Mega fistula
Definition

• Flow
  – Normal – up to 1.5 L/min
  – High – 1.5 to 2L/min
  – Mega > 2L/min

• Normal CO = 4L/min
  – Mega fistula 50% of CO
The “Mega-AVF”: CAUSE?

- Central vein obstruction?
  - NO!
  - Pressure does not cause dilation; turbulence does.
  - High enough pressure to cause dilation would cause fistula to fail (or be ligated) well before it dilates

- REPETITIVE CANNULATION.
Physiology

- Flow proportional to radius x 4
- Artery adjusts to increased flow by dilatation
- Normal artery at anastomosis = 3 – 4 mm
- Dilate in 3 D – buckling as increase in length
- Vein grafts in legs do not dilate- Vein in leg is artery to artery
- not pressure but cannulation, turbulence, Flow
Endovascular/Minimally Invasive Approach: Initial Ultrasound Evaluation

48y.o. WF with "MECA-AVF" and failing LRKTx (92), CKD4. She is asymptomatic, yet has increasing fistula size (created 2008) and + Nicoladoni sign (HR drops by 15 BPM). Referred for banding in 5/2011.
Complications

• Hand Ischemia- steal
• CCF
• Reduced Clearance – cardiopulmonary recirculation
• Swollen Arm- CV stenosis
• Bleeding cannula sites
100% flow
(from brachial artery)

25% flow
(through fistula body)

75% flow
(entering fistula body)

Brachial artery
Cephalic vein
Fistula body
Recirculation
NEW METHODS TO MEASURE AR

Sensor: Temp, Conductivity, Hematocrit, Impedance

Suddenly change: Dialysate (Na Temp.)

Inject cold saline

Distal

Proximal
**CO, Qa and CPR:**
Data on 96 AVF

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<td>1580 +/- 553</td>
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* Stage C AHA HF with CI>8.01

Central Vein Stenosis
Relationship Between CO and Qa

\[ Y = 0.552x^3 - 2.084x^2 + 3.7953x + 4.2145 \quad R^2 = 0.4307 \]

\[ Y = 0.548x^3 - 1.999x^2 + 3.7658x + 4.01452 \quad R = 0.4409 \]

- Lower arm AVFs
- Upper arm AVFs

A third-order polynomial regression model

CO vs Qa

![Box plot showing the comparison between mean cardiac output and access blood flow](image)

- P < 0.0001
- NS
- P = 0.005

Mean cardiac output (l/min)

Access blood flow (l/min): < 0.95, 0.95–2.20, > 2.20

## CO, Qa and CPR:
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* Stage C AHA HF with CI > 3.01

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* Stage C AHA HF with CI > 8.01

Definitions:

- **“Mega AVF” or High-flow AVF:**
  - No clear definition
  - ?? Access flow (Qa) > 1–1.5L/min; Or > 2.2L/min (Basile)
  - ?? Cardio-Pulmonary Recirculation (CPR) > 20% (per *Vascular Access Society*) or >30% (Pandaya and Lindsay)
  - Clinically: large caliber vein with hypertrophied feeding artery often double in size to contralateral arm.

- **High output Heart Failure:** (NI CO 4–8L/min and CI 2.5–4.2L/min/m²)
  - Definition: + symptoms of HF (i.e. stage C or greater AHA) and ?? CI >3.01 L/min/m² (Basile et al)
  - PE: ↑HR, ↑ pulse pressure, hyperkinetic precordium, + Nicoladoni sign
  - Additional findings (RHC and Echo): ↑ LVEDP/LVEDD/LVEDV, ↑ LVMI, LVH, LV dilation, low or high LVEF, ↑ PAP with normal PVR, low SVR, ↑ SVO2.
  - CXR: Cardiomegaly +/- pulmonary congestion
  - Laboratory: ↑ANP (d/t increased blood volume) and BNP (d/t diastolic dysfunction)
  - Multiple case reports show improvement of HF sx/signs and different parameters with the closure or banding of the fistula.
Definition of Megafistula

• Blood flow > 2.2 L/min
• Cardiopulmonary Recirculation > 20%[30%]
• Hypertrophied feeding artery
  – Double other side
• High output heart failure - ? Definition
  – CO - > 4-8 L/min
  – CI > 3 [ CO/ BSA]
When Should We Intervene on MEGA AVF?

