MANAGEMENT OF VASCULAR ACCESS IN PATIENTS WITH HEART FAILURE AND ISCHEMIC HEART DISEASE

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PATIENTS WITH ESRD

- Cardiovascular disease (CVD) is the leading cause of morbidity and mortality
- It accounts for half of the deaths and one-third of hospitalizations of dialysis patients
- 35–40% have an established CHF diagnosis at initiation of hemodialysis

MacRae JM, et al. Sem in Dialysis 2006.
Locatelli F, et al. Nephrol Dial Transplant 2000.
Alkhouli M, et al. Nefrologia 2015.

Congestive Heart Failure(CHF) in ESRD patients

- **Left Ventricular Hypertrophy (LVH)** is the most common cardiac change
  - A key risk factor for the development of **CHF**
  - Ass. with **CV morbidity ,mortality & all cause death**
  - **74%** in patients at the beginning of HD
  - Incidence rate (after AVF creation) : **12.2-17%**

- Pathogenesis factors :

  volume & pressure overload , creation of an AVF , anemia

Stewart GA, et al. Kidney Int. 2005 ,Stack AG, et al. Am J Kidney Dis. 2002
Zoccali C, et al. Kidney Int. 2004 ,Ayus JC, et al.J Am Soc Nephrol 2005

Heart Failure

Low output cardiac failure

High output cardiac failure

Physiological

- Fever
- Exercise
- Pregnancy
- Stress
- Dermatological (e.g. Psoriasis)

Pathological

- Beri Beri
- Anemia
- Arteriovenous fistula (congenital , acquired)
- Hyperthyroidism
- Skeletal disorder (e.g. Paget's disease,MM)

Wasse H, Singapuri MS. Semin Nephrol. 2012.

High-cardiac output(CO) states

- A resting CO in adults > 8 L/min or A cardiac index > 3.9 L/min/m^2

- High CO + physical findings of systemic venous or pulmonary congestion

→ High-output heart failure

Anand IS, Florea VG. Curr Treat Options Cardiovasc Med. 2001

HIGH-OUTPUT HEART FAILURE

- Symptomatic high-output heart failure
  - High AV access flow 3-4 L/min
  - increased CO of 7-10 L/min
- High-flow AVF
  - no threshold access flow rate that defines risk
  - Current studies (Evidence-based)

    VA blood flow (Qa) ≥ 2.0 L/min

    Cardiac Output ratios(Qa/CO) ≥ 0.3

Stern AB, Klemmer PJ.Hemodial Int.2011., Acharya S, et al. Semin Dial.2009., Basile C, et al. Nephrol Dial Transplant.2008., Malik J, et al. Contrib Nephrol 2015.

Hemodialysis AV access related heart failure

- Can cause or exacerbate heart failure
- Often overlooked
- Dialysis access blood flow categories:
  - Low (600ml/min) ,
  - Normal (600-1500 ml/min)
  - High (1500-4000 ml/min)

Bourquelot P, Stolba J. Nephrologie. 2001.
Miller GA, et al. Semin Nephrol. 2012.
ReddyYNV, et al. Eur Heart J 2017.

Epidemiology
Hemodialysis AV access related heart failure

- Incidence is low, and that most patients with ESRD tolerate AVFs
- Limited to case reports and small series
- The rate of AVF banding due to worsening CHF in a cohort of 204 patients (322 accesses) **was only 2.6%**

- KT recipients + AV access
  - 25.7% AV access closure (symptoms of HF)
- AV access (median 2.6yr)+ Echocardiography
  - 43% : no prior history developed incident HF(75% : HFpEF)

Unal A, et al. Hemodial Int. 2010., Dixon BS, et al. Am J Kidney Dis. 2002.
Schier T, et al. Clin Transplant. 2013., ReddyYNV, et al. Eur Heart J 2017.

Risk factors

Hemodialysis AV access related heart failure

- Pre-existing cardiac dysfunction
  - RV , LA dilatation, LVH
  - Underlying coronary & valvular heart disease
- Male sex
- Prior vascular access surgery
- High AV access flow rate (Qa≥ 2.0 L/min)
- Upper-arm AV fistula (1.58 vs 0.95 L/min)

Basile C, et al. Nephrol Dial Transplant.2008.
ReddyYNV, et al. Eur Heart J 2017.

Arteriovenous Vessel Remodeling

Brachial artery (50ml/min)

Fistula creation → 10-20 folds

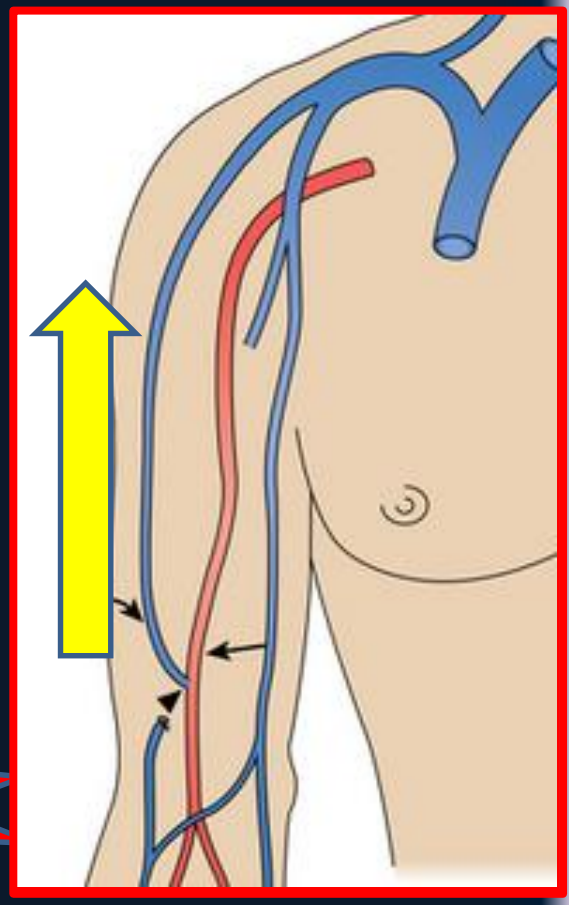
40-60% of max. blood flow (1day)

Remodeling

Maximal blood flow (4 weeks)

