SVM APP Course Handouts Table of Contents
Sunday, March 17, 2024

* Handout not included in packet

Diagnosing PAD

March 2024

Bryan J. Wells, MD

@SVM_tweets vascularmed.org @VascularMed

1

Learning Objectives

- Discuss differential of PAD and other possible diagnoses of LE pain
- Review classic presentation/ physical exam in PAD
- Role of ABI and other vascular testing in diagnosis

@SVM_tweets vascularmed.org @VascularMed

2

Case

- 57-year-old man with a history of tobacco abuse presents to the clinic c/o calf pain
- States that after he walks in the parking lot, he gets a burning sensation in the back of his legs
- This is worse with hills and resolves completely after 30 seconds of rest
- Past Medical and Social History
  - Tobacco Abuse
    - Tried to quit with Chantix but failed
  - HLD
  - EtOH
  - HTN
  - Works as a bartender and is on his feet most of the day

@SVM_tweets vascularmed.org @VascularMed

3

SVM Society for Vascular Medicine

Case Continued

MEDS
- Aspirin
- Atorvastatin
- Ibuprofen
- Cyclobenzaprine

EXAM
- 2+ DP/PT bilaterally
- No peripheral edema
- No abdominal bruits

4

SVM Society for Vascular Medicine

Why Screen for PAD?

- To identify disease and prevent progression and complications related to PAD
- To identify patients at high risk for other forms of cardiovascular disease and aggressively treat risk factors to prevent cardiovascular events

5

SVM Society for Vascular Medicine

Question 1

- What is the differential diagnosis for lower extremity pain?

6

SVM
Society for Vascular Medicine

Lower Extremity Pain

- History and physical is important to determine the etiology
- Differential diagnosis is broad
  - Acute versus Chronic
  - Resting versus exertional
  - Positional, location, associated signs/symptoms
- 3 main categories
  - Vascular
  - Neurological
  - Musculoskeletal

7

SVM
Society for Vascular Medicine

VASCULAR CAUSES	
DVT	Unilateral pain, swelling, discoloration; risk factors include smoking, recent travel, cancer, etc
Peripheral vascular disease	Bilateral claudication; history of smoking, atherosclerosis
Arterial endofibrosis	Associated with repetitive hip flexion, unilateral, most common in cyclists; ischemic pain and loss of power
Cystic adventitial disease	Men in mid-40s, intermittent claudication with activity
Popliteal artery aneurysm	Most common peripheral aneurysm, more common in males, associated with smoking and HTN; acute or chronic ischemic pain or arterial insufficiency, often asx
Popliteal artery entrapment syndrome	Lower limb pain and ischemia with high-intensity exercise associated with excessive dorsiflexion and plantar flexion of ankle

8

SVM
Society for Vascular Medicine

NEUROLOGICAL CAUSES	
Lumbar radiculopathy	Possible association w/ low back pain, sx in distribution of dermatome, often unilateral
Peripheral neuropathy	History of DM, vitamin deficiency, or other systemic disease; pain and sensory loss
Spinal stenosis	Age >/- 50, lower back pain, symptoms worse with activity, relieved with sitting or flexing spine; numbness and tingling from buttocks into legs
Nerve entrapment	Pain and tingling worse with activity in distribution of affected nerve; trauma more likely than overuse

MUSCULOSKELETAL CAUSES	
CECS	Consistent bilateral symptoms; numbness and weakness may occur
MTSS	Common in runners, often bilateral, diffuse tenderness
Muscle strain	Immediate onset of symptoms, unilateral, no pain at rest
Stress fracture	Common in athletes, especially female athlete triad; unilateral, focal pain, tenderness
Tendinopathy	Gradual onset of symptoms related to overuse

9

SVM Society for Vascular Medicine

True or False

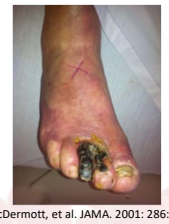
- The majority of patients with peripheral arterial disease will have typical claudication symptoms

10

SVM Society for Vascular Medicine

PAD Symptoms

- Classic claudication symptoms
  - Exertional leg pain that resolves within 10 minutes of rest
  - Present in only 32% of patients; 20% have no leg pain, 48% have atypical symptoms
- Rest pain
- Ulcer
- Gangrene
- Leriche's syndrome



McDermott, et al. JAMA. 2001: 286:1599.

11

SVM Society for Vascular Medicine

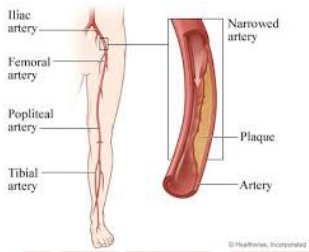
	Claudication	Pseudoclaudication
Characteristic of discomfort	Cramping, tightness, aching, fatigue	Same as claudication + tingling, burning, numbness
Location of discomfort	Buttock, hip, thigh, calf, foot	Same as claudication
Exercise-induced	Yes	Variable
Distance	Consistent	Variable
Occurs with standing	No	Yes
Action for relief	Stand	Sit, change position
Time to relief	<5 minutes	≤30 minutes

Hirsch AT, et al. J Am Coll Cardiol. 2006;47:1239-1312.

12

SVM Society for Vascular Medicine

Lower Extremity Peripheral Arterial Disease (PAD)



13

SVM Society for Vascular Medicine

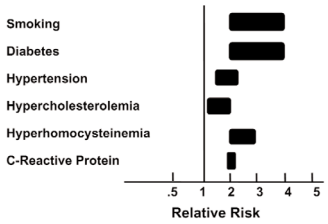
Question 2

- What are the risk factors for peripheral arterial disease?

14

SVM Society for Vascular Medicine

Risk Factors for PAD

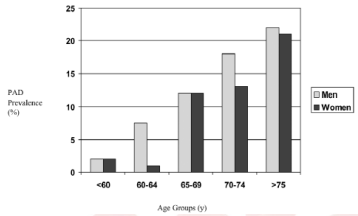


Dormandy JA, et al. J Vasc Surgery, 2000, 31.

15

SVM Society for Vascular Medicine

PAD Prevalence Increases with Age



Criqui. Circulation 1985;71:510-5 (77).

16

SVM Society for Vascular Medicine

Question 3

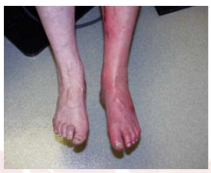
- What are the physical examination findings associated with PAD?

17

SVM Society for Vascular Medicine

PAD Physical Exam Findings

- Peripheral pulses
- Skin temperature
- Skin color
- Bruits
- Hair loss
- Tissue loss
- Signs of infection



Khan NA, JAMA 2006; 295:536.

18

SVM Society for Vascular Medicine

Question 4

- What diagnostic testing is available to evaluate for PAD?

19

SVM Society for Vascular Medicine

AHA/ACC 2016 Guidelines

Recommendations for Resting ABI for Diagnosing PAD		
COR	LOE	Recommendations
I	B-NR	In patients with history or physical examination findings suggestive of PAD (Table 4), the resting ABI, with or without segmental pressures and waveforms, is recommended to establish the diagnosis (60-65).
I	C-LD	Resting ABI results should be reported as abnormal (ABI ≤0.90), borderline (ABI 0.91–0.99), normal (1.00–1.40), or noncompressible (ABI >1.40) (46, 63-66).
IIa	B-NR	In patients at increased risk of PAD (Table 3) but without history or physical examination findings suggestive of PAD (Table 4), measurement of the resting ABI is reasonable (41, 42, 67-89).
III: No Benefit	B-NR	In patients not at increased risk of PAD (Table 3) and without history or physical examination findings suggestive of PAD (Table 4), the ABI is not recommended (87, 90).

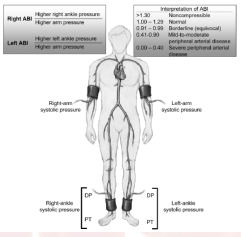
20

SVM Society for Vascular Medicine

Ankle-Brachial Index

$$ABI = \frac{\text{Ankle systolic pressure}}{\text{Brachial systolic pressure}}$$

- ABI has excellent accuracy in detecting stenosis **>50%**



21

SVM Society for Vascular Medicine

Diagnostic Performance of the ABI

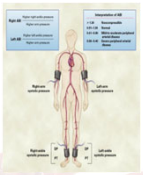
TEST	SENSITIVITY	SPECIFICITY
ABI	**95-97%**	**99-100%**
PULSE EXAM (DP)	50%	73%
PULSE EXAM (PT)	71%	91%
Rose Claudication Questionnaire	20%	96%

@SVM_tweets vascularmed.org @VascularMed

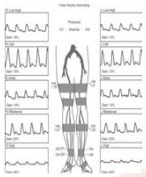
22

SVM Society for Vascular Medicine

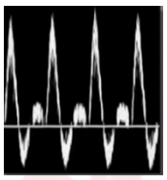
Diagnostic studies to evaluate for PAD



Ankle-Brachial Index



Segmental Pressures & Pulse Volume Recordings



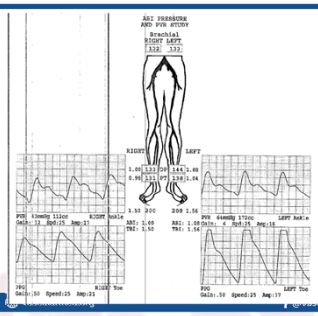
Spectral Doppler Waveforms

@SVM_tweets vascularmed.org @VascularMed

23

SVM Society for Vascular Medicine

Our Patient's Resting ABI



@SVM_tweets

24

SVM Society for Vascular Medicine

Exercise ABI

POST EXERCISE ANKLE PRESSURES

	BRACHIAL	TIME	RIGHT ANKLE	RIGHT ABI	RIGHT TIME	LEFT ANKLE	LEFT ABI	LEFT TIME
RESTING								
IMMEDIATE	163	02:09	59	0.36	00:55	148	0.91	01:30
PERIOD 1			75		02:53			
PERIOD 2								
PERIOD 3								
PERIOD 4								
PERIOD 5								

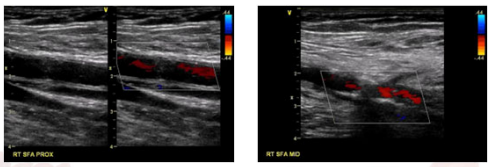
Total Exercise Time: 05:14
RIGHT CALF symptomatic at: 01:36

