteriovenous fistula. pAVF percutaneous arteriovenous fistula.

# Brachial veins and CV

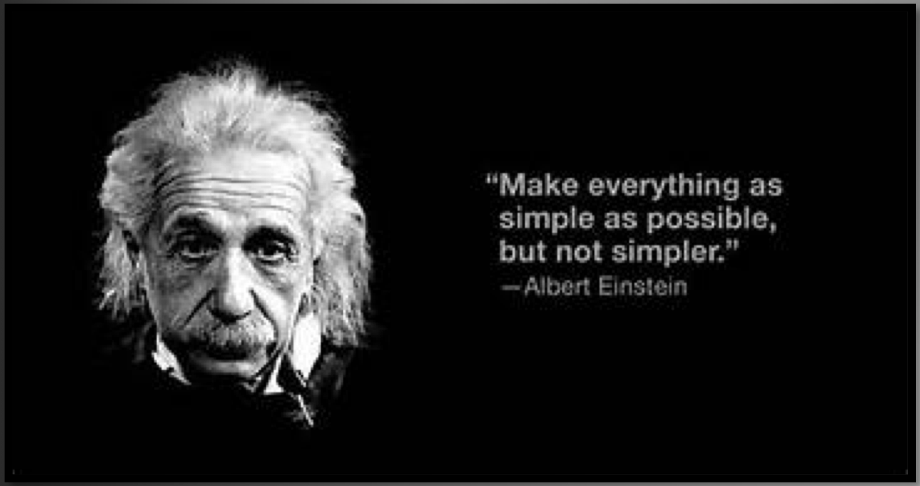
| | sRCAVF | pAVF | P-value |
|---|---|---|---|
| **BR. V area mm²** | 33 (8-85, SD: 16) | 13 (7-37, SD: 6) | 0.06 |
| **Ø CV mm** | 7.2 (4-10, SD: 1.5) | 6.5 (2-9 SD: 1.8) | 0.12 |

**Table 2.** Summary of results of venous measurements for sRCAVF and pAVF
**BrV area**: sum of cross-sectional area of medial brachial and lateral brachial vein($mm^2$)
**Ø CV :** cephalic vein diameter; **SD**: standard deviation**. sRCAVF**: Radiocephalic arteriovenous fistula.
**pAVF**:percutaneous arteriovenous fistula.

# CONCLUSION

## P.AVF LEADS US TO THINK OUT OF THE BOX


- **ALL CONCERNS REGARDING**
  **HIGH FLOW**
  **STEAL**
- **APPEAR UNFOUNDED**


"Make everything as
simple as possible,
but not simpler."
—Albert Einstein


Complicated
Simple