Biological

Physical

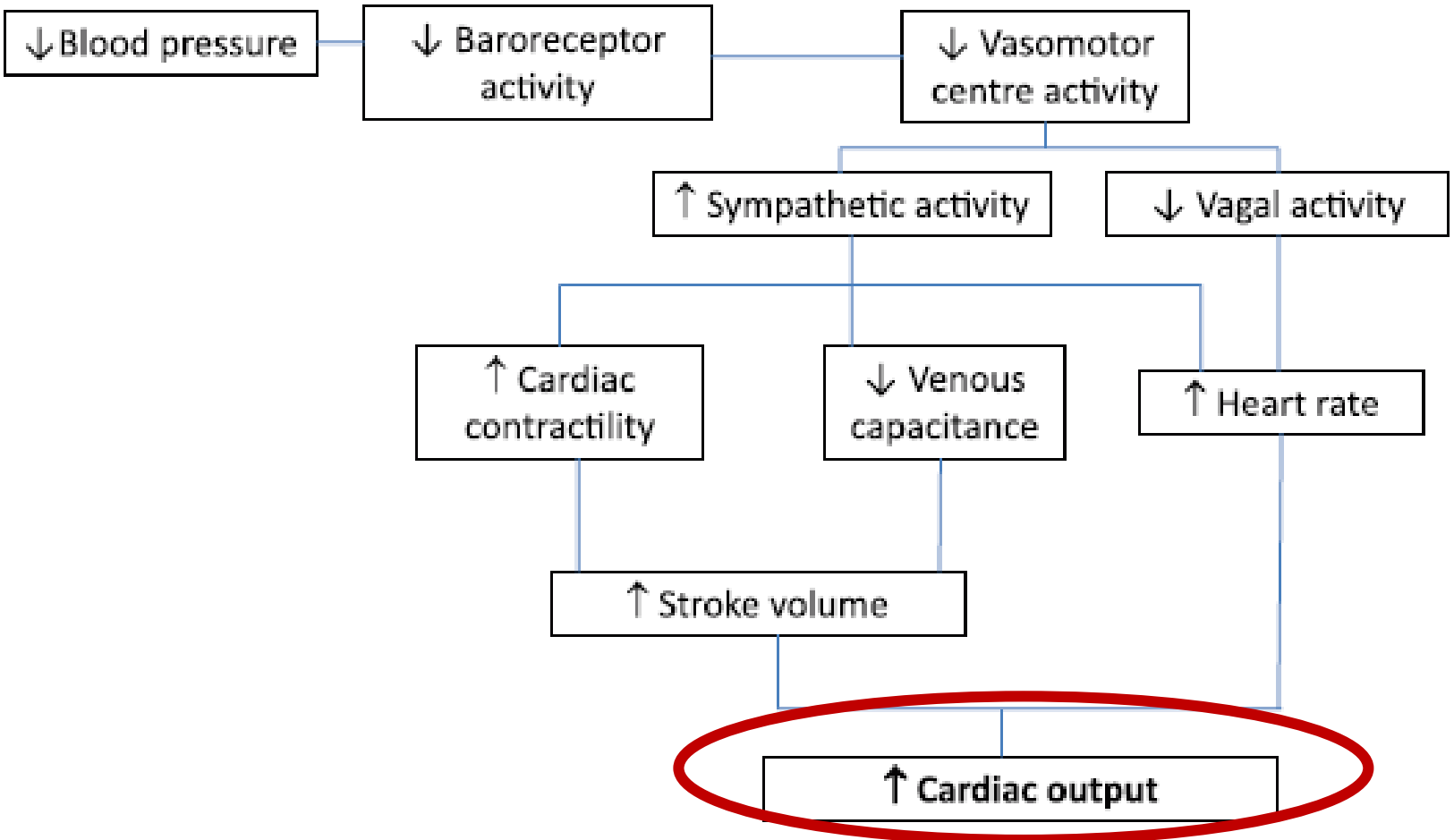


Functioning or Hyperfunctioning AVF

MacRae JM, et al. Can J Kidney Health Dis. 2016.

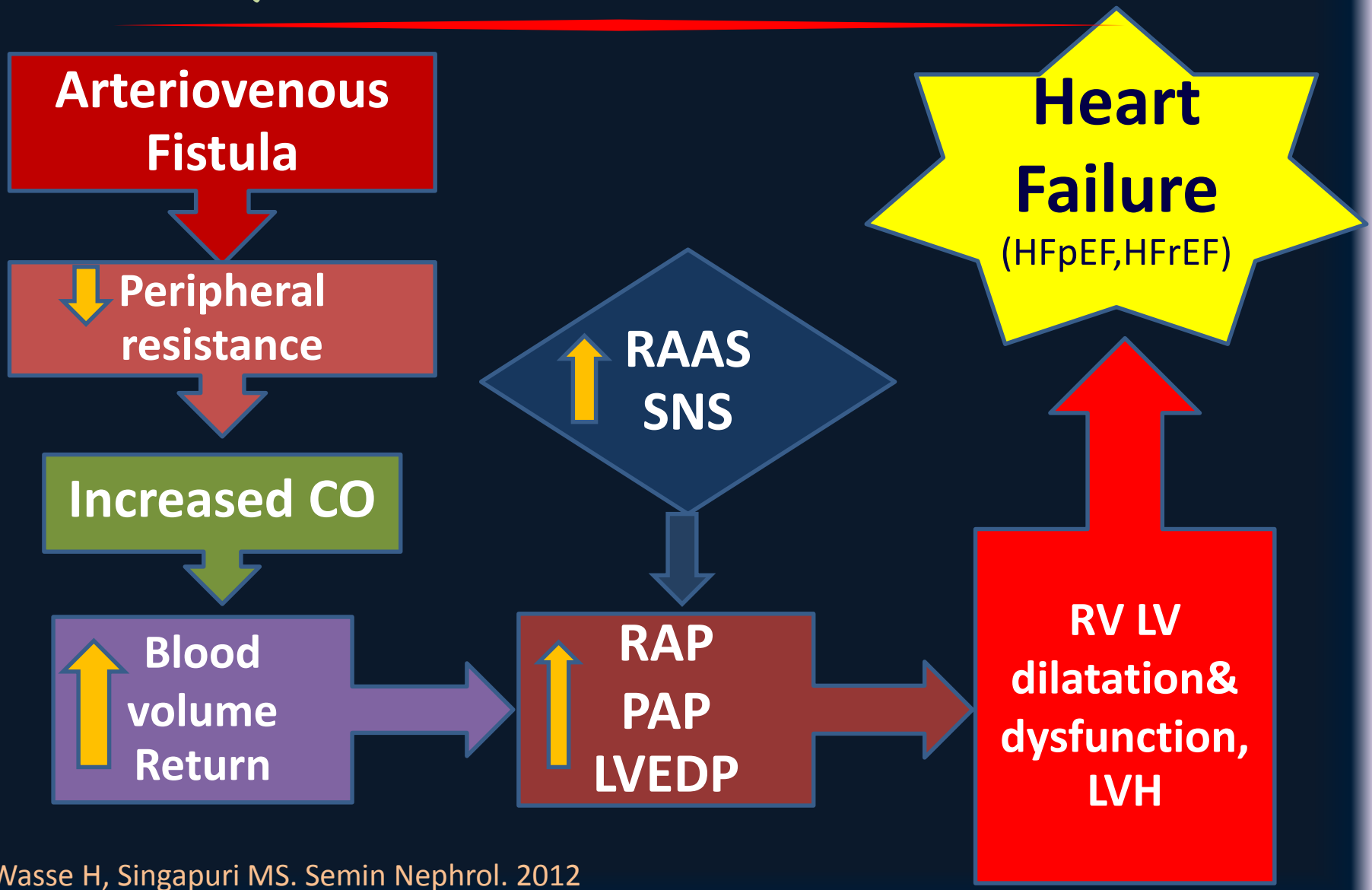
Cardiac Hemodynamic Changes with AV access creation