@SVM_tweets vascularmed.org @VascularMed

25

SVM Society for Vascular Medicine

Arterial Duplex

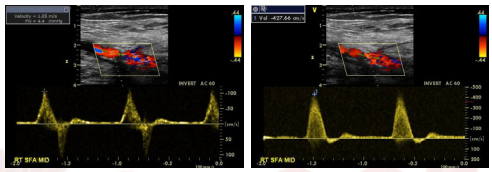


@SVM_tweets vascularmed.org @VascularMed

26

SVM Society for Vascular Medicine

Arterial Duplex

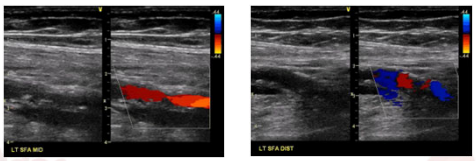


@SVM_tweets vascularmed.org @VascularMed

27

SVM
Society for Vascular Medicine

Arterial Duplex

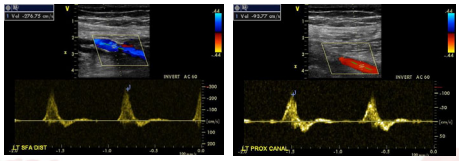


@SVM_tweets vascularmed.org @VascularMed

28

SVM
Society for Vascular Medicine

Arterial Duplex



@SVM_tweets vascularmed.org @VascularMed

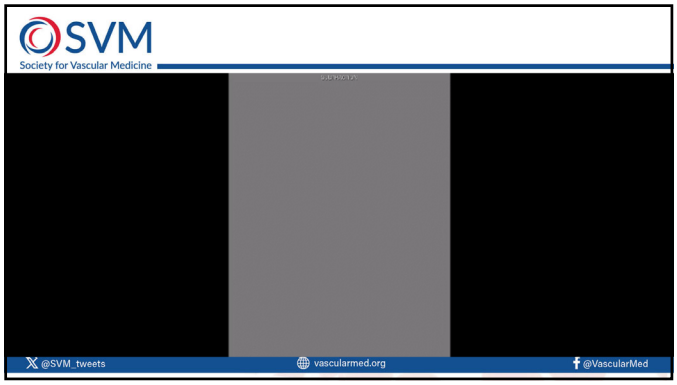
29

SVM
Society for Vascular Medicine

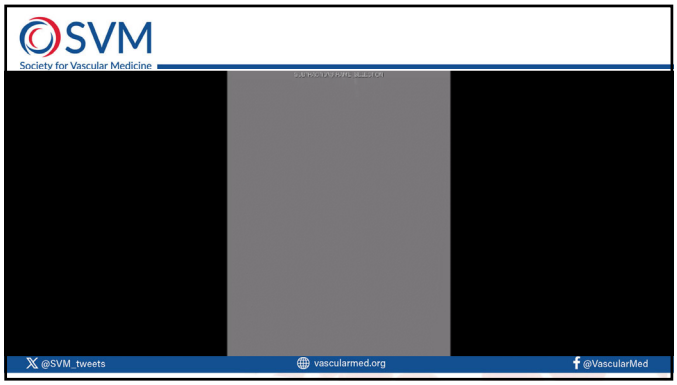
Lower Extremity Angiogram

@SVM_tweets vascularmed.org @VascularMed

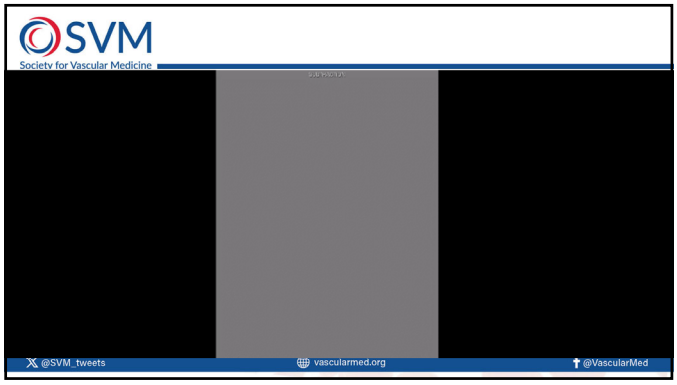
30


SVM
Society for Vascular Medicine
@SVM_tweets
vascularmed.org
@VascularMed

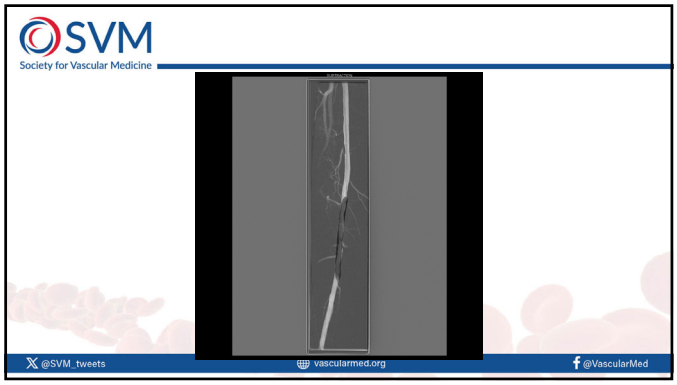
31


SVM
Society for Vascular Medicine
@SVM_tweets
vascularmed.org
@VascularMed

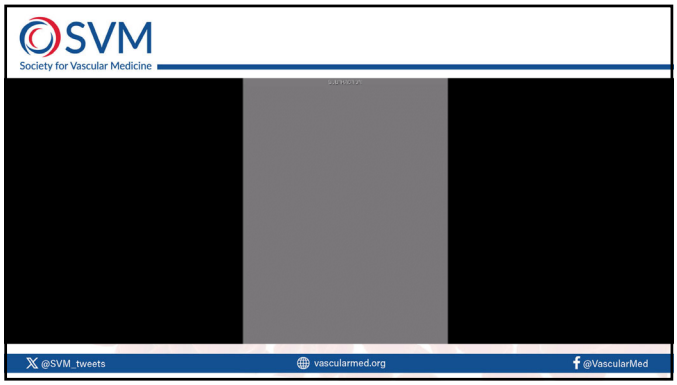
32


SVM
Society for Vascular Medicine
@SVM_tweets
vascularmed.org
@VascularMed

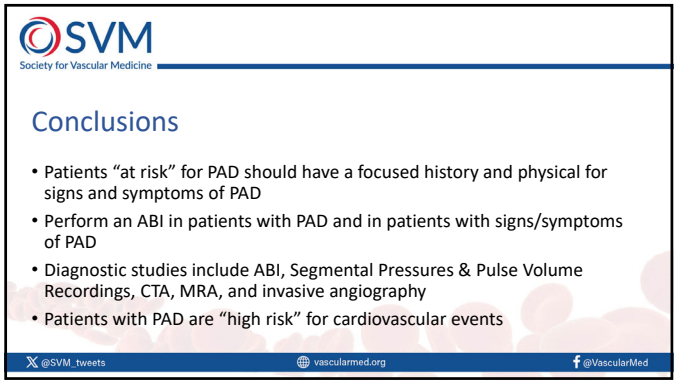
33


SVM
Society for Vascular Medicine
@SVM_tweets
vascularmed.org
@VascularMed

34


SVM
Society for Vascular Medicine
@SVM_tweets
vascularmed.org
@VascularMed

35


SVM
Society for Vascular Medicine
Conclusions
• Patients “at risk” for PAD should have a focused history and physical for signs and symptoms of PAD
• Perform an ABI in patients with PAD and in patients with signs/symptoms of PAD
• Diagnostic studies include ABI, Segmental Pressures & Pulse Volume Recordings, CTA, MRA, and invasive angiography
• Patients with PAD are “high risk” for cardiovascular events
@SVM_tweets
vascularmed.org
@VascularMed

36

Preserving Life and Limb in PAD

Aditya Sharma, MBBS, FSVM
Director, Vascular Medicine
Associate Professor of Medicine
University of Virginia
adityasharmamd

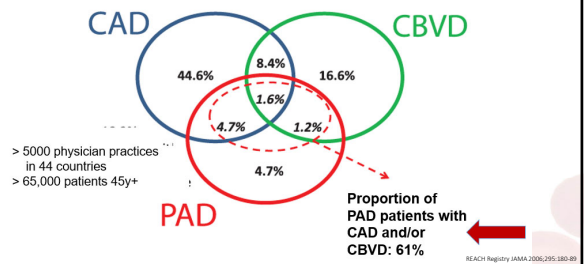
1

Disclosures

- Research funding:
  - PI: Boston Scientific (HI-PEITHO)
  - PI: Vascular Medcure
  - PI: NIH (C-TRACT)
  - Co-I: Thrombolex (RESCUE) and NIH (ATTRACT)
- Speakers bureau and consulting:
  - Boston Scientific
  - enVVeno
- Clinical Excellence Committee:
  - Thrombolex

2

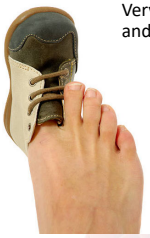
PAD: A POLYVASCULAR DISEASE



REACH Registry JAMA 2006;295:180-89
EUCLID JACC 2020;75:498–508

3

Not ALL PAD is the SAME



Patients with PAD who have undergone a REVASCULARIZATION: Very high risk for major adverse cardiovascular events (MACE) and major adverse limb events (MALE)

Compared to stable PAD
→4x higher risk of ALI
→> 30% increased risk of MI

J Am Coll Cardiol. 2016;67:2719–2728

@SVM_tweets vascularmed.org @VascularMed

4

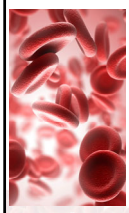
PAD patient

- Antithrombotics
- Hyperlipidemia
- Diabetes
- Diet and Smoking
- Hypertension
- Exercise therapy

@SVM_tweets @VascularMed

5

Antithrombotic Therapy



- ATT data: Reduced CV event rate by 22% ↓ in large meta-analysis
- CAPRIE trial: Incremental benefit of clopidogrel vs. aspirin (8.7 RR reduction)
- Berger et al: 2009 meta-analysis suggests aspirin not adequately proven to be anti-platelet agent of choice for preventing CV events in PAD patients
- EUCLID trial: ticagrelor monotherapy not superior to clopidogrel
- Path specimens: plaque thrombosis and microembolism
  - 2/3rd of infrapopliteal lesions are thrombosis without atherosclerosis

N Engl J Med 2017; 376:32-40
JACC Cardiovasc Imaging. 2019;12:1501–1513.
BMJ. 2002;324:71.
Lancet. 1996;348:1329
Eur Heart J. 2009;30:192.

@SVM_tweets vascularmed.org @VascularMed

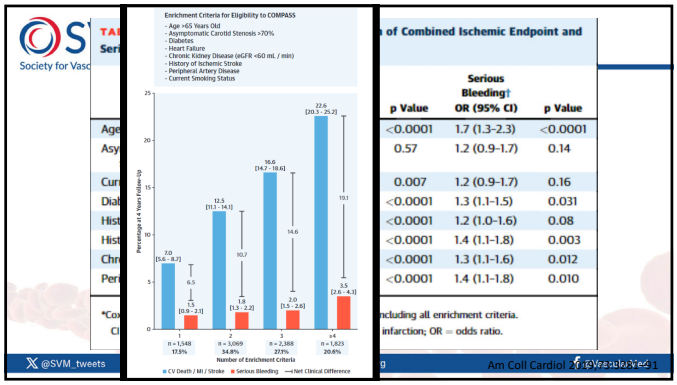
6

Combination Therapies

	Aspirin+ticagrelor 60 mg twice daily vs aspirin
Pivotal studies	PEGASUS-TIMI 54[125,126]
Population	Prior MI with symptomatic PAD subgroup†
Effects for MACE	15% relative risk reduction
Effects for MALE	35% relative risk reduction
Bleeding	2.32-fold relative excess in TIMI major bleeding

@SVM_tweets vascularmed.org @VascularMed

7



of Combined Ischemic Endpoint and

p Value	Serious Bleeding† OR (95% CI)	p Value
<0.0001	1.7 (1.3-2.3)	<0.0001
0.57	1.2 (0.9-1.7)	0.14
0.007	1.2 (0.9-1.7)	0.16
<0.0001	1.3 (1.1-1.5)	0.031
<0.0001	1.2 (1.0-1.6)	0.08
<0.0001	1.4 (1.1-1.8)	0.003
<0.0001	1.3 (1.1-1.6)	0.012
<0.0001	1.4 (1.1-1.8)	0.010

ncluding all enrichment criteria.
infarction; OR = odds ratio.

@SVM_tweets Am Coll Cardiol

8

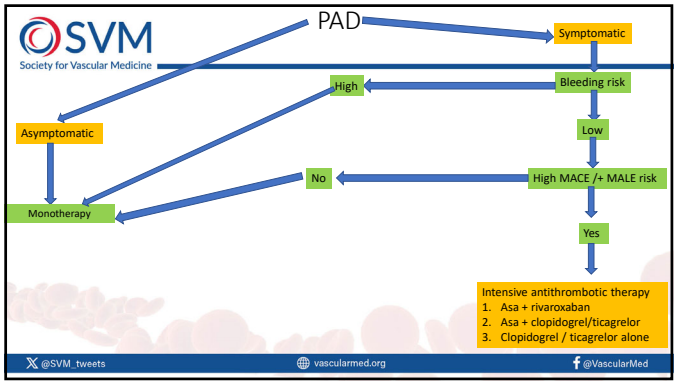
Individualized Approach of Antithrombotic Therapy in PAD

Increase Ischemic Events (MACE)	Increase Limb Events (MALE)	Increase bleeding events
Polyvascular disease (CAD/CVD)	Prior bypass (especially prosthetic or below the knee bypass) or Prior revascularization	Recent major bleeding
Diabetes Mellitus	Prior amputations / tissue loss	Prior Intracranial bleeding
Old age	Below the knee disease/ multilevel disease	Chronic anticoagulation (A fib/VTE)
Active smoking	CLI (ARR higher 5.7% vs. 3.9%)	Anemia
Heart failure / Renal disease	Prior arterial thrombotic events	Fragility / old age

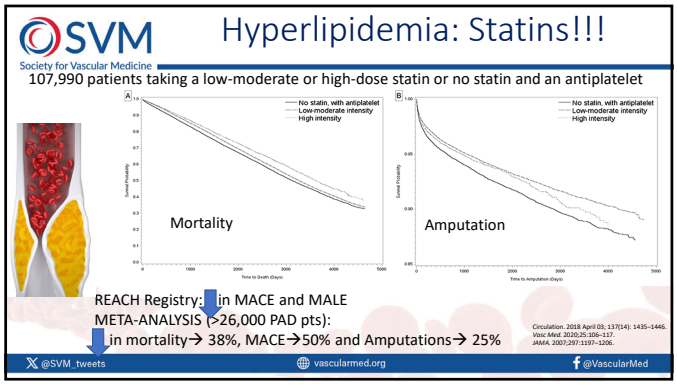
J Am Coll Cardiol. 2018;71(21):2450-67

@SVM_tweets @VascularMed

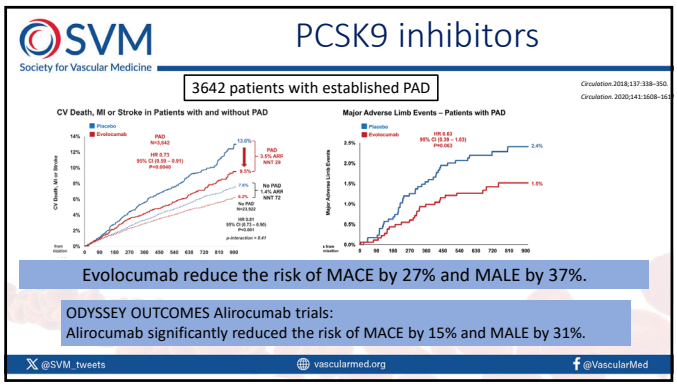
9


SVM
Society for Vascular Medicine
PAD
Symptomatic
Bleeding risk
High
Low
Asymptomatic
No
High MACE /+ MALE risk
Monotherapy
Yes
Intensive antithrombotic therapy
1. Asa + rivaroxaban
2. Asa + clopidogrel/ticagrelor
3. Clopidogrel / ticagrelor alone
@SVM_tweets
vascularmed.org
@VascularMed