No guidelines... Hence, some thoughts to chew on:

- Patient with coexisting **hand ischemia** ++
- Patient with **stage C** or greater HF and evidence of high output HF (C.I. > 8), + clinical and investigational studies supportive to that?
- Patient with **stage C** or greater HF and High flow AVF regardless CO/CI?
- “Young patient” or “older patient” with good life expectancy AND stage A or B HF, YET, has significantly elevated Qa (？>2.5–3.0 L/min)?? (preventive?)
- Patient with **major structural cardiac changes** (e.g. severe aortic or mitral stenosis), severe pulmonary HTN or other??
- Patient with symptomatic/severe or occlusive **central vein stenosis** OR rapidly recurring **cephalic arch stenosis**??

Other unanswered questions:

- Does High flow AVF have an increased cardiovascular mortality?? (No per Al Ghonaim et al CJASN 2008)
- Should we ligate the MEGA AVF in refractory HF after failed intervention for flow restriction?
- Should every candidate undergo a right heart catheterization prior to banding??
- What is an acceptable vein diameter to band??
When to intervene

• Hand ischemia
• CCF – Cardiac Index > 3
  – CI = CO/ BSA, normal 2.5- 4.2
  – CI < 2= cardiogenic shock
• Any symptomatic patient with CCF
• Young patient asymptomatic with 3l/min
• Patients with structural heart disease
• Patients with poor clearance
• Recurrent CV Stenosis
MILLER Procedure
Endovascular/Minimally Invasive Approach: Initial Ultrasound Evaluation

Q1 = 2984 mL/min (pre-bandaging)
MILLER Procedure:
Ultrasound & Balloon Guided Suture Banding
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\[ Q_a = 1,580 \text{mL/min (post-banding)} \]
Outcomes of MILLER’s Procedure:
In High Flow AVF Only (n=69 AVF)

- Average flow reduction: 52% (2,629mL/min to 1,354mL/min)
- Primary access patency: 63% at 3 months
- Secondary access patency: 89% at 24 months
- Primary band patency: 85% at 6 months
  - 29% required multiple banding procedure including
  - 100% of those with brachial artery diameter >9mm

Anatomic Models:
Complications:

- Band failure
- Recurrent PTA to “suture band” due to poor flow
- Thrombosis (1/69)
- Infection at banding site
- Bleeding

- Cutaneous nerve entrapment
- Hand/FA edema due to hyperemia with poor venous return...

Complications of MILLER’s procedure:
Hand/FA edema due to hyperemia with poor venous return...

39y.o. WF with "MECA-AVF" and hand ischemia (pain, numbness, discoloration, worse on AD)
Flow ceased after 20 minutes with severe hand edema/pain
GCS = 5,100 mL/min pre banding
GCS = 2,680 mL/min post banding to 5mm; GCS = 1,620 mL/min post banding to 4mm
Pitaval thrombosed 24hrs later with transient worsening of hand edema for 48h and subsequent slow improvement over 48hrs
Resection, Reduction, and Revision of Aneurysmal AV Fistulas

Patrick R. Cook DO, FACS
Timothy G. Canty Jr. MD
Robert J. Hye MD, FACS

Kaiser Permanente
San Diego, CA
The “Mega-AVF”:
TAMPA (USF) EXPERIENCE

- Start with the “Cook/Woo” technique:
  - Completely mobilize fistula
  - Resect length to eliminate redundancy
  - Resect circumference to plicate
  - Close over 20Fr RRC bougie

- Two modifications:
  - Leave fistula directly under final incision, and
  - Try to leave an untouched length for cannulation (to avoid the “white tube of death” in the neck)
First rib resection/drain

Connulation site until this heals
(3-4 weeks)
Summary

• Awareness of concept

• Not benign

• Intervene early
Description of Surgery

- A slight flap is created in the upper skin edge to make room for the new AVF and the skin is closed.

- A tunneled catheter is placed for between 6-8 wks, at which time it is removed and dialysis is started in the new AVF.

Cook, Canty, and Hye, 2007
**Description of Surgery**

- Aneursymal AVF is first exposed and dissected free from the surrounding tissue
- The amount of excess length is determined
- After heparin, the fistula is clamped and opened
- The excess length is then resected
- The suture line is positioned medially on the arm
- Excess and scarred skin is resected

*Cook, Canty, and Hye, 2007*