↓ Systemic vascular resistance



PATHOGENESIS

Hemodialysis AV access related heart failure



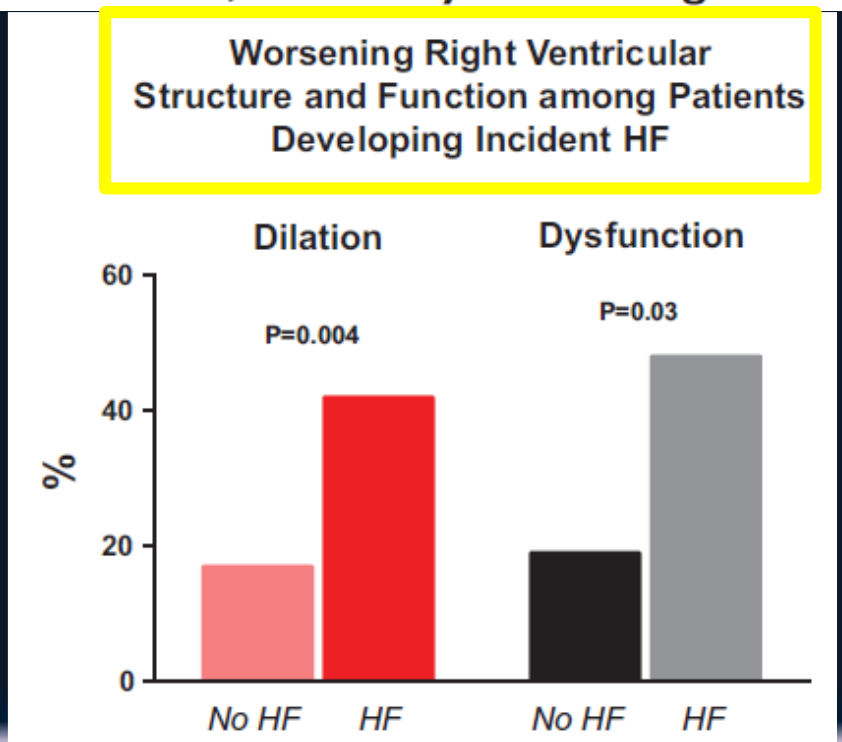
Wasse H, Singapuri MS. Semin Nephrol. 2012

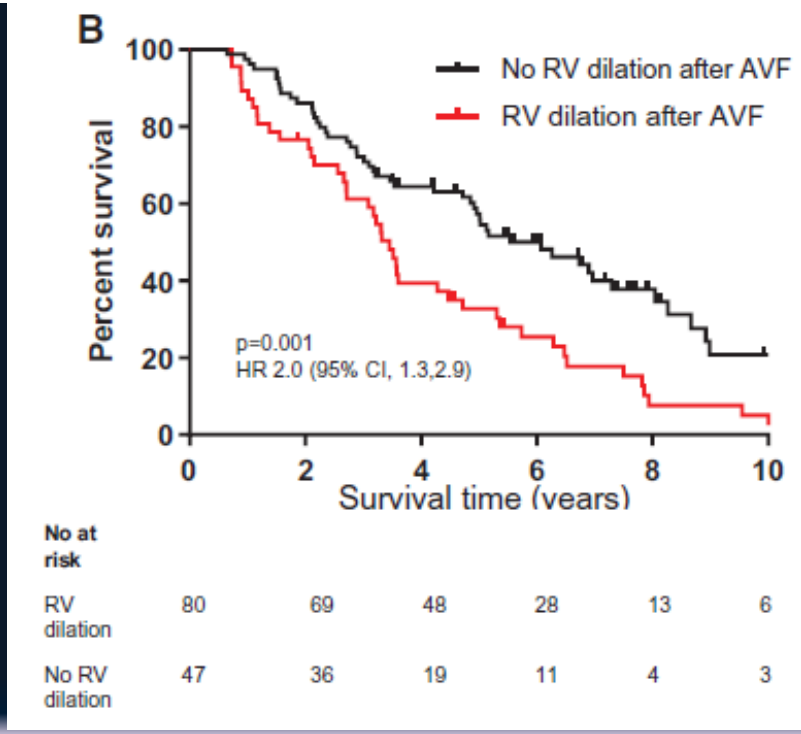
European Heart Journal (2017) **38**, 1913–1923
doi:10.1093/eurheartj/ehx045

Long-term cardiovascular changes following creation of arteriovenous fistula in patients with end stage renal disease

15-year period, 137patients

Yogesh N. V. Reddy[1], Masaru Obokata[1], Patrick G. Dean[2], Vojtech Melenovsky[4], Karl A. Nath[3], and Barry A. Borlaug[1]*





Monitoring strategy

- Monitor for S/S of HF as a routine part of every visit
  - Large distended fistula or graft with very strong pulse augmentation and thrill
  - **Qa ≥ 2 L/min** by U/S AVF flow measurement

Clinical practice guidelines for vascular access. Am J Kidney Dis.2006.
Malik J, et al. Contrib Nephrol 2015.