10


SVM
Society for Vascular Medicine
Hyperlipidemia: Statins!!!
107,990 patients taking a low-moderate or high-dose statin or no statin and an antiplatelet
No statin, with antiplatelet
Low-moderate intensity
High intensity
Mortality
Amputation
REACH Registry: in MACE and MALE
META-ANALYSIS (>26,000 PAD pts):
in mortality→ 38%, MACE→50% and Amputations→ 25%
@SVM_tweets
vascularmed.org
@VascularMed

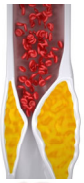
11


SVM
Society for Vascular Medicine
PCSK9 inhibitors
3642 patients with established PAD
CV Death, MI or Stroke in Patients with and without PAD
Major Adverse Limb Events – Patients with PAD
Evolocumab reduce the risk of MACE by 27% and MALE by 37%.
ODYSSEY OUTCOMES Alirocumab trials:
Alirocumab significantly reduced the risk of MACE by 15% and MALE by 31%.
@SVM_tweets
vascularmed.org
@VascularMed

12

SVM Approach to Lipid management

Society for Vascular Medicine



- ALL PATIENTS WITH PAD -HIGH INTENSITY STATINS
  - Atorvastatin 40 to 80 mg or Rosuvastatin 20-40 mg
- PCSK9i considered in some scenarios
  - LDL > 70 or less than 50% reduction from base LDL on high intensity statins
  - Statin intolerance
- It reasonable to have a low LDL even up to 25 mg/dl
- GOAL is to keep < 70 mg/dl

@SVM_tweets vascularmed.org @VascularMed

13

SVM Diabetes Management: More than LOWERING GLUCOSE !!! SGLT2 inhibitors and GLP-1 agonists

Society for Vascular Medicine

- GLP-1 agonists: Liraglutide and Semiglutide

- Liraglutide: LEADER trial (>9000 patients)
  - Lower MACE (HR, 0.87; $p < 0.001$) and CV death (HR, 0.78; $p = 0.00$
  - Amputation reduction by 35% (HR, 0.65; $p = 0.03$)
- Semiglutide:
  - SUSTAIN-6 trial: (>3000 patients), lowered MACE (HR, 0.74; $p < 0.001$)
  - POST HOC ANALYSIS OF ONLY PAD patients (>1500 patients): MACE is 35% higher in PAD and greater benefits seen compared to non-PAD patients.
  - Taiwan National database: Lower risk of MALE and MACE

Vascular Medicine 2023, Vol. 28(1) 62–76c

@SVM_tweets vascularmed.org @VascularMed

14

SVM SGLT2 inhibitors

	Empaglifozin	Canagliflozin	Dapagliflozin
Trial			
CV or renal Outcome			
Limb outcomes			

@SVM_tweets vascularmed.org @VascularMed

15

Approach to Diabetes

- At risk for amputations (previous amputation, CLI or neuropathy): GLP-1 agonists
- Heart failure and/ renal disease: SGLT2 inhibitors

Vascular Medicine 2023, Vol. 28(1) 62–76c

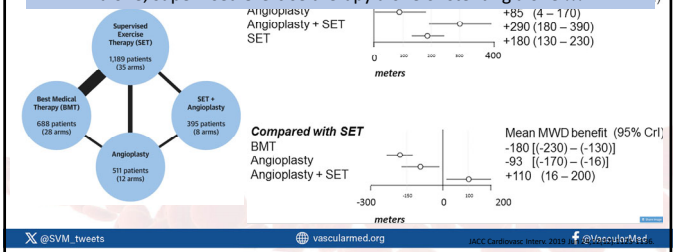
@SVM_tweets vascularmed.org @VascularMed

16

Supervised Exercise Therapy and Revascularization for Intermittent Claudication

Network Meta-Analysis of Randomized Controlled Trials

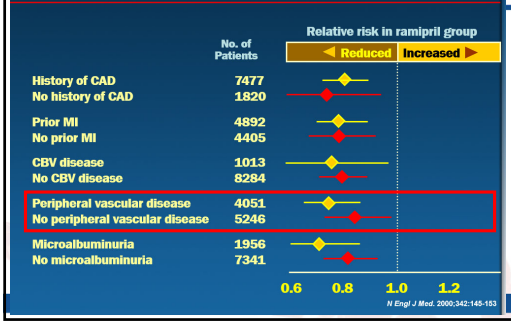
Stenting with supervised exercise therapy is superior to medical therapy alone, supervised exercise therapy alone or stenting alone !!!



@SVM_tweets vascularmed.org @VascularMed

17

HOPE: Benefits in CV Risk Subgroups



- ACEI and ARB are first line anti-hypertensive therapies for hypertension in PAD patients.
- CV event risk reduction seen independent of BP reduction.

@VascularMed

18

Minimizing Tissue Loss in Patients With PAD

- Counsel your patients on ***daily*** self-foot examination
- Prompt diagnosis and treatment of foot infection
- Biannual foot examination by a clinician is reasonable for patients with PAD and diabetes mellitus

Circulation 2017;135:e726

@SVM_tweets vascularmed.org @VascularMed

19

Take Home Points

Save Limbs

Save Lives

- All patients with PAD require medical therapy and risk factor modification
- Select patients will benefit from intensive antithrombotic therapy
  - These includes those with polyvascular disease, CLI, HF, DM, prior LER
- Hyperlipidemia:
  - High intensity statins for ALL
  - If intolerant or LDL > 70 mg/dl on statins → PCSK9i
- Diabetes:
  - Goal HbA1c < 7
  - Prior amputations or CLI: GLP1 agonists
  - Heart failure or kidney disease: SGLT2i (avoid canaglifazon)
- Exercise therapy, diet and smoking cessation for ALL
- Hypertension: Consider ACEI/ ARB

@SVM_tweets vascularmed.org @VascularMed

20

SVM Society for Vascular Medicine

CLTI Controversies – Case CLTI – Surgical Revascularization Approach

Olamide Alabi MD MS
Chief Quality Officer, Division of Vascular Surgery and Endovascular Therapy
Emory University School of Medicine

Sunday May 17, 2024

1

SVM Society for Vascular Medicine

Objectives

- Open versus Endo
- "No Stent Zones"
- Angiosome Concept

2

SVM Society for Vascular Medicine

Objectives

- Open versus Endo
- "No Stent Zones"
- Angiosome Concept

3

SVM Society for Vascular Medicine

Objectives

- ~~Open versus Endo~~ Complementary Therapies
- "No Stent Zones"
- Angiosome Concept

4

SVM Society for Vascular Medicine

Open Surgical Revascularization: Complementary Therapies

	BEST-CLI	BASIL-2
Trial Endpoint	composite of major adverse limb events or death from any cause	Composite time to above ankle amputation of the trial limb or death from any cause
Study Period	8/2014-10/2019	7/2014-11/2020
Intended N	2100	600
Actual N	1830	345
Differences in inclusion criteria	• Life expectancy 2 years • Availability of autogenous bypass conduit	• Life expectancy >6mo • Required an infrapopliteal target
Exclusions	Excessive risk for open vascular surgery	• Prior vascular intervention to infrapopliteal target within prior 12mo • Ischemic pain or tissue loss considered not primarily due to PAD

5

SVM Society for Vascular Medicine

Open Surgical Revascularization: Complementary Therapies

TABLE 2. Comparison of key patient characteristics comparing BEST-CLI and BASIL-2.

	BEST-CLI COHORT 1	BEST-CLI COHORT 2	BASIL-2
Patients who did not undergo any procedure	4.3% / 1.1%	3.6% / 2.0%	8.7% / 1.2%
Cross-over to other revascularization method	3.5% / 0.4%	1.0% / 2.0%	7% / 3.5%
Median age (years)	66.9 / 67.0	68.4 / 68.8	72.4 / 72.5
Male	72% / 71.1%	71.6% / 72.4%	81% / 82%
Diabetes mellitus	72.1% / 71.6%	62.2% / 58.3%	68% / 69%
Mean eGFR (ml/min)	NA	NA	[illegible]
Chronic hemodialysis	9.4% / 11.8%	12.8% / 10.1%	6% / 3%
Previous stroke	12.8% / 13.9%	19.4% / 12.1%	15% / 20%
Coronary artery disease	42.3% / 44.4%	49.5% / 53.8%	NA
Previous MI	NA	NA	24% / 13%
Previous PCI & CABG	NA	NA	26% / 19%
Previous intervention study leg	5.6% / 5.2%	10.3% / 10.1%	31% / 39%
RBC 4	20.3%/20%	29.4%/30.2%	13% / 11%
RBC 5 (and 6)	79.7%/80%	70.6%/69.8%	87% / 89% (RBC 5 only)
ASA class 3 or 4	80.8%/75.9%	83.5%/80.9%	NA
No. patients completing the trial	560/1434 (39%)	226/396 (57.1%)	212/345 (61.4%)

J CRIT LIMB ISCHEM 2023

6

Open Surgical Revascularization: Complementary Therapies

Table 3. Comparison of key outcome characteristics comparing BEST-CLI and BASIL-2.

	BEST-CLI Cohort 1	BEST-CLI Cohort 2	BASIL-2
Bypass location			
Femoro-popliteal	40%	47.9%	1%
Femoro-popliteal AK	NA	NA	0%
Femoro-popliteal BK	NA	NA	1%
Femoro-BTK	35.7%	37.4%	59%
Popliteal-BTK	15.7%	8.4%	40%

J CRIT LIMB ISCHEM 2023

Table 3. Comparison of key outcome characteristics comparing BEST-CLI and BASIL-2.

	BEST-CLI Cohort 1	BEST-CLI Cohort 2	BASIL-2
Endovascular techniques			
Balloon angioplasty	52.7%	47.2%	60%
Atherectomy	13.6%	15.4%	0%
Drug-coated balloon	27.8%	25.1%	0%
Bare-metal stent	39.3%	43.1%	10%
Drug-eluting stent	24.2%	21.5%	0%
Stent graft	8.6%	12.8%	0%
Technical success	98.3% / 84.7%	100%/80.6%	96% / 80%

@SVM_tweets

7

Open Surgical Revascularization: Complementary Therapies

Table 3. Comparison of key outcome characteristics comparing BEST-CLI and BASIL-2.

	BEST-CLI Cohort 1	BEST-CLI Cohort 2	BASIL-2
Technical success	98.3% / 84.7%	100%/80.6%	96% / 80%
All cause death	33% / 37.6%	25.9% / 24.1%	53% / 45%
Major amputation (above ankle)	10.4%/14.9%	15.2%/14.1%	20%/18%
AK amputation	NA	NA	NA
BK amputation	NA	NA	NA
Amputation free survival	43.3%/52.4%	41.1%/38.2%	37%/47%
Cross-over intervention during FU	NA	NA	27% / 19%
Reintervention****	9.2% / 33.1%	14.2%/25.6%	5% / 19%

J CRIT LIMB ISCHEM 2023

@SVM_tweets vascularmed.org @VascularMed

8

Open Surgical Revascularization

- BEST-CLI and BASIL-2 are not really comparable
- Neither should be used as an 'end all argument'
- Lessons to learn from both:
  - Nothing beats single segment great saphenous vein….if this is available
    - Get vein mapping prior to the angiogram
  - The toolbox is large – USE IT!
  - Shared decision making
    - There is a small but not insignificant cohort of patients who would benefit from primary amputation

@SVM_tweets vascularmed.org @VascularMed

9

SVM Society for Vascular Medicine

Open Surgical Revascularization

- ~~Open versus Endo~~ Complementary Therapies
- "No Stent Zones"
- Angiosome Concept

10

SVM Society for Vascular Medicine

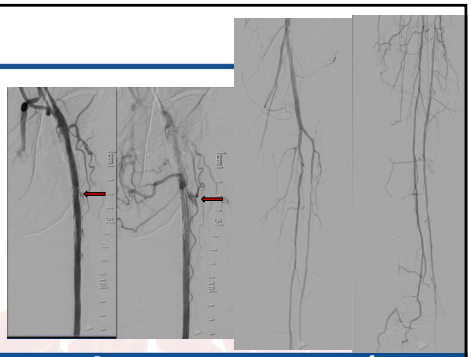
TH

- 3/2012 Left SFA stent
- 8/2012 left SFA atherectomy and BAP of stent
- 11/2012 left SFA laser and BAP of stent
- 7/2013 left SFA revascularization
- 3/2014 BAP Left SFA in-stent stenosis
- 6/2021 shockwave lithotripsy of left CFA and popliteal + DCB BAP
- 6/2023 left SFA stent recanalization
- 8/2023 left SFA stent recanalization

11

SVM Society for Vascular Medicine

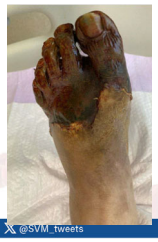
- 9/18/23 Procedure
- 1) Ultrasound guided access of the right common femoral artery
- 2) Angiogram of abdominal aorta and bilateral iliac arteries
- 3) Angiogram of the left femoral, popliteal, anterior tibial, posterior tibial, and popliteal vessels
- 4) Angiogram of the right femoral, popliteal, anterior tibial, posterior tibial, and popliteal vessels
- 3) PTA of L SFA (stents present)
- 5) Shockwave Lithotripsy
- 6) Laser atherectomy of the L SFA
- 7) Drug coated balloon of the L SFA

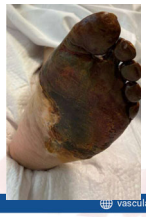


12

SVM Society for Vascular Medicine

And then this happened…what would you do?



