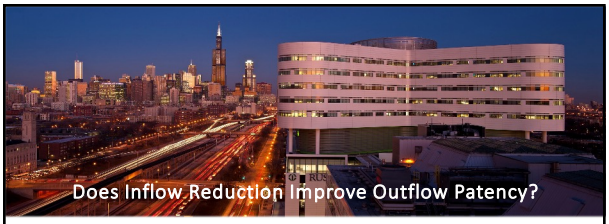

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Disclosures

- Consultant for Medtronic, Vascudyne, VenoVa
- National PI for post-market Ellipsys device clinical trial

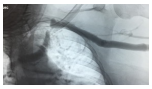
AV access blood flow

- Require 500-800 ml/min for dialysis
- High flow access not well-defined
  - ≥2 L/min
- Just enough flow to avoid thrombosis while providing efficient, reliable dialysis

Basile C, et al, NDT, 2008

Treatment of outflow stenosis

- Primary approach to rx: is to address the pathological anatomy
  - PTA/ Stent



- Role of excess volume flow in lesion development/ recurrence is generally ignored

When do we consider AV access inflow reduction?

- Recurrent outflow vein stenosis
- Aneurysm enlargement
- Symptomatic central venous stenosis/occlusion
- High-output heart failure

Jaberi A, J Vasc Access 2007; [2]Miller GA J Vasc Access 2010
Jennings WC et al, J Vasc Access, 13 (2), 2012

Does banding reduce access inflow?

- Yes!
- Methods vary with retrospective case series demonstrating varying reintervention rates
- Majority of reported outcomes of banding
  - Steal syndrome
  - Symptomatic venous hypertension

Miller et al, KI 2009
Shukla et al, J Clin Med, 2016
Wang Y, Renal Faiilure 2023
Nojima T et al, Ann Vasc Dis 2018
Alqassieh A et al, Am Surg, 2023

J Vasc Access. 2010 Oct-Dec;11(4):281-7. doi: 10.5301/jva.2010.592.

Access flow reduction and recurrent symptomatic cephalic arch stenosis in brachiocephalic hemodialysis arteriovenous fistulas

Abstract

Background: Recurrent cephalic arch stenosis (CAS) has been linked to high flow and has a high rate of recurrence following angioplasty. This study investigates the effectiveness of access flow reduction in decreasing rapidly recurrent symptomatic CAS.

Methods: A retrospective study of patient records from February 2005 to April 2009 was conducted. Patients with brachiocephalic fistulas who had undergone two or more instances of cephalic arch angioplasty within 3 months, and thereafter underwent flow reduction via banding of the access inflow (n=33) were included. A before-and-after analysis was conducted: the rates of cephalic arch angioplasty were calculated for each patient before and after the banding procedure, and compared via a paired t-test.

Results: At 3, 6, and 12 months, the cephalic arch primary lesion patency was 91%, 76%, and 57%. The cephalic arch intervention rate was reduced from 3.34 to 0.9 per access-year (t=7.74, p<.001). The average follow-up time was 14.5 months (range, 4.8-32).

Conclusion: Flow reduction of a brachiocephalic arteriovenous hemodialysis fistula may effectively diminish the incidence of symptomatic CAS.

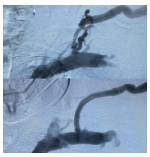
What about flow reduction leading to improved access patency?

- **Impact of High Flow on Venous Outflow**
  High flow in AV access can lead to a mismatch between inflow and the carrying capacity of the venous outflow system. This results in backpressure and turbulent flow, which accelerate endothelial damage and neointimal hyperplasia. These changes predispose to venous stenosis, particularly at the cephalic arch and central veins. The backpressure associated with high flow can also exacerbate central vein stenosis, especially in cases of pre-existing venous occlusion【33】

ChatGPT– there is no reference 33

Outflow stenosis in the BC-AVF

- Brachial-cephalic AVF make up approximately 1/3 of prevalent AVF's
- Cephalic arch stenosis is the primary lesion
  - Incidence from 15-77%
  - Accounts for 50-70% of upper arm AVF stenosis
- Frequent cause of AVF dysfunction
  - Prevalence, resistance to rx, high recurrence rates

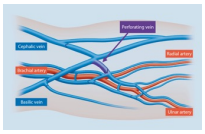


Beathard GA et al. JVA 2021

Choice of inflow artery matters

- Blood flow through cephalic arch is generally higher with brachial artery inflow vs. proximal radial artery anastomosis
  - BC-AVF– nearly all flow passes through cephalic arch
  - PRC-AVF- 3 outflow channels (median-cephalic, median cubital, perforator to brachial veins)
    - Better long-term patency [1,2]
    - Lower incidence of CAS [3,4]