Mega-fistula

Clinical manifestations

Symptoms

- Dyspnea at rest, with exertion
- Orthopnea
- Fatigue that do not improve with ultrafiltration(if on dialysis) to optimal dry weight or anemia correction
- More difficult to achieve dry weight on hemodialysis (intradialytic hemodynamic instability)

Physical examination

- Tachycadia
- Peripheral edema
- Jugular venous distention
- A wide pulse-pressure
- An enlarged apical impulse
- A midsystolic murmur
- Pulmonary crakles
- Warm extremities

May develop weeks or years after AV access creation

Approach to diagnosis

Nicoladoni – Branham sign

- help determine if an AVF is a cardiac stressor

- Brief manual compression of the AVF (30 sec)
  - arterial baroreceptor activation
  - decrease sympathetic nerve traffic

Acute Bradycardia

Branham H. Int J Surg. 1890.

Approach to diagnosis

- **Chest radiograph** :

  Cardiomegaly ,Pulmonary edema ,Pleural effusion

- **Transthoracic echocardiogram** :
  - Dilation of the IVC
  - New RV dilation and dysfunction
  - LV enlargement
  - Increasing estimated PAP
  - LVEF can be normal or reduced

Mehta PA, Dubrey SW. QJM. 2009.

Approach to diagnosis

To definitiely establish

- **Right heart catheterization**
  - definite assessment of volume status
  - determination of cardiac output & PAP
  - examination of the hemodynamic response to transient fistula occlusion
  - cardio-pulmonary circulation (CPR) value :

    Qa/CO ratio > 0.3

Wasse H, Singapuri MS. Semin Nephrol. 2012.

Differential diagnosis

New or worsening heart failure

- Other causes of heart failure
  - Volume overload
  - Left ventricular systolic dysfunction
  - Valvular heart disease
- Other causes of high-output HF

Prevention

For patients with HF who are treated with HD

1. ACC/AHA stage C heart failure with NYHA functional class I, II

   - Radial- cephalic AV fistula

2. ACC/AHA stage C heart failure with NYHA functional class III, IV or stage D

   - Tunnelled dialysis catheter

Wijnen E, et al. Artif Organs. 2005.

Management of AV access related HF
Medical therapy

- Control of volume status with dialysis and diuretics
- Correction of anemia
- Treatment of hypertension
- Pharmacologic management of heart failure

Management of AV access related HF

HF remains uncontrolled despite medical therapy

1. Closed any unused fistulas

2. If refractory HF persists, reduce blood flow of the AV access
   - access banding
   - surgical revision (creation of a new distal anastomosis)

3. If refractory HF persists, close the AV access
   - tunneled catheter or a small graft
   - peritoneal dialysis
   - not attempt a lower flow fistula (radial AV access)

Closed any unused fistulas

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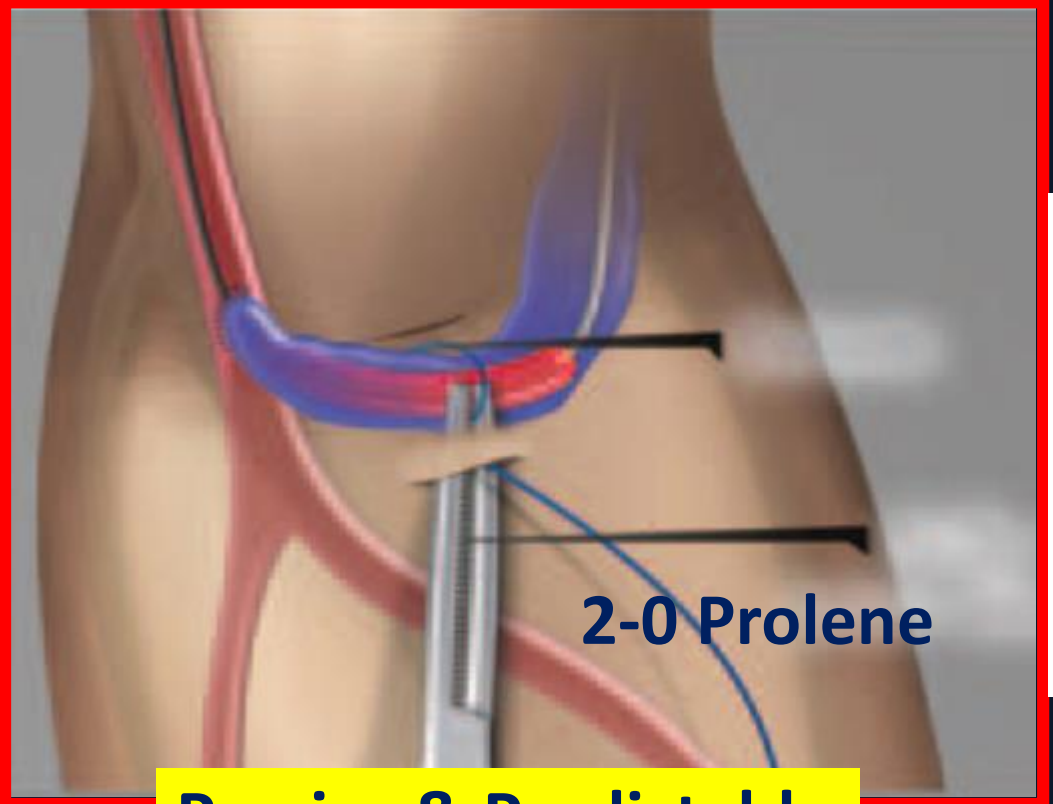
The MILLER banding procedure is an effective method for treating dialysis-associated steal syndrome

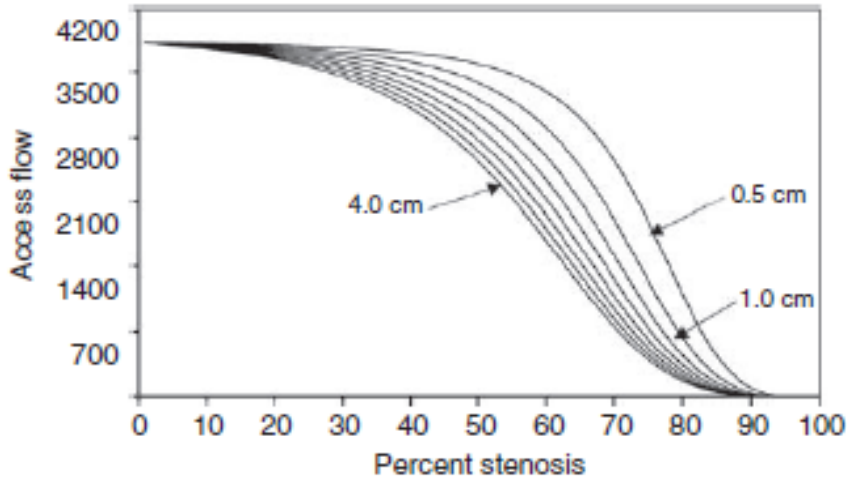
Gregg A. Miller[1], Naveen Goel[2], Alexander Friedman[1], Aleksandr Khariton[1], Manish C. Jotwani[3], Yevgeny Savransky[4], Konstantin Khariton[1], William P. Arnold[1] and Dean C. Preddie[5]