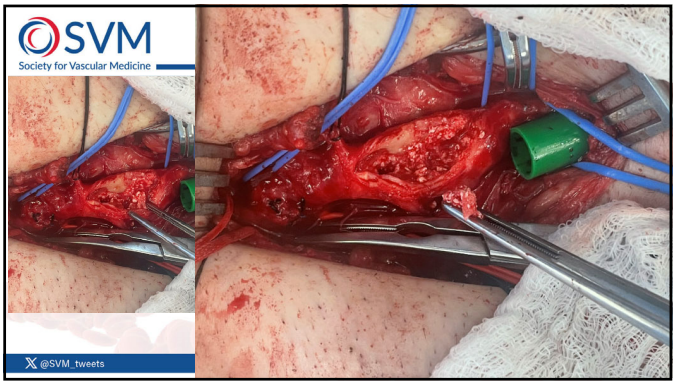


- Abi
- Lt Brachial: 118 mmHg
- Lt Posterior Tibial: 48 mmHg
- Lt Posterior Tibial: 0.41
- Lt Dorsalis Pedis: 50 mmHg
- Lt Dorsalis Pedis: 0.42

@SVM_tweets vascularmed.org @VascularMed

13

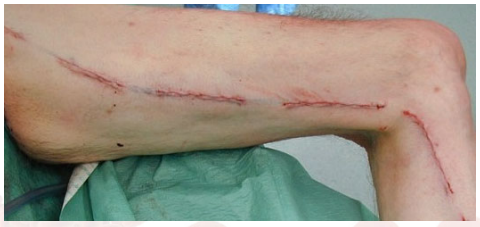
SVM Society for Vascular Medicine

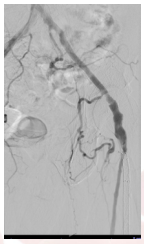


@SVM_tweets

14

SVM Society for Vascular Medicine





@SVM_tweets vascularmed.org @VascularMed

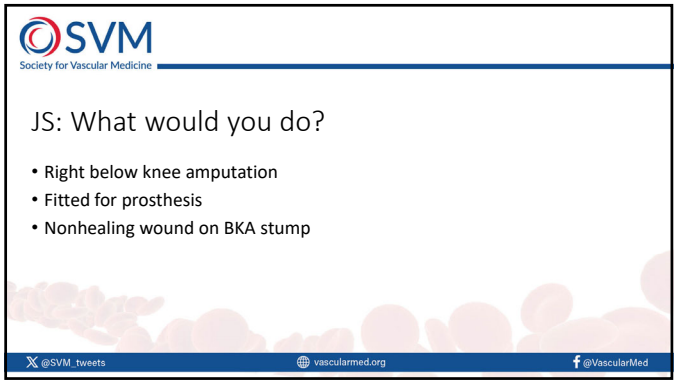
15


SVM
Society for Vascular Medicine
@SVM_tweets
vascularmed.org
@VascularMed

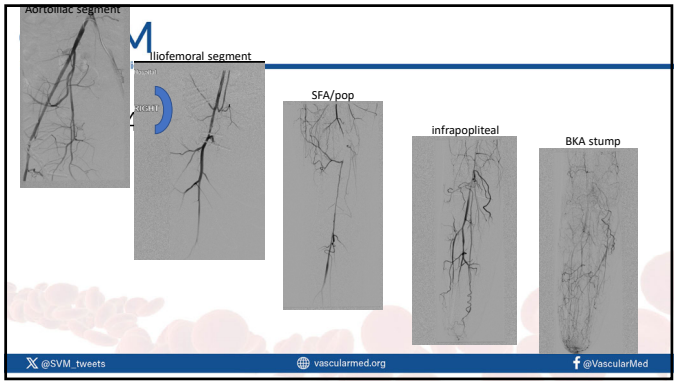
16


SVM
Society for Vascular Medicine
@SVM_tweets
vascularmed.org
@VascularMed

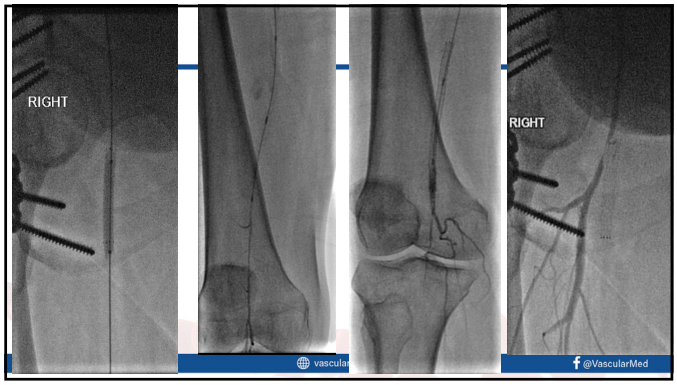
17


SVM
Society for Vascular Medicine
JS: What would you do?
• Right below knee amputation
• Fitted for prosthesis
• Nonhealing wound on BKA stump
@SVM_tweets
vascularmed.org
@VascularMed

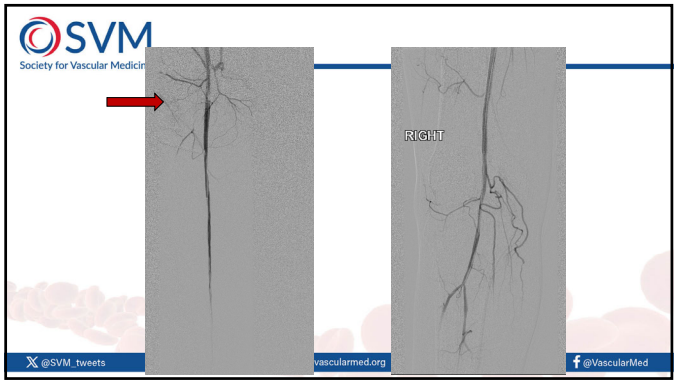
18


Aortoiliac segment
Iliofemoral segment
SFA/pop
infrapopliteal
BKA stump
@SVM_tweets
vascularmed.org
@VascularMed

19


RIGHT
RIGHT
@VascularMed

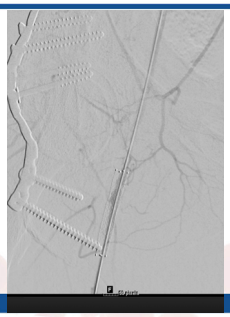
20


SVM
Society for Vascular Medicin
RIGHT
@SVM_tweets
vascularmed.org
@VascularMed

21

SVM Society for Vascular Medicine

Went to OR:



@SVM_tweets @VascularMed

22

SVM Society for Vascular Medicine

@SVM_tweets vascularmed.org @VascularMed

23

SVM Society for Vascular Medicine

@SVM_tweets vascularmed.org @VascularMed

24

SVM Society for Vascular Medicine

DH: What would you do?

- 3rd toe wound with underlying osteomyelitis
- No frank cellulitis
- Vein mapping: single segment vein present
- Angiogram

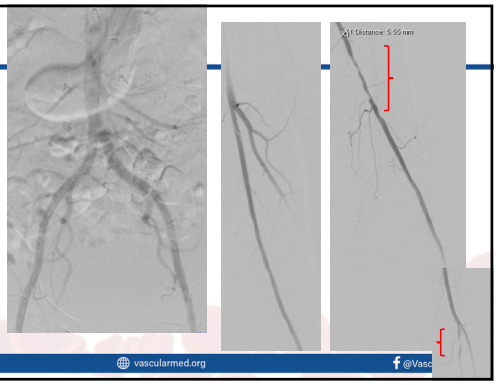
@SVM_tweets vascularmed.org @VascularMed

25

SVM Society for Vascular Medicine

DH

- Single segment vein present…



@SVM_tweets vascularmed.org @Vasc

26

SVM Society for Vascular Medicine

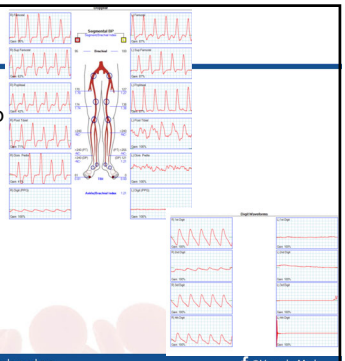
@SVM_tweets vascularmed.org @VascularMed

27

SVM Society for Vascular Medicine

CD: What would you do?

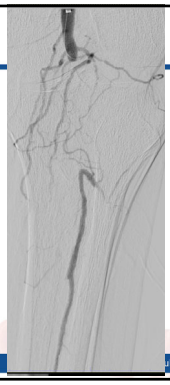
- Chronic emboli from mitral valve vegetation over time
- Developed CLTI with lateral 5th toe wound at base of toe

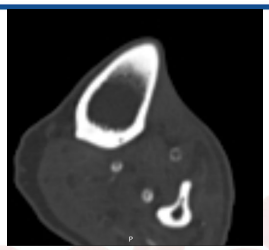


@SVM_tweets vascularmed.org @VascularMed

28

SVM Society for Vascular Medicine

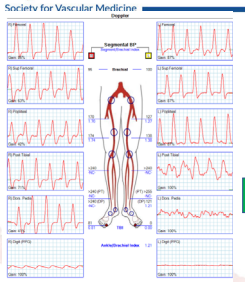


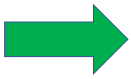


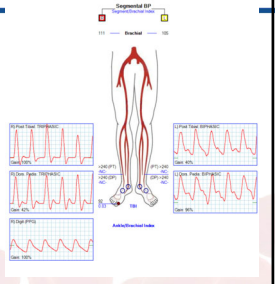
@SVM_tweets ularmed.org @VascularMed

29

SVM Society for Vascular Medicine

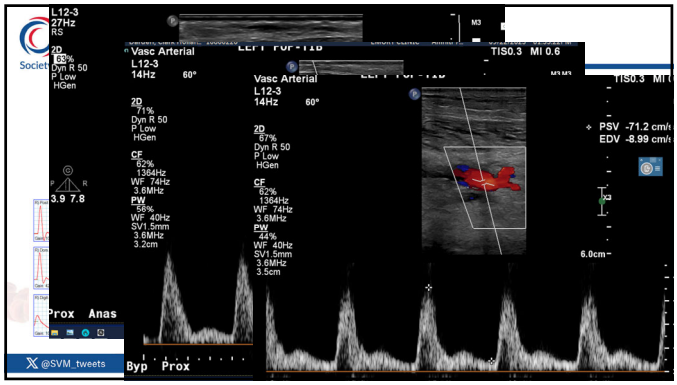






@SVM_tweets vascularmed.org @VascularMed

30



31

SVM
Society for Vascular Medicine

Open Surgical Revascularization

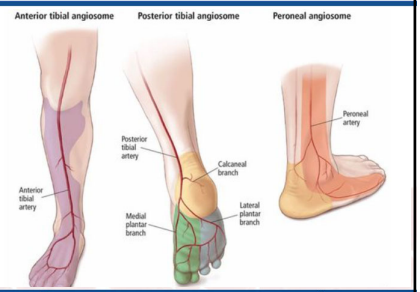
- ~~Open versus Endo~~ Complementary Therapies
- "No Stent Zones"
- Angiosome Concept

@SVM_tweets vascularmed.org @VascularMed

32

SVM
Society for Vascular Medicine

Angiosomes



@SVM_tweets vascularmed.org @VascularMed

33

Direct versus Indirect Revascularization

- Meta-analysis. 9 studies
  - 715 direct revascularization
  - 575 indirect revascularization
- Direct revascularization associated with:
  - Lower risk of unhealed wound (HR 0.64, 95% CI 0.52-0.8, I2 0%)
  - Lower risk of major amputation (0.44, 95% CI 0.26-0.75, I2 62%)
  - Limb salvage rates
    - 1 year: 86.2% direct; 77.8% indirect
    - 2 years: 84.9% direct; 70.1% indirect

Biancari F, Juvonen T. Angiosome-targeted lower limb revascularization for ischemic foot wounds: systematic review and meta-analysis. *Eur J Vasc Endovasc Surg*. 2014;47(5):517-522.

@SVM_tweets vascularmed.org @VascularMed

34

Open Surgical Revascularization

- ~~Open versus Endo~~ Complementary Therapies
- "No Stent Zones"
- Angiosome Concept

@SVM_tweets vascularmed.org @VascularMed

35

Questions

@SVM_tweets vascularmed.org @VascularMed

36

I think we need to revascularize!

What about medications?

Not just a procedure!!