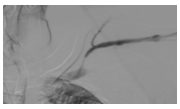
1 Rodriguez JA et al, NDT 2000
2 Lamprou A et al, JVA, 2017
3 Amaoutakis DJ et al, J Vasc Surg, 2017
4 Krampf et al, JVA 2021

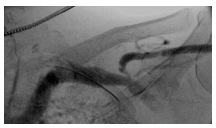


Steinke T et al, Gefasschirurgie, 2019; TVA Medical illustration

Inflow reduction for outflow stenosis

- Cephalic arch stenosis often results from:
  - Mismatch between volume flow, outflow diameter
- AVF flow rate correlates with cephalic arch stenosis [1]
- Flow reduction in BC-AVF's can reduce number of cephalic arch interventions [2]





[1] Jaberi A, J Vasc Access 2007; [2]Miller GA J Vasc Access 2010

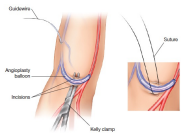
Management strategies for cephalic arch stenosis

- Mean number re-interventions required are 1.5-3.5/yr [1,2]
- Treatment options:
  - Angioplasty
    - Focus on proper balloon sizing, ultra-high pressure PTA
    - Drug-eluting balloons may improve primary patency [3]
  - Stent graft placement
    - Typically used for vein rupture or lesion recurrence < 3 months

1 Rajan DK et al, JCIR, 2003
2 Kian K et al. Semin Dial 2008
3 Lookstein RA NEJM 2020

Management strategies for CAS

- Blood flow reduction
  - Best via surgical or endovascular "precision-banding"
  - Must define threshold Qa & optimal target Qa
    - Threshold Qa for development & recurrence CAS, CV complications, is not known
    - Optimal target: Qa should exceed pump speed by at least 100 ml/min for effective dialysis
      - US DOPPS 2014 : mean 417 ml/min pump speed
      - Caveat: must consider blood pressure
- Surgical intervention
  - Often used late in pts with recurrent problems
  - Turn down of outflow vein or bypass using graft material



Inflow reduction: Treatment goals

- To avoid thrombosis, Qa ~800 mL/min
  - AVF ≥ 5-600 mL/min
  - AVG ≥ 800 mL/min
  - Increased risk of access thrombosis in absence of venous outflow collaterals
- Ensure patient has a sufficient cannulation segment of good quality

Jennings WC et al, J Vasc Access, 13 (2), 2012

ASDIN

JVA The Journal of Vascular Access

ASDIN white paper: Management of cephalic arch stenosis endorsed by the American Society of Diagnostic and Interventional Nephrology*

Gerald A Beathard[1], William C Jennings[2], Haimanot Wasse[3], Surendra Shenoy[4], Abigail Falk[5], Aris Urbanes[6], John Ross[7], George Nassar[8], Dirk M Hentschel[9], Bharat Sachdeva[10], Micah R Chan[11], Loay Salman[12] and Arif Asif[13]

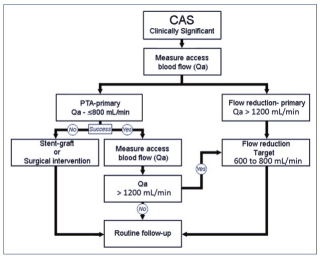
The Journal of Vascular Access
1–12

DOI: 10.1177/11297298211033519
journals.sagepub.com/home/jva
SAGE

Management algorithm of CAS: Individualize based on flow & imaging

Goal: To restore & maintain access function for longest possible period with the fewest interventions

Useful to rx the lesion & pathophysiology
- flow measurement
- angiography



Beathard G et al, JVA 2019

Prevention of CAS

- Avoiding high flow is important in prevention
  - Direct linear relationship between flow velocity & development of CAS [1]
- If distal RC-AVF can't be created, prioritize proximal radial-cephalic AVF > BC-AVF
- If BC-AVF, limit anastomosis to 4 mm or 75% of diameter of brachial artery, whichever is less
- Regular AVF examinations to detect excessive blood flow, CAS

[1] Hammes M et al, Plos One, 2016

Conclusions

- Limited quality data highlights the importance of personalized surgical planning and patient selection when considering inflow reduction to optimize outcomes in AV access circuits