3-4 mm Balloon as a sizing dowel



Precise & Predictable

- 60-80% reduction in lumen diameter
-Less than 1 L/min



Murray's nomogram

Miller GA, et al. Kidney Int. 2010

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Study	Procedure	Indication	Access type	Patients (*n*)	Symptom resolution (%)	Secondary patency at 12 months (%)	Flow reduction (%)
Aschwanden *et al.*[35]	Banding	Steal	Fistula	3	100	100	68
DeCaprio *et al.*[36]	Banding	Steal	Graft	11	91	10	ND
Meyer *et al.*[37]	Banding	Steal	Fistula	7	100	ND	ND
Morsy *et al.*[3]	Banding	Steal	Fistula and graft	6	67	33	ND
Odland *et al.*[21]	Banding	Steal	Fistula and graft	16	100	39	ND
Schneider *et al.*[38]	T-banding	Steal	Fistula and graft	6	83	100[a]	45
		HF	Fistula and graft	20	95		49
Thermann *et al.*[39]	Banding	Steal	Fistula	25	68	65[b]	ND
Zanow *et al.*[20]	Banding	Steal and CF	Fistula	7	86	85	ND
Berman *et al.*[40]	DRIL	Steal	Fistula	21	100	94[b]	ND
Haimov *et al.*[41]	DRIL	Steal	Fistula	23	96	73	ND
Katz *et al.*[42]	DRIL						ND
Knox *et al.*[28]	DRIL						ND
Korzets *et al.*[43]	DRIL						ND
Lazarides *et al.*[15]	DRIL						ND
Mwipatayi *et al.*[29]	DRIL						ND
Schanzer *et al.*[44]	DRIL						ND
Sessa *et al.*[45]	DRIL						ND
Stierli *et al.*[46]	DRIL	Steal	Fistula	6	100	ND	ND
Zanow *et al.*[20]	PAI	Steal	Fistula and graft	30	84	90	ND
Presented data	MILLER banding	Steal	Fistula and graft	114	87	90	50
		HF	Fistula and graft	69	94	97	52

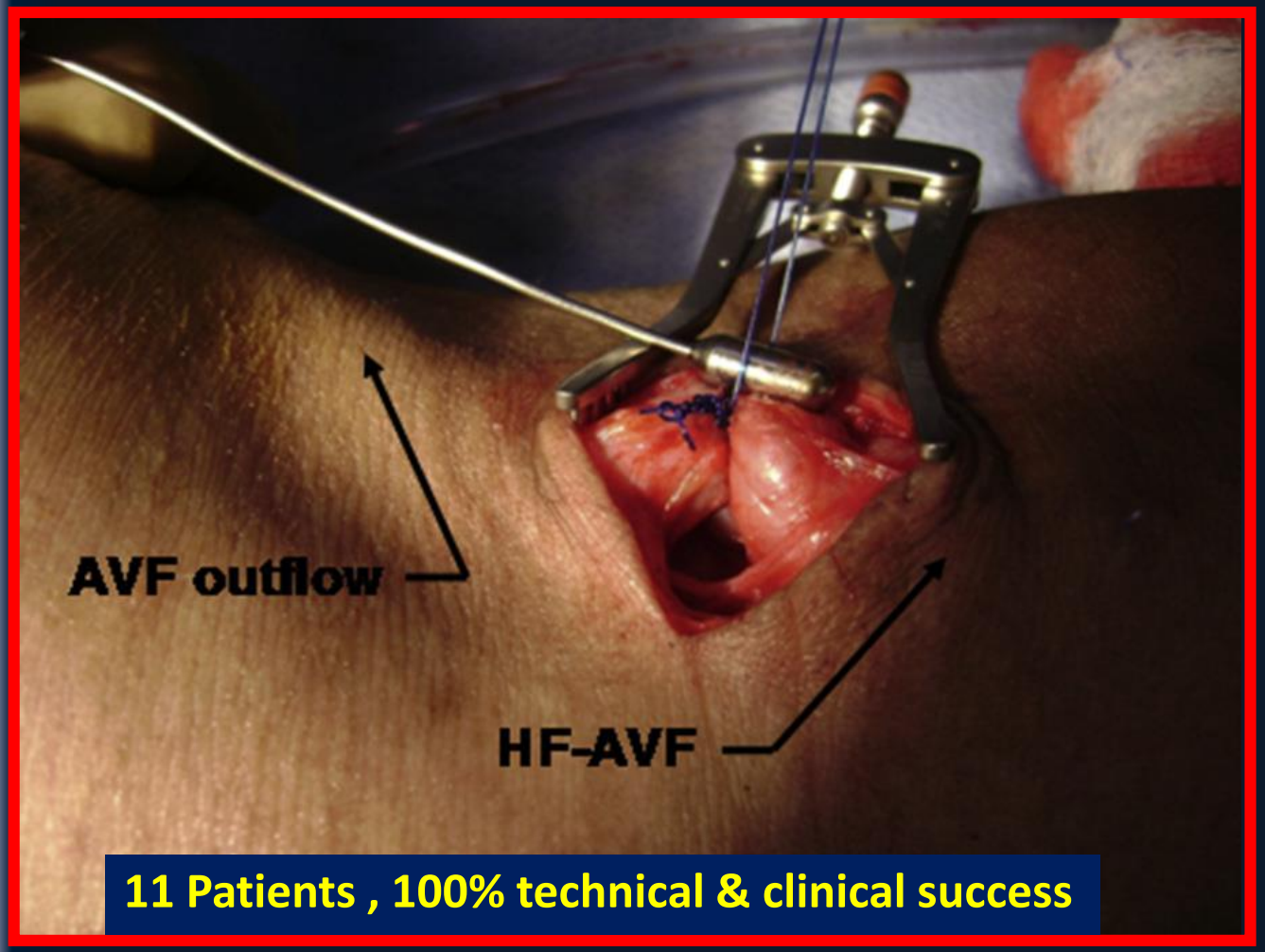
Symptom resolution **94%**
Secondary patency at 12 months **97%**

Abbreviations: CF, cardiac failure; DRIL, distal revascularization and interval ligation; HF, high flow; MILLER, minimally invasive limited ligation endoluminal-assisted revision; ND, no data; PAI, proximalization of the arterial inflow; RUDI, revision using distal inflow.