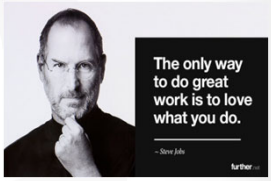
Andrew J. P. Klein, MD, FACC, FSCAI
Interventional Cardiology
Vascular and Endovascular Medicine
Piedmont Heart Institute
Atlanta, GA

Piedmont HEART

1

Disclosure

- No Financial Disclosures
- I am
  - **An Internist**
  - A Cardiologist
  - An Interventional Cardiologist
  - A Vascular and Endovascular Specialist

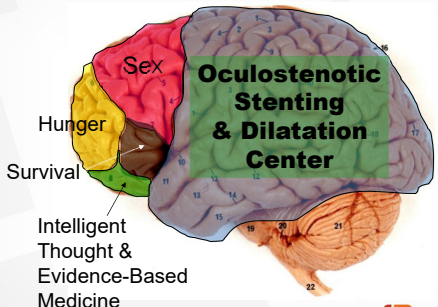


Piedmont HEART

2

DISCLAIMER

Interventional Cardiology Brain

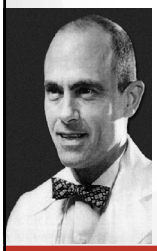


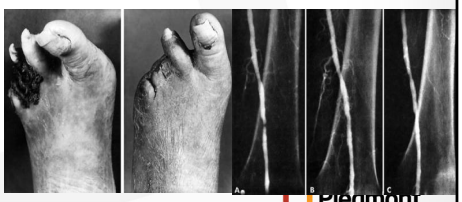
Piedmont HEART

Slide compliments of Jim Hermiller and Chris White

3

"My favorite conceptual trademark is a sketch that I did years ago of a crossed pipe and wrench. It's a gross oversimplification, of course, but what it means to me is that if a plumber can do it to pipes, we can do it to blood vessels"





Piedmont HEART

Dotter CT, Judkins MP. Transluminal treatment of arteriosclerotic obstruction. Description of a new technic and a preliminary report of its application. Circulation. 1964;30:654–70.

4

Objectives

1. PVD care is a medical disease!
2. Revascularization techniques are **complimentary not competitive**
3. "Right procedure for the right patient at the right time"

Piedmont HEART

5

PAD

Symptom Terminology

Intermittent Claudication

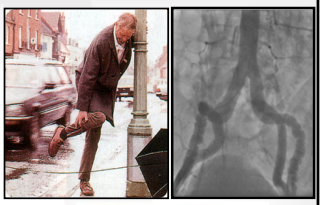
- Cramping pain
- One or both legs, foot/calf moving up
- Occurs with walking consistent distance
- Does not resolve with continued activity
- Abates with rest (standing) or reduction in walking speed

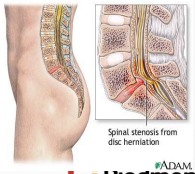
Pseudocladication

- Spinal stenosis
  - Sharp/paresthetic pain, numbness
  - Variable walking distance
  - Relief with sitting or leaning forward
  - Thigh or back moving downward

Miscellaneous

- FMD, Iliac syndrome in cyclist, Buerger's disease, Large vessel vasculitis (Takayasu's, Giant cell arteritis)





Spinal stenosis from disc herniation

©ADAM.

Piedmont HEART

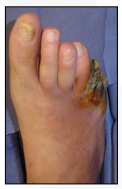
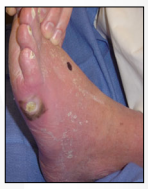
www.sscfund.org/claudication.html

6

Lower Extremity PAD
Terminology

Critical Limb Threating Ischemia

- Limb pain that occurs at rest or impending limb loss that is caused by severe compromise of blood flow to the affected extremity.
- Chronic versus acute limb ischemia

Piedmont HEART

Hirsch AT, et al. ACC/AHA Guidelines for the Management of Patients with PAD 2005.

7

PAD vs. CAD
Terminology Comparison

CAD		PAD	
STEMI	ACS	CLI	Gangrene
NSTEMI			Wound
Unstable Angina			Rest Pain
Stable Angina			Claudication

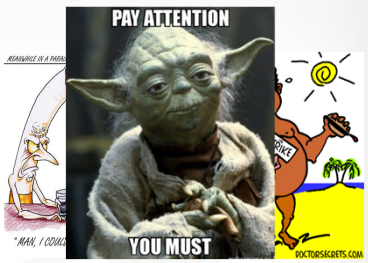
Piedmont HEART

Slide compliments of Ivan Casserly

8

PAD
Risk Factors

- **Smoking**
- **Diabetes**
- **Age**
- Male gender
- Race
- HTN
- Hyperlipidemia
- Hyperhomocystenemia



Piedmont HEART

9

Peripheral Arterial Disease

Prevalence

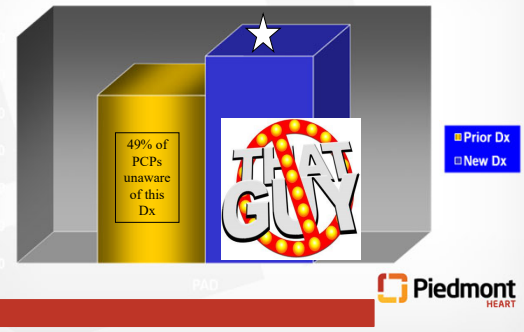
- PARTNERS Program (PAD Awareness, Risk, and Treatment: New Resources for Survival)
  - 350 Primary care sites
  - Patients (n=~7,000)
    - >70 yrs
    - 50-69 yrs with history DM or smoking
  - PVD diagnosis
    - ABI <0.9
    - Previous documentation
    - Abnormal vascular studies
    - Prior revascularization
  - **PAD detected in 1865 patients (29%)**

Hirsch AT, JAMA 2001;286:1317-1324

10

Peripheral Arterial Disease

Prevalence

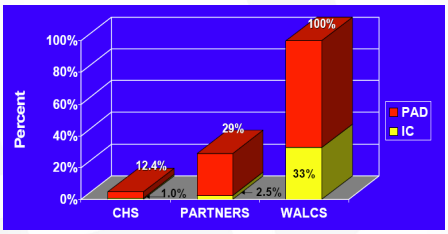


Hirsch AT, JAMA 2001;286:1317-1324

11

PAD

Asymptomatic is the rule!



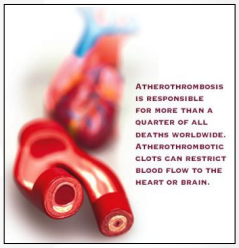
1. Newman A J Clin Epi 2001;54:294-300
2. Hirsch A JAMA 2001;286:1317-1324
3. McDermott M JAMA 2001;286:1599-1606

Graph Courtesy of McDermott, M

12

PAD
Clinical Impact

- **Mortality 2-3x higher than age and sex-matched controls[1]**
- 5 Year Mortality 30%[2]
- 15 year Mortality 70%[2]
- 60-80% of patients with PAD have CAD in at least 1 vessel[3,4]
- ~25% of PAD patients have a carotid stenosis of >70%[5]



1. Dormandy J J Cardiovasc Surg (Torino) 1989;30:50-57
2. Weitz JI et al. Circulation. 1996;94:3026.
3. Valentine RJ, et al. J Vasc Surg. 1994 Apr;19(4):668.
4. McFalls EO, et al. CARP Trial. N Engl J Med. 2004 Dec 30;351(27):2795.
5. Cheng Sw, et al. Cardiovasc Surg. 1999 Apr;7(3):303

Piedmont HEART

13

PAD
Clinical Significance

- Major Risk Factor for Amputation
  - Diabetes
- Quality of Life
  - **More severe than that of CHF or recent MI[3]**
  - CLI patients~Terminal Cancer
- Functional impairment and decline is common even in asymptomatic patients[2,3]

1. Schneider JR et al. Ann Vasc Surg. 1993;7:419.
2. McDermott MM et al. Ann Intern Med. 2002;136:873.
3. McDermott MM, et al. JAMA 2004 292;453-461.

Piedmont HEART

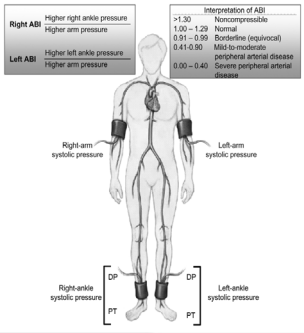
14

Ankle-Brachial Index

R brachial
150 mmHg

R DP 150
R PT 160

Right ABI
160/150=1.06



L brachial
145

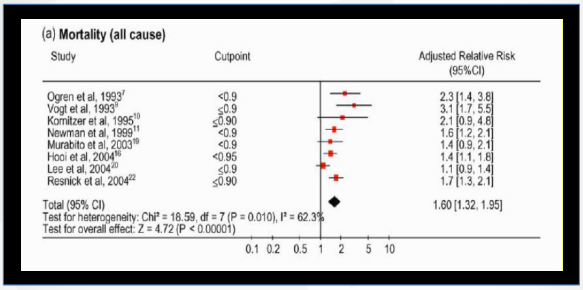
L DP 140
L PT 150

Left ABI
150/150=1.00

Piedmont HEART

15

Abnormal ABI and Mortality

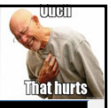


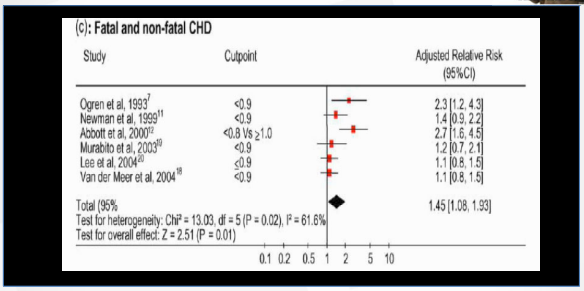
Piedmont HEART

Heald C Atherosclerosis 2006 189;61-69

16

Abnormal ABI and CHD



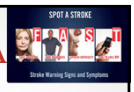


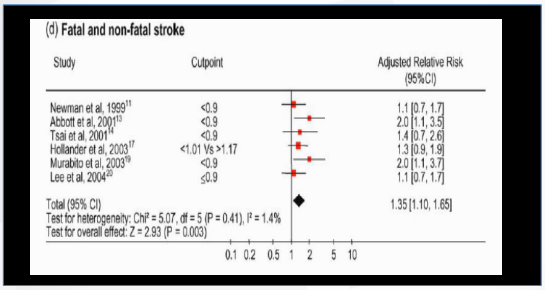
Piedmont HEART

Heald C Atherosclerosis 2006 189;61-69

17

Abnormal ABI and CVA



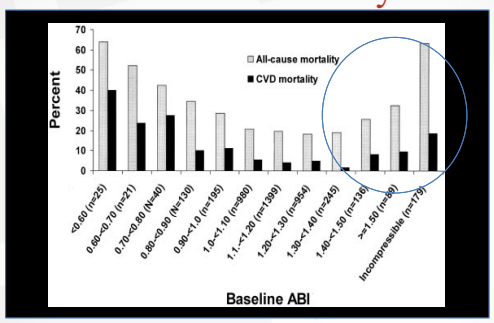


Piedmont HEART

Heald C Atherosclerosis 2006 189;61-69

18

ABI and Mortality

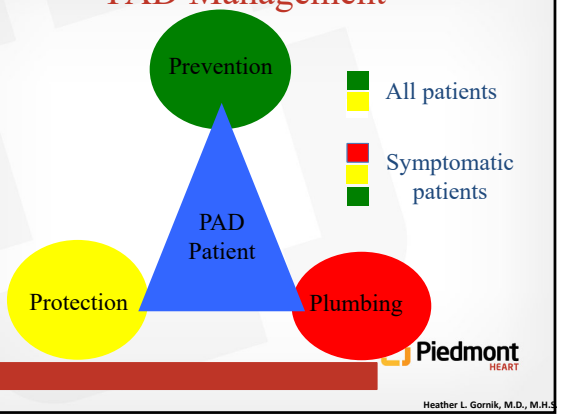


Piedmont HEART

Resnick H Circulation. 2004 Feb 17;109(6):733-9

19

PAD Management



Piedmont HEART

Heather L. Gornik, M.D., M.H.S.

20

Newer Guidelines

2016 AHA/ACC Guideline on the Management of Patients With Lower Extremity Peripheral Artery Disease

A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines

Developed in Collaboration With the American Association of Cardiovascular and Pulmonary Rehabilitation, Society for Cardiovascular Angiography and Interventions, Society for Clinical Vascular Surgery, Society of Interventional Radiology, Society for Vascular Medicine, Society for Vascular Nursing, Society for Vascular Surgery, Trans-Atlantic Inter-Society Consensus for the Management of Peripheral Arterial Disease, and Vascular and Endovascular Surgery Society

WRITING COMMITTEE MEMBERS*

Marie D. Gerhard-Herman, MD, FACC, FAHA, Chair
Heather L. Gornik, MD, FACC, FAHA, FSVM, Vice Chair*

2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease Circulation. 2016 Nov 13 And JACC 2016 Nov

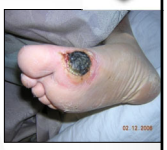
Piedmont HEART

21

PROTECTION

Foot Care

- Meticulous foot and nail care
- Daily foot self-inspection
- Appropriate footwear
- DM patients
  - Podiatry consultation/collaboration
  - Review warning signs of critical limb ischemia (CLI)
  - Reinforce importance of foot care at each office visit



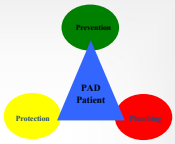
NEW GUIDELINES

I	C-LD	Patients with PAD and diabetes mellitus should be counseled about self-foot examination and healthy foot behaviors (222, 223).
I	C-LD	In patients with PAD, prompt diagnosis and treatment of foot infection is recommended to avoid amputation (224-228).

2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

22

PREVENTION



- Smoking cessation
- Anti-platelet therapy
- Lipid lowering therapy
  - Statins
- Antihypertensive therapy
- Ace-inhibitors/ARBs
- Glycemic control

Piedmont HEART

23

Prevention

Smoking Cessation

I	A	Patients with PAD who smoke cigarettes or use other forms of tobacco should be advised at every visit to quit (170-172).
I	A	Patients with PAD who smoke cigarettes should be assisted in developing a plan for quitting that includes pharmacotherapy (i.e., varenicline, buproprion, and/or nicotine replacement therapy) and/or referral to a smoking cessation program (170, 180-182).
I	B-NR	Patients with PAD should avoid exposure to environmental tobacco smoke at work, home, and public places (185, 186).

Piedmont HEART

2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

24

Prevention
Anti-platelet Therapy

- Meta-analysis of anti-platelet therapy for cardiovascular disease
- 42 clinical trials enrolled patients with PAD
  - Major reductions in Vascular Event rate with Aspirin therapy
  - Benefits similar among PAD subtypes (intermittent claudication, peripheral grafting, and peripheral angioplasty)
- CAPRIE Trial
  - Benefit of clopidogrel over ASA in symptomatic PAD patients with respect to CV risk reduction

Piedmont HEART

Antithrombotic Trialists' Collaboration. BMJ. 2002;324:71.

25

Updated Anti-Platelet Statements

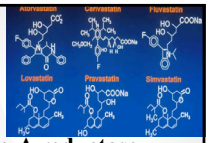
Recommendations for Antiplatelet Agents		
COR	LOE	Recommendations
I	A	Antiplatelet therapy with aspirin alone (range 75–325 mg per day) or clopidogrel alone (75 mg per day) is recommended to reduce MI, stroke, and vascular death in patients with symptomatic PAD (139-142).
IIa	C-EO	In asymptomatic patients with PAD (ABI ≤0.90), antiplatelet therapy is reasonable to reduce the risk of MI, stroke, or vascular death.
IIb	B-R	In asymptomatic patients with borderline ABI (0.91 to 0.99), the usefulness of antiplatelet therapy to reduce the risk of MI, stroke, or vascular death is uncertain (75, 76, 139, 142).
IIb	B-R	The effectiveness of dual antiplatelet therapy (DAPT) (aspirin and clopidogrel) to reduce the risk of cardiovascular ischemic events in patients with symptomatic PAD is not well established (143, 144).
IIb	C-LD	DAPT (aspirin and clopidogrel) may be reasonable to reduce the risk of limb-related events in patients with symptomatic PAD following lower extremity revascularization (145-148).
IIb	B-R	The overall clinical benefit of vorapaxar in patients with symptomatic PAD is uncertain (149-152).

Piedmont HEART

2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

26

Prevention
Statins



CLASS I

- **Treatment with an HMG coenzyme-A reductase inhibitor (statin) medication is indicated for all patients with peripheral arterial disease to achieve a target LDL cholesterol of less than 100 mg/dl.**

NEW GUIDELINES

I	A	Treatment with a statin medication is indicated for all patients with PAD (96, 153-157).

Piedmont HEART

Hirsch AT, et al. ACC/AHA Guidelines for the Management of Patients with PAD 2005.

27

Prevention
HTN Treatment

Class I
Benefit >>> Risk
Procedure/Treatment SHOULD be performed/administered

Class I

- **Antihypertensive therapy should be administered to hypertensive patients with lower extremity PAD**
- **Beta-adrenergic blocking drugs are effective antihypertensive agents and** are not contraindicated in patients with **PAD.**

NEW GUIDELINES

I	A	Antihypertensive therapy should be administered to patients with hypertension and PAD to reduce the risk of MI, stroke, heart failure, and cardiovascular death (158-162).

Piedmont HEART

2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

28

Prevention
HTN Treatment

ACE-Inhibitors and ARBS

- **HOPE trial: Beneficial in PAD patients**
- **ONTARGET Trial: Benefit of Telmisartan in PAD**
- **Also have been shown to increase walking distance versus placebo**

NEW GUIDELINES

IIa	A	The use of angiotensin-converting enzyme inhibitors or angiotensin-receptor blockers can be effective to reduce the risk of cardiovascular ischemic events in patients with PAD (161, 168, 169).

Piedmont HEART

Ahimastos AA, et. al. Ann Intern Med. 2006;144:660 AND JAMA. 2013 Feb 6;309(5):453-60.
2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

29

Prevention
Diabetes Therapies

Class I

- **Proper foot care, including use of appropriate footwear, chiropody/podiatric medicine, daily foot inspection, skin cleansing, and use of topical moisturizing creams, should be encouraged and skin lesions and ulcerations should be addressed urgently in all diabetic patients with lower extremity PAD. *(Level of Evidence: B)***

NEW GUIDELINES

I	C-LD	Patients with PAD and diabetes mellitus should be counseled about self-foot examination and healthy foot behaviors (222, 223).
I	C-EO	Management of diabetes mellitus in the patient with PAD should be coordinated between members of the healthcare team.

Piedmont HEART

Hirsch AT, et al. ACC/AHA Guidelines for the Management of Patients with PAD 2005.
2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

30

Prevention
Diabetes Therapies

Class IIa

- **Treatment of diabetes in individuals with lower extremity PAD by administration of glucose control therapies to reduce the hemoglobin A1C to less than 7% can be effective to reduce microvascular complications and potentially improve cardiovascular outcomes. *(Level of Evidence: C)***

NEW GUIDELINES

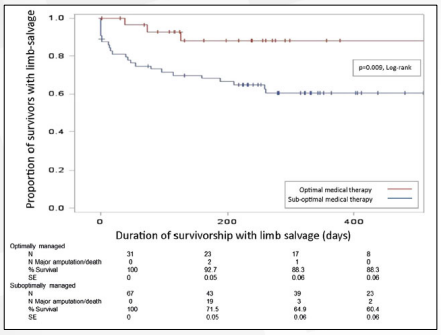
IIa	B-NR	Glycemic control can be beneficial for patients with CLI to reduce limb-related outcomes (191, 192).

Piedmont HEART

Hirsch AT, et al. ACC/AHA Guidelines for the Management of Patients with PAD 2005.
2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

31

Guideline Concordance Saves Limbs

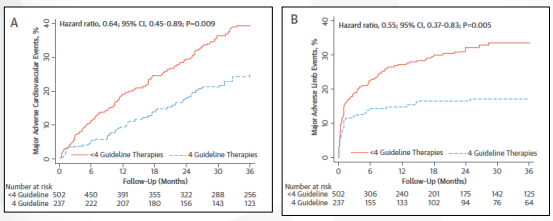


Piedmont HEART

Chung et al. JVS 2013 58:792-80

32

Guideline Concordance Saves Lives



ASA Rx 88%; Smoking Abstinence 71%; ACE 60%; STATIN 67%

Piedmont HEART

Armstrong EJ et al. J Am Heart Assoc 2014;3

33

Plumbing
Symptomatic Patient

- **Medical Therapy**
- **Exercise Therapy**
- **Endovascular Therapy**
- **Surgical Therapy**

Piedmont HEART

34

Plumbing
Symptomatic Patient
Medical Treatment

Cilostazol

- Mechanism of Action: Phosphodiesterase inhibitor
- Extensive metabolism issues
  - Diltiazem, Fluoxetine, Omeprazole
  - Consider 50 mg BID starting dose
- Side effects of cilostazol are common; 20% DC Rate
  - Headaches (25-35%)
  - Abnormal stools or diarrhea (~15-20%)
  - Palpitations or tachycardia (~15%)
- **Cilostazol is contraindicated in patients with congestive heart failure of any severity**

Piedmont HEART

35

Plumbing
Symptomatic Patient
Medical Treatment

CLASS IA

- **Cilostazol (100 mg orally 2 times per day) is indicated as an effective therapy to improve symptoms and increase walking distance in patients with lower extremity PAD and IC.**
- **A therapeutic trial of cilostazol should be considered in all patients with lifestyle-limiting claudication (in the absence of heart failure).**

NEW GUIDELINES

COR	LOE	Recommendation
I	A	Cilostazol is an effective therapy to improve symptoms and increase walking distance in patients with claudication (199, 200).

Piedmont HEART

Hirsch AT, et al. ACC/AHA Guidelines for the Management of Patients with PAD 2005.

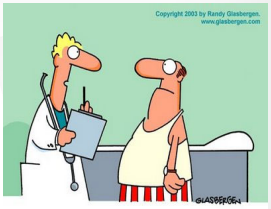
36

Plumbing

Symptomatic Patient

Exercise Treatment

- Improves
  - Exercise performance
  - Walking ability
  - Physical functioning
  - Quality of Life
- Highly cost-effective
- Supervised exercise



"What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?"

NEW GUIDELINES

I	A

In patients with claudication, a supervised exercise program is recommended to improve functional status and QoL, and to reduce leg symptoms (36-38, 40-46, 48, 210, 211).

2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

Stewart KJ, et al. N Engl J Med. 2002;347:1941.

37

Plumbing

Symptomatic Patient

Exercise Treatment

CLEVER

- RCT of aorto-iliac claudicants to Endovascular Therapy (EVT) vs. Optimal Medical Therapy (OMT) vs. Supervised Exercise Therapy (SET)
- At 18 months, the peak-walking time improved for both EVT and SET, but not OMT
- QOL was better for EVT compared with SET or OMT

ERASE

- RCT of aorto-iliac and femoral-popliteal claudicants to EVT + SET vs. SET alone
- **EVT + SET had greater improvement in walking distance and health-related QOL vs. SET alone**

CONCLUSIONS

- SET is an effective alternative to revascularization
- **SET + EVT in the presence of GDMT = best option**

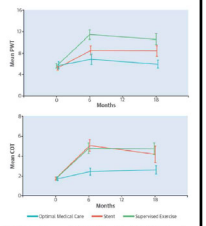


FIGURE 1 Upper panel: Peak Walking Time (PWT): Patients with 18-month follow-up visit only. Lower panel: Claudication Onset Time (COT): Patients with 18-month follow-up visit only. (Figure 1 reproduced with permission) [56]

Murphy T et al. J Am Coll Cardiol 2015;65:999–1009.

Fakhry F et al. JAMA 2015;314:1936–1944.

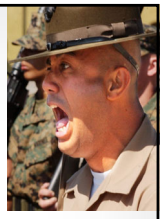
38

Plumbing

Symptomatic Patient

Exercise Treatment

Guidelines



- Warm-up and cool down for 5-10 minutes
- Types of Exercise
  - Treadmill and track walking most effective
  - Resistance training complementary only
- Intensity
  - Initial workload to elicit sxs within 3-5 minutes
  - Walk until moderate severity occurs, rest for brief period till sxs abide
- Duration
  - Exercise-rest-exercise; 35 minutes and increasing 5 minutes each session until 50 minutes of intermittent walking can be accomplished
- Frequency
  - Treadmill or track 3-5x per week
- Supervision
  - As ability improves, workload should be increased by increasing grade or speed to ensure stimulus of claudication pain always occurs

Stewart KJ, et al. N Engl J Med. 2002;347:1941.

39

Plumbing
Symptomatic Patient
Exercise Treatment

Supervised exercise program (COR I, LOE A)

- Takes place in a hospital or outpatient facility.
- Uses intermittent walking exercise as the treatment modality.
- Program can be stand alone or within a cardiac rehabilitation program.
- Program is directly supervised by qualified health-care provider(s)
- Training performed for a minimum of 30–45 min/session; sessions performed at least 3 times/wk for a minimum of 12 wk (36-46).
- Training involves intermittent bouts of walking to moderate-to-maximum claudication alternating with periods of rest.
- Warm-up and cool-down periods precede and follow each session of walking.

Structured community or home-based exercise program (COR IIa, LOE A)

- Takes place in the personal setting of the patient rather than in a clinical setting (41, 47-51).
- Self-directed program with guidance of health-care providers.
- Health-care providers prescribe an exercise prescription similar to that of a supervised program.
- Patient counseling ensures understanding of how to begin and maintain the program and how to progress the difficulty of the walking (by increasing distance or speed).
- Program may incorporate behavioral change techniques such as health coaching and/or use of activity monitors.

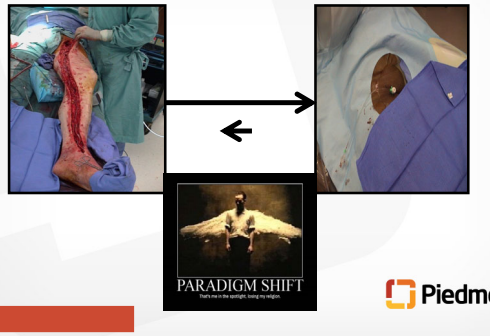
COR indicates Class of Recommendation; LOE, Level of Evidence; and PAD, peripheral artery disease.