[a]At 3 months.
[b]At 18 months.

Miller GA, et al. Kidney Int. 2010

Modified Simple Precision Banding Technique



-3-4 mm banding

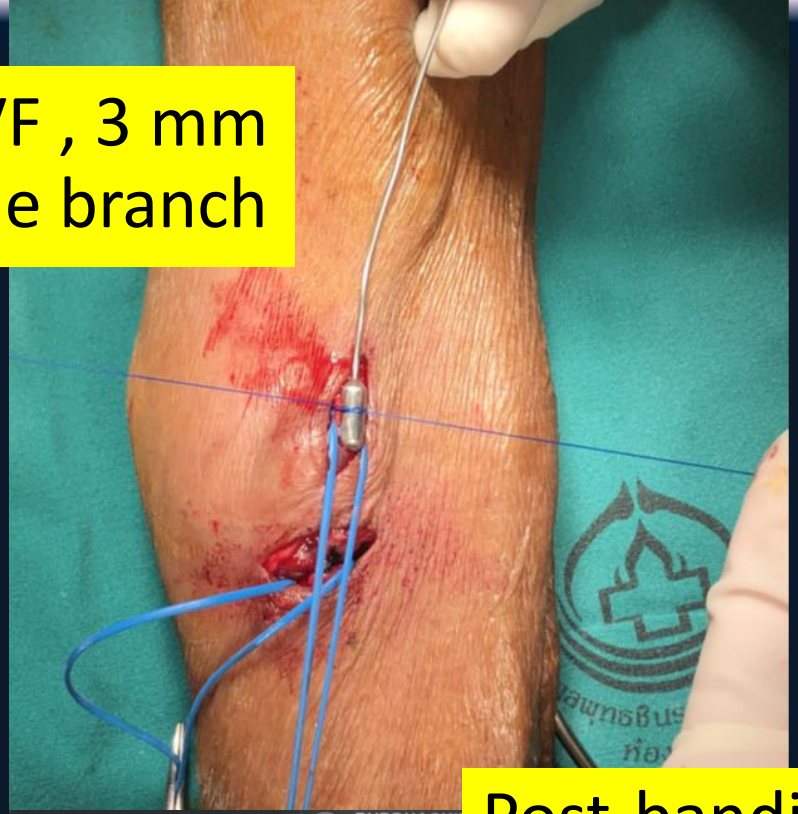
-using a coronary dilator as a dowel

-target access flow 500-800 ml/min (intraop. U/S)

-Two 2-0 polypropylene sutures

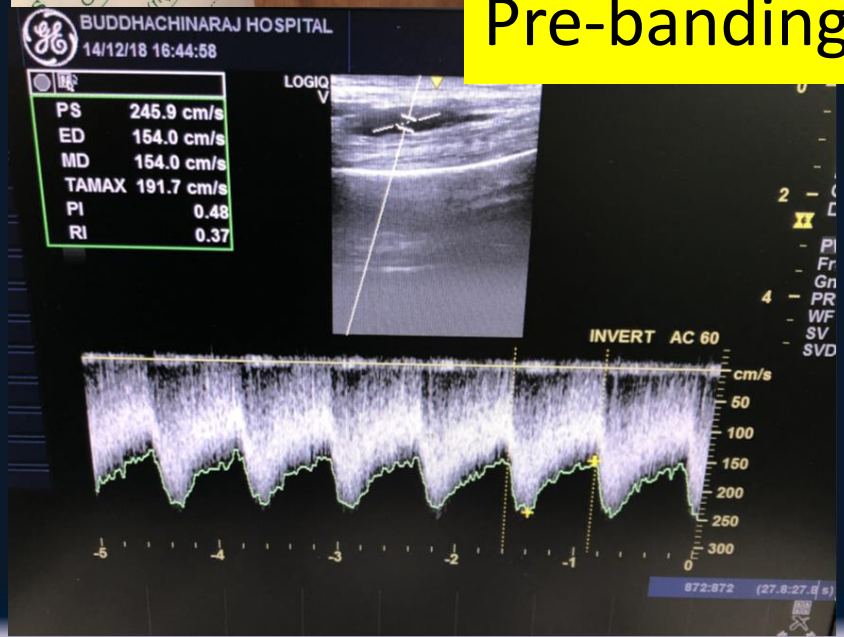
Gkotsis G, et al. Ann Vasc Surg. 2016.