Piedmont HEART

2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

40

Plumbing
Symptomatic Patient
Paradigm is Changing

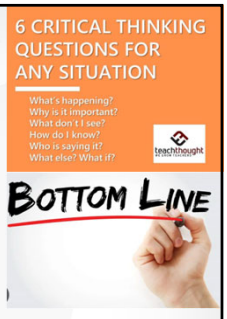


Piedmont HEART

41

Plumbing
Symptomatic Patient

- **Should you revascularize?**
- **What is the Indication?**
- **Where is the disease?**
- **What are the patient's co-morbidities?**
- **What are you trying to achieve?**
- **What is the disease like?**
- **What is the renal function?**
- **What is the realistic long term patency?**
- **Who is your operator?**
- **What is your personal threshold?**
- **What would you do for your family or yourself?**



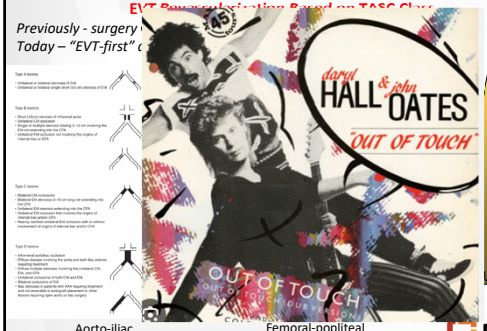
Piedmont HEART

42

Plumbing

Symptomatic Patient

Previously - surgery
Today – "EVT-first"



TASC A

Endovascular

urgery

TASC D

Aorto-iliac

Femoral-popliteal

Piedmont HEART

TASC II Working Group JVS January 2007

43

Plumbing

Symptomatic Patient

Surgical therapy: Claudication

8.1.2. Surgical Revascularization for Claudication: Recommendations

Recommendations for Surgical Revascularization for Claudication		
COR	LOE	Recommendations
I	A	When surgical revascularization is performed, bypass to the popliteal artery with autogenous vein is recommended in preference to prosthetic graft material (263-271).
IIa	B-NR	Surgical procedures are reasonable as a revascularization option for patients with lifestyle-limiting claudication with inadequate response to GDEM, acceptable perioperative risk, and technical factors suggesting advantages over endovascular procedures (232, 265, 275-277).
III: Harm	B-R	Femoral-tibial artery bypasses with prosthetic graft material should not be used for the treatment of claudication (287-289).
III: Harm	B-NR	Surgical procedures should not be performed in patients with PAD solely to prevent progression to CLI (234-237, 262).

Where are you going to suture?
Is there a suitable vein?
Perioperative risk
Wound infection risk

Piedmont HEART

44

Plumbing

Symptomatic Patient

Endovascular therapy: CLAUDICATION

Recommendations for Endovascular Revascularization for Claudication		
COR	LOE	Recommendations
I	A	Endovascular procedures are effective as a revascularization option for patients with lifestyle limiting claudication and hemodynamically-significant aortoiliac occlusive disease (12, 37, 38, 232, 240, 242, 246).
IIa	B-R	Endovascular procedures are reasonable as a revascularization option for patients with lifestyle limiting claudication and hemodynamically-significant femoropopliteal disease (217, 232, 243-245, 250, 251).
IIb	C-LD	The usefulness of endovascular procedures as a revascularization option for patients with claudication due to isolated infrapopliteal artery disease is unknown (256-258).
III: Harm	B-NR	Endovascular procedures should not be performed in patients with PAD solely to prevent progression to CLI (234-237, 259-261).

Where is the disease?
Who is your operator?
Periprocedural risk?

Piedmont HEART

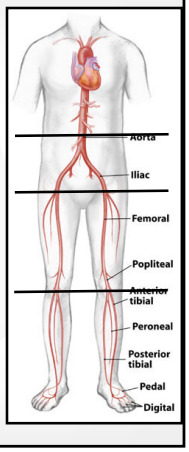
45

Plumbing

Symptomatic Patient

EVT Treatment

- Aorto-Iliac
  - Endovascular approach unless AAA to be also repaired or failure of EVT
- Femoral-Popliteal
  - Depends on type of disease (focal vs. diffuse), patient risk factors and comorbidities, claudicant vs. CLI, long term patency, renal function
- Infra-popliteal
  - Medical therapy for most, unless CLI
  - DES consideration
  - May change with bioasorbable scaffolds



46

Plumbing

Symptomatic Patient

Aortoiliac Revascularization Indications

Aorto-iliac disease *with symptoms*

- Relieve claudication
- Wound healing in CLI
- Improve functional status and Quality of Life (QOL)

Aorto-iliac disease *without symptoms*

- Situations where large-bore arterial access is required for hemodynamic support devices (e.g., intra-aortic balloon pumps (IABP) or other catheter-based ventricular assist devices), for structural, valvular (e.g., TAVR), and vascular (e.g., endovascular aortic aneurysm repair (EVAR)) procedures

Piedmont HEART

Klein A, Jaff M, Gray B et al. Catheter Cardiovasc Interv. 2017;90:E90–E110.

47

Plumbing

Symptomatic Patient

EVT Treatment

2005 ACC/AHA Guidelines

Class I

- **Endovascular procedures are indicated for individuals with a vocational or lifestyle-limiting disability due to intermittent claudication when clinical features suggest a reasonable likelihood of symptomatic improvement with endovascular intervention and (a) there has been an inadequate response to exercise or pharmacological therapy and/or (b) there is a very favorable risk-benefit ratio (e.g., focal aortoiliac occlusive disease). *(Level of Evidence: A)***

2016 ACC/AHA GUIDELINES

I	A	Endovascular procedures are effective as a revascularization option for patients with lifestyle limiting claudication and hemodynamically-significant aortoiliac occlusive disease (12, 37, 38, 232, 240, 242, 246).

Piedmont HEART

Hirsch AT, et al. ACC/AHA Guidelines for the Management of Patients with PAD 2005.
2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

48

Plumbing

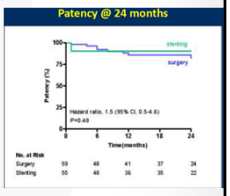
Symptomatic Patient EVT in CFA

Registry Data

- Supports EVT-first approach, 5 year f/u data on CFA stenting
  - 79% freedom form TLR

TECCO Trial

- 117 pts RCT of **common femoral endarderectomy vs. EVT** for isolated CFA disease
- 1°outcome: M&M within 30 days
  - 16 of 61 patients (26%) in the CFE group and 7 of 56 patients (12.5%) in the EVT group (odds ratio, 2.5; 95% CI, 0.9 to 6.6; p<0.05).
- The mean duration of hospitalization was significantly lower in the EVT group (3.2±2.9 days 6.3±3 days; p<0.0001).
- **At 24-months: No difference in the sustained clinical improvement, the primary patency rate, and the target lesion and extremity revascularization rates**



Piedmont HEART

Goueffic Y et al. JACC Cardiovasc Interv. 2017 Jul 10;10(13):1344-1354
Azema L et al. J Vasc Endovasc Surg 2011;41:787– 793.

49

Plumbing

Symptomatic Patient
EVT in FP Disease: TASC and ACC/AHA guideline

- TASC 2015 update recommends
  - "endovascular first" recommendation for experienced operators and teams
- 2016 ACC/AHA guidelines on PAD provide a class IIA recommendation (Level of Evidence B) for EVT of FP disease

CONCLUSION

"the choice of EVT as a revascularization approach for claudication due to femoral-popliteal disease should include a **discussion of outcomes, addressing the risk of restenosis and repeat intervention, particularly for lesions with a poor likelihood of long-term durability**"

Piedmont HEART

Jaff MR et al. Catheter Cardiovasc Intervent Off J Soc Cardiac Angiogr Intervent 2015;86:611–625
Gerhard-Herman MD et al. J Am Coll Cardiol 2016;69:1465–1508

50

Plumbing

Symptomatic Patient
EVT in Infrapopliteal Dz

- Generally limited to Critical Limb Ischemia (CLI) patients
- Small vessels, diffuse and long disease, high rates of restenosis
- Intervention to provide straight line flow to the foot, angiosome-based approach
- For claudicants, only moderate to severe (>50% diameter stenosis) lesions and multivessel tibial disease (2 tibial vessels) should be considered for revascularization.
- Prior to considering infra-popliteal intervention, all hemodynamically significant inflow disease should be treated to normalize inflow to the infra-popliteal circulation.

Piedmont HEART

51

Plumbing

Symptomatic Patient

CTLI

Guidelines

9.1. Revascularization for CLI: Recommendations

Recommendation for Revascularization for CLI		
COR	LOE	Recommendation
I	B-NR	In patients with CLI, revascularization should be performed when possible to minimize tissue loss (290).
I	C-EO	An evaluation for revascularization options should be performed by an interdisciplinary care team (Table 9) prior to amputation in the patient with CLI.

9.1.1. Endovascular Revascularization for CLI: Recommendations

Recommendations for Endovascular Revascularization for CLI		
COR	LOE	Recommendations
I	B-R	Endovascular procedures are recommended to establish in-line blood flow to the foot in patients with nonhealing wounds or gangrene (292, 293).

9.1.2. Surgical Revascularization for CLI: Recommendations

Recommendations for Surgical Revascularization for CLI		
COR	LOE	Recommendations
I	A	When surgery is performed for CLI, bypass to the popliteal or infrapopliteal arteries (i.e., tibial, pedal) should be constructed with suitable autogenous vein (263, 266, 269, 272).

Piedmont HEART

52

Plumbing

Symptomatic Patient

- Who is at your center?
  - Culture may drive things but don't let it
- Who is doing the procedure?
  - Experience
  - Back-up
  - Thoughtful
  - Collaborative

Piedmont HEART

53

PTA vs. Bypass

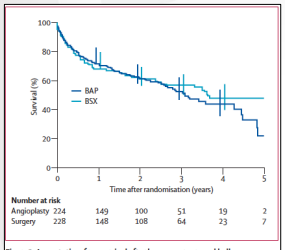


Figure 2: Amputation-free survival after bypass surgery and balloon angioplasty
Bars show 95% CIs for survival up to 1, 2, 3, and 4 years of follow-up, which were calculated from the cumulative hazards.

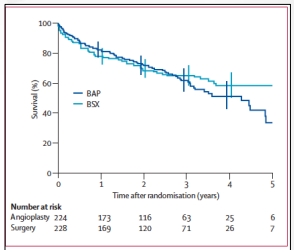


Figure 3: All-cause mortality after bypass surgery and balloon angioplasty
Bars show 95% CIs for survival up to 1, 2, 3, and 4 years of follow-up, which were calculated from the cumulative hazards.

Rates of MI, wound complications, Pulmonary comps increased in Surgery group vs. repeat revasc in PTA group

Basil Trial Lancet 2005; 366: 1925–34

Piedmont HEART

54

BEST-CLI

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 DECEMBER 22, 2022 VOL. 387 NO. 25

Surgery or Endovascular Therapy for Chronic Limb-Threatening Ischemia

A. Farber, M.T. Menard, M.S. Conte, J.A. Kaufman, R.J. Powell, N.K. Choudhry, T.H. Hamza, S.F. Assmann,* M.A. Creager, M.J. Cziraky, M.D. Dake, M.R. Jaff, D. Reid, F.S. Siami, G. Sopko, C.J. White, M. van Over, M.B. Strong, M.F. Villarreal, M. McKean, E. Azene, A. Azarbal, A. Barleben, D.K. Chew, L.C. Clavijo, Y. Douville, L. Findeiss, N. Garg, W. Gasper, K.A. Giles, P.P. Goodney, B.M. Hawkins, C.R. Herman, J.A. Kalish, M.C. Koopmann, I.A. Laskowski, C. Mena-Hurtado, R. Motaganahalli, V.L. Rowe, A. Schanzer, P.A. Schneider, J.J. Siracuse, M. Venermo, and K. Rosenfield, for the BEST-CLI Investigators†

Piedmont HEART

55

BEST-CLI

- **~30% of patients were dead at end of trial (3 years)** no matter what intervention

You want your leg filleted open when you have 1/3 chance of being dead soon?

Piedmont HEART

56

BEST-CLI: Cohort 1

- Comparison of the BEST Surgical intervention (GSV) vs. "Best Endo"
- What is 'best' Endo?
  - DCB/DES
  - Trial started in 2014
  - Trial Data
    - **52% PTA only**
    - 15% Atherectomy
    - 25% DCB
    - 22% DES

Piedmont HEART

57

BEST-CLI: WHO?

- Endovascular interventions were performed by:
  - **Vascular surgeons: 73%**
  - Interventional cardiologists: 15%
  - Interventional radiologists:13%
- The **technical success** of the index procedure was **98% in the surgical** group and **85% in the endovascular** group

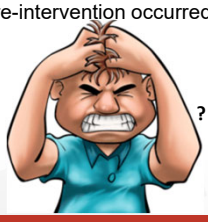
15% failure rate in ENDO
Is this 'Best Endo"

JVS 2016;63:958-965 Large Series report Endovascular Success rates >90%

58

BEST-CLI: Cohort 1

- **'BEST' Endo: Success Rate equal to BASIL 1: 17 years ago !!!!!**
- 108 cases of early technical failure in the endovascular group→ 66 were treated with a bypass operation within 30 days.
- 42.5% re-intervention occurred within 30 days.