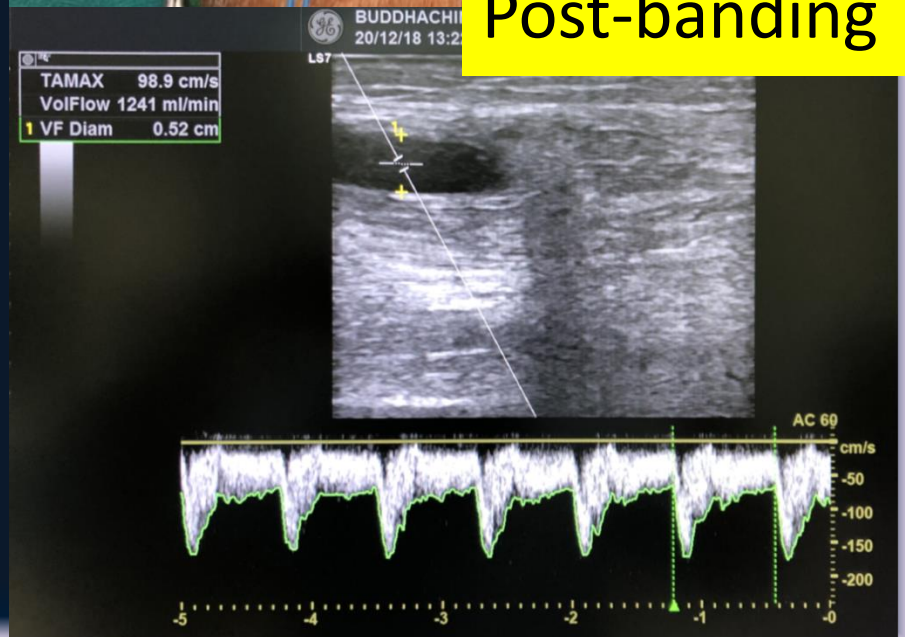
Banding AVF , 3 mm +ligated side branch



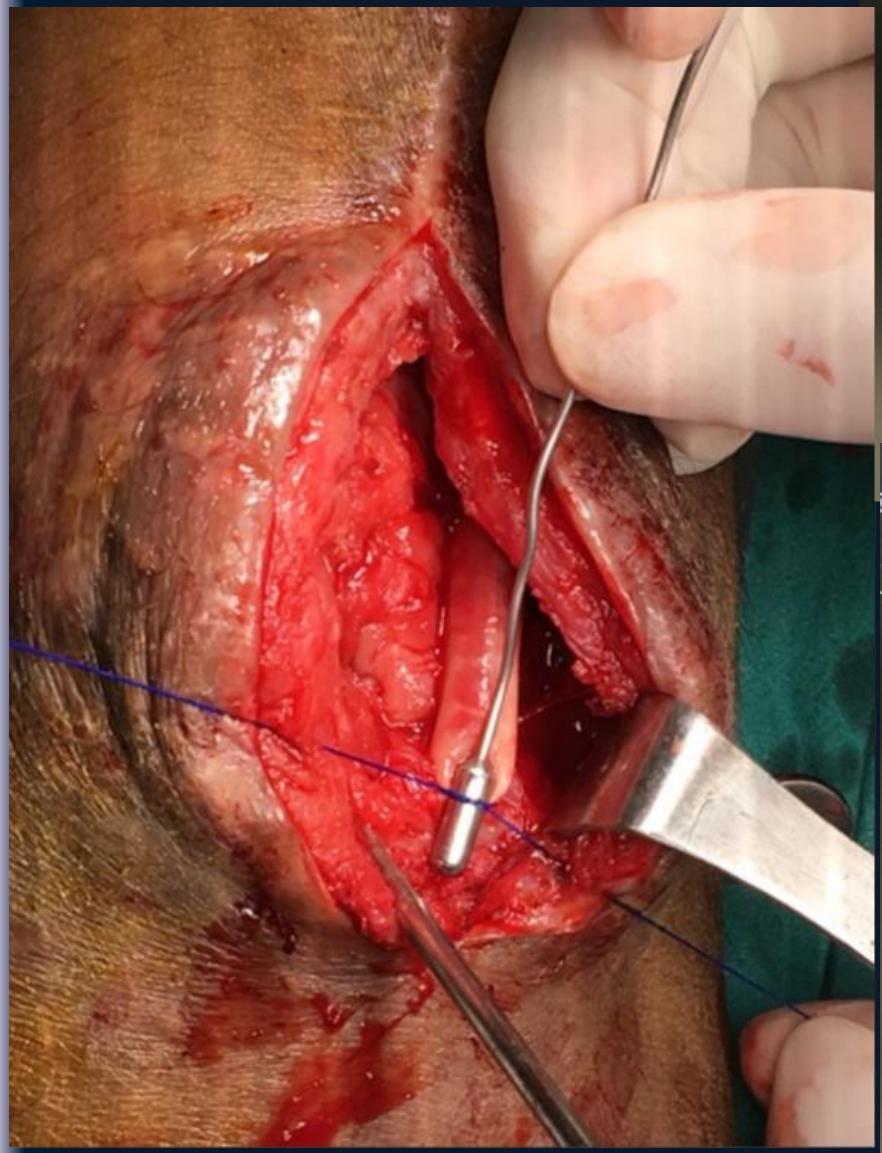
Pre-banding

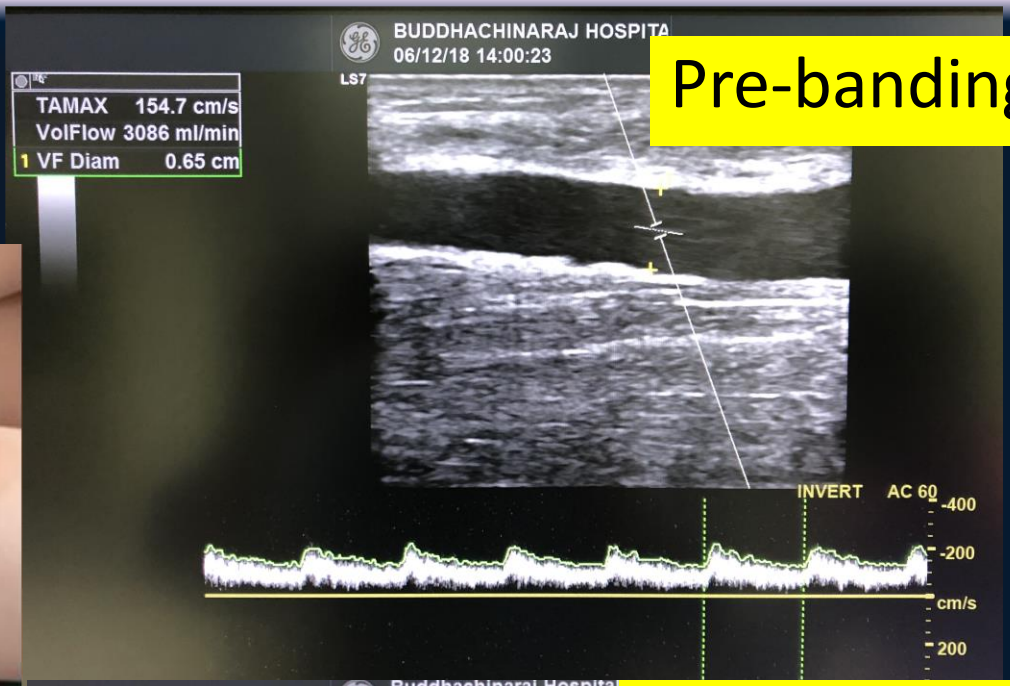
Post-banding



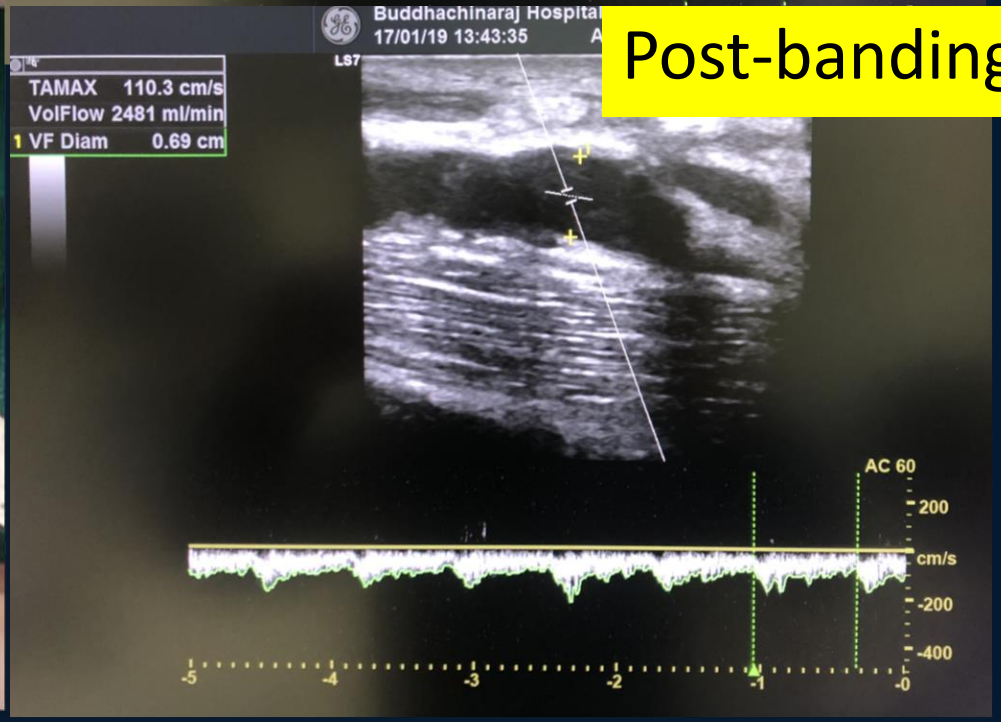


Banding AVG , 3 mm





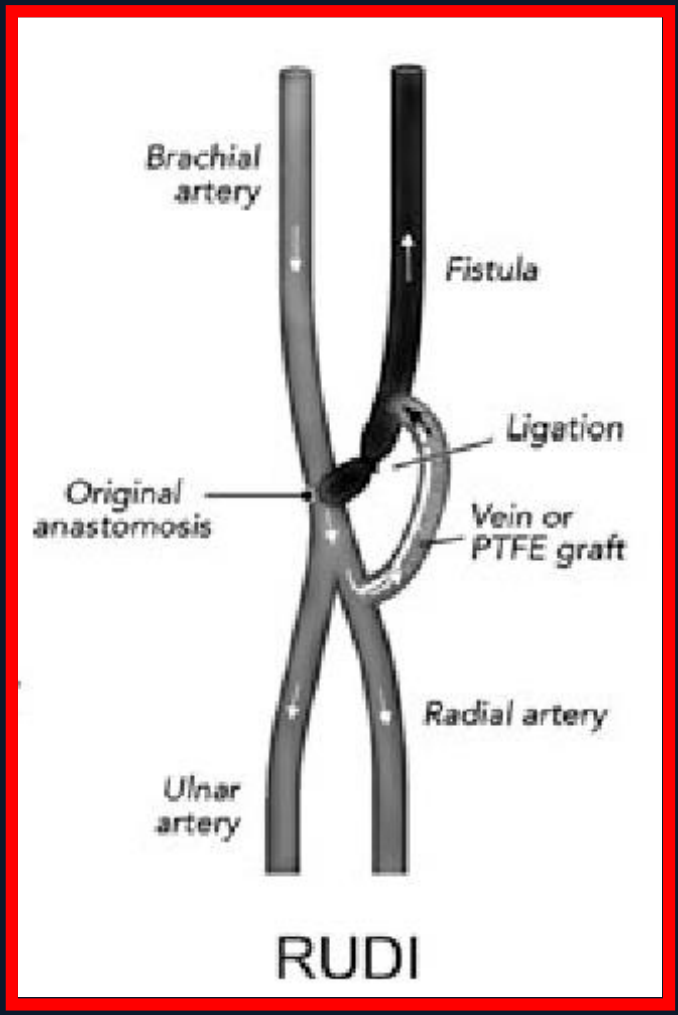
Pre-banding



Post-banding

Creation of a new distal anastomosis
Revision using distal inflow (RUDI)

- Upper-arm AVFs with >20-mm peri-anastomotic area
- Prefer autologous saphenous vein conduit
- Various degrees of success



Chemla ES, et al. Semin Dial. 2007., Parmar CD, et al. J Vasc Access. 2009., Miller GA, et al. Semin Nephrol. 2012.

Management of AV access related HF

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   - peritoneal dialysis
   - not attempt a lower flow fistula (radial AV access)

Closure of AV fistula

- Improvement in cardiac function
- Decrease in both eccentric and concentric LV hypertrophy
- Stable decrease in PAP
- The left ventricular ejection fraction also increased

Movilli E, et al. Am J Kidney Dis. 2010
Clarkson MR, et al. Am J Kidney Dis. 2002

Management of vascular access in IHD patients

- Significant coronary artery disease (CAD) is found in 30–40% of ESRD patients on hemodialysis

- Silent subendocardial myocardial ischemia

  Coronary perfusion (decreased LV diastolic pressure and shortening of the diastolic period)

Levin A. Semin Dial. 2003.
Amerling R, et al. Blood Purif. 2011.
Alkhouli M, et al. Nefrologia 2015.

Upper-extremity VA creation in patients with CAD undergoing CABG

- Ipsilateral internal mammary artery (IMA) bypass graft

Coronary steal & Increase the risk for MACE

- Controversy exists
- Proximal subclavian artery stenosis should be evaluated before
- AVF should be considered first rather than an AVG

Alkhouli M, et al. Nefrologia 2015.
Han Y, et al. PloS ONE 2017.

Conclusions

- Qa of ≥2 L/min >>> High-output HF
- **Symptoms are similar** >>> Low-output HF
- **Management** 1)medical treatment 2) reduction of access inflow by banding procedures ; if unsuccessful, 3) ligation is indicated
- **NYHA class III and IV heart failure**

  Tunnelled dialysis catheter or PD

THANK YOU