15% failure rate in ENDO
? Shocked that this led to 42.5% reintervention rate

59

BEST-CLI

CONCLUSIONS

Among patients with CLTI who had an adequate great saphenous vein for surgical revascularization (cohort 1), the incidence of a major adverse limb event or death was significantly lower in the surgical group than in the endovascular group. Among the patients who lacked an adequate saphenous vein conduit (cohort 2), the outcomes in the two groups were similar. (Funded by the National Heart, Lung, and Blood Institute; BEST-CLI ClinicalTrials.gov number, NCT02060630.)

IF

1. You are at a Center with a HIGH Endo failure rate
2. Endo therapy that is given is not based on the most current evidence

60

BEST-CLI: Limitations (Listed)

- White male patients
- **Majority of pts with CLTI do not have SSGSV**
- Trial ran out of funds so follow up limited on cohort 2
- MAJOR DROP IN DCB use because of Paclitaxel debate (which is now been settled) but started in 2014 so……..BS
- 66% infrapopliteal disease but lots of fem-pop bypasses?
- Angiographic analysis pending

Piedmont HEART

61

BEST-CLI: Limitations (not listed)

- **Majority of operators were VS**
  - Procedure 1: 98-100% Success rate
  - Procedure 2: 80-85% Success rate

    Which one were people better at ?
- **No real DCB/DES use**
- Major endpoint driven by re-intervention (not CD-TLR)
- Low enrollment of women and Black patients
- **High burden of CV disease but Medical therapy Awful:**
  - 65-70% only on ASA and/or statins

Piedmont HEART

62

BEST-CLI: Limitations (not listed)

- 75% of sites had some combo of IR, VS, IC
- Only 13% had all 3 and 28% of sites with only VS performing surgery and endo procedures
- *High mortality for endo procedures ??GETA for VS*
- POBA was used most of the time vs DCB/DES/atherectomy
- Enrollment was very very slow
- SUBGROUP ANALYSIS
  - COHORT 1: NO difference in
    - Age>80
    - CKD
    - Black Patients

Piedmont HEART

63

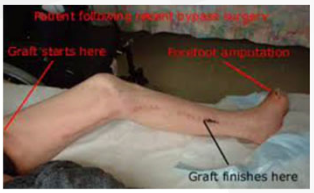
BEST-CLI Take Home

- GSV + Cohort did well with surgery
  - **Low periop Death rate: 1.9%**
- Comparing the **best surgical** procedure to **crappy endo** procedures
  - **80-85% Failure rate**
  - Heterogenous procedure w >50% POBA alone
- QOL showed Endo to be better
- Need better and more meds
- Cannot generalize results
  - What is your center like?
  - Who are your operators
  - What is your threshold?
  - If you have no out to the OR would you work harder at endo? Activation Energy

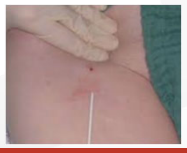
Simons JP, Schanzer A, Flahive JM, et al. Survival prediction in patients with chronic limb-threatening ischemia who undergo infrainguinal revascularization. J Vasc Surg 2019;69(6S):137S-151S.e3

64

Which one do you want?



VS.



65

How should we best treat PAD?

Team Approach

Who is on your team?

66

Bottom Line: TEAMWORK

Table 9. Interdisciplinary Care Team for PAD

A team of professionals representing different disciplines to assist in the evaluation and management of the patient with PAD. For the care of patients with CLI, the interdisciplinary care team should include individuals who are skilled in endovascular revascularization, surgical revascularization, wound healing therapies and foot surgery, and medical evaluation and care.

Interdisciplinary care team members may include:

- Vascular medical and surgical specialists (i.e., vascular medicine, vascular surgery, interventional radiology, interventional cardiology)
- Nurses
- Orthopedic surgeons and podiatrists
- Endocrinologists
- Internal medicine specialists
- Infectious disease specialists
- Radiology and vascular imaging specialists
- Physical medicine and rehabilitation clinicians
- Orthotics and prosthetics specialists
- Social workers
- Exercise physiologists
- Physical and occupational therapists
- Nutritionists/dieticians

Faster. Stronger. Farther.

better

Piedmont HEART

2016 AHA/ACC Guideline on the Management of Patients with Lower Extremity Peripheral Arterial Disease

67

Conclusions

- PAD is common
- Patients with PAD die from CV complications
- Prevention, Protection, Plumbing
- Endo and Surgery are not competing but complimentary therapies
- "Right procedure for the right patient at the right time" on top of solid medical and exercise therapy

Piedmont HEART

68

Get the word out!!!

•70% of Americans are not familiar with PAD and its devastating risks.
•Approximately all (91%) of the survey respondents would dismiss pain as just part of getting older, although pain in the leg when walking that goes away with rest is one of the first symptoms of PAD.
•More than half (53%) of respondents would wait more than a week with ongoing leg pain before calling their doctor.
•8 in 10 Black and Hispanic respondents never had a doctor or healthcare provider talk with them about PAD.
•Amputations are 4-5x high in African Americans compared to Caucasions
•Despite 71% of Black adults having one or more risk factors for PAD or knowing someone with one or more risk factors, 65% report they are at little to no risk at all for developing PAD.
•Three-quarters of Hispanic adults have one or more risk factors for PAD or know someone with one or more risk factors but 70% think they are not at risk for developing PAD.

PADPulse.org.

Piedmont HEART

69

Get a Pulse on PAD
Kick Off The Conversation

PAD Pulse Alliance Founding Partners

PAD Pulse Alliance Supporting Partners

PADPulse.org.

Piedmont HEART

70

Thank you!

Piedmont HEART

71

SVM Society for Vascular Medicine

CLTI Controversies – Case CLTI – Surgical Revascularization Approach

Olamide Alabi MD MS
Chief Quality Officer, Division of Vascular Surgery and Endovascular Therapy
Emory University School of Medicine

Sunday May 17, 2024

1

SVM Society for Vascular Medicine

Objectives

- Open versus Endo
- "No Stent Zones"
- Angiosome Concept

2

SVM Society for Vascular Medicine

Objectives

- Open versus Endo
- "No Stent Zones"
- Angiosome Concept

3

SVM Society for Vascular Medicine

Objectives

- ~~Open versus Endo~~ Complementary Therapies
- "No Stent Zones"
- Angiosome Concept

4

SVM Society for Vascular Medicine

Open Surgical Revascularization: Complementary Therapies

	BEST-CLI	BASIL-2
Trial Endpoint	composite of major adverse limb events or death from any cause	Composite time to above ankle amputation of the trial limb or death from any cause
Study Period	8/2014-10/2019	7/2014-11/2020
Intended N	2100	600
Actual N	1830	345
Differences in inclusion criteria	• Life expectancy 2 years • Availability of autogenous bypass conduit	• Life expectancy >6mo • Required an infrapopliteal target
Exclusions	Excessive risk for open vascular surgery	• Prior vascular intervention to infrapopliteal target within prior 12mo • Ischemic pain or tissue loss considered not primarily due to PAD

5

SVM Society for Vascular Medicine

Open Surgical Revascularization: Complementary Therapies

TABLE 2. Comparison of key patient characteristics comparing BEST-CLI and BASIL-2.

	BEST-CLI COHORT 1	BEST-CLI COHORT 2	BASIL-2
Patients who did not undergo any procedure	4.3% / 1.1%	3.6% / 2.0%	8.7% / 1.2%
Cross-over to other revascularization method	3.5% / 0.4%	1.0% / 2.0%	7% / 3.5%
Median age (years)	66.9 / 67.0	68.4 / 68.8	72.4 / 72.5
Male	72% / 71.1%	71.6% / 72.4%	81% / 82%
Diabetes mellitus	72.1% / 71.6%	62.2% / 58.3%	68% / 69%
Mean eGFR (ml/min)	NA	NA	[illegible]
Chronic hemodialysis	9.4% / 11.8%	12.8% / 10.1%	6% / 3%
Previous stroke	12.8% / 13.9%	19.4% / 12.1%	15% / 20%
Coronary artery disease	42.3% / 44.4%	49.5% / 53.8%	NA
Previous MI	NA	NA	24% / 13%
Previous PCI & CABG	NA	NA	26% / 19%
Previous intervention study leg	5.6% / 5.2%	10.3% / 10.1%	31% / 39%
RBC 4	20.3%/20%	29.4%/30.2%	13% / 11%
RBC 5 (and 6)	79.7%/80%	70.6%/69.8%	87% / 89% (RBC 5 only)
ASA class 3 or 4	80.8%/75.9%	83.5%/80.9%	NA
No. patients completing the trial	560/1434 (39%)	226/396 (57.1%)	212/345 (61.4%)

J CRIT LIMB ISCHEM 2023

6

Open Surgical Revascularization: Complementary Therapies

Table 3. Comparison of key outcome characteristics comparing BEST-CLI and BASIL-2.

	BEST-CLI Cohort 1	BEST-CLI Cohort 2	BASIL-2
Bypass location			
Femoro-popliteal	40%	47.9%	1%
Femoro-popliteal AK	NA	NA	0%
Femoro-popliteal BK	NA	NA	1%
Femoro-BTK	35.7%	37.4%	59%
Popliteal-BTK	15.7%	8.4%	40%

J CRIT LIMB ISCHEM 2023

Table 3. Comparison of key outcome characteristics comparing BEST-CLI and BASIL-2.

	BEST-CLI Cohort 1	BEST-CLI Cohort 2	BASIL-2
Endovascular techniques			
Balloon angioplasty	52.7%	47.2%	60%
Atherectomy	13.6%	15.4%	0%
Drug-coated balloon	27.8%	25.1%	0%
Bare-metal stent	39.3%	43.1%	10%
Drug-eluting stent	24.2%	21.5%	0%
Stent graft	8.6%	12.8%	0%
Technical success	98.3% / 84.7%	100%/80.6%	96% / 80%

@SVM_tweets

7

Open Surgical Revascularization: Complementary Therapies

Table 3. Comparison of key outcome characteristics comparing BEST-CLI and BASIL-2.

	BEST-CLI Cohort 1	BEST-CLI Cohort 2	BASIL-2
Technical success	98.3% / 84.7%	100%/80.6%	96% / 80%
All cause death	33% / 37.6%	25.9% / 24.1%	53% / 45%
Major amputation (above ankle)	10.4%/14.9%	15.2%/14.1%	20%/18%
AK amputation	NA	NA	NA
BK amputation	NA	NA	NA
Amputation free survival	43.3%/52.4%	41.1%/38.2%	37%/47%
Cross-over intervention during FU	NA	NA	27% / 19%
Reintervention****	9.2% / 33.1%	14.2%/25.6%	5% / 19%

J CRIT LIMB ISCHEM 2023

@SVM_tweets vascularmed.org @VascularMed

8

Open Surgical Revascularization

- BEST-CLI and BASIL-2 are not really comparable
- Neither should be used as an 'end all argument'
- Lessons to learn from both:
  - Nothing beats single segment great saphenous vein….if this is available
    - Get vein mapping prior to the angiogram
  - The toolbox is large – USE IT!
  - Shared decision making
    - There is a small but not insignificant cohort of patients who would benefit from primary amputation

@SVM_tweets vascularmed.org @VascularMed

9

SVM Society for Vascular Medicine

Open Surgical Revascularization

- ~~Open versus Endo~~ Complementary Therapies
- "No Stent Zones"
- Angiosome Concept

10

SVM Society for Vascular Medicine

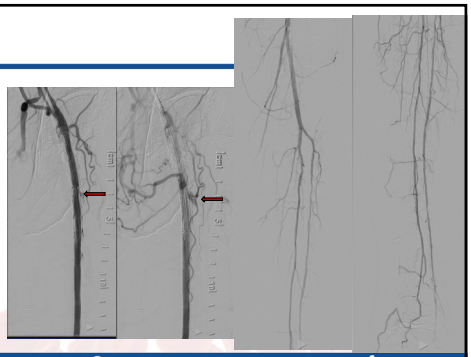
TH

- 3/2012 Left SFA stent
- 8/2012 left SFA atherectomy and BAP of stent
- 11/2012 left SFA laser and BAP of stent
- 7/2013 left SFA revascularization
- 3/2014 BAP Left SFA in-stent stenosis
- 6/2021 shockwave lithotripsy of left CFA and popliteal + DCB BAP
- 6/2023 left SFA stent recanalization
- 8/2023 left SFA stent recanalization

11

SVM Society for Vascular Medicine

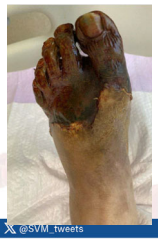
- 9/18/23 Procedure
- 1) Ultrasound guided access of the right common femoral artery
- 2) Angiogram of abdominal aorta and bilateral iliac arteries
- 3) Angiogram of the left femoral, popliteal, anterior tibial, posterior tibial, and popliteal vessels
- 4) Angiogram of the right femoral, popliteal, anterior tibial, posterior tibial, and popliteal vessels
- 3) PTA of L SFA (stents present)
- 5) Shockwave Lithotripsy
- 6) Laser atherectomy of the L SFA
- 7) Drug coated balloon of the L SFA

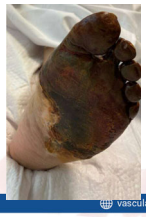


12

SVM Society for Vascular Medicine

And then this happened…what would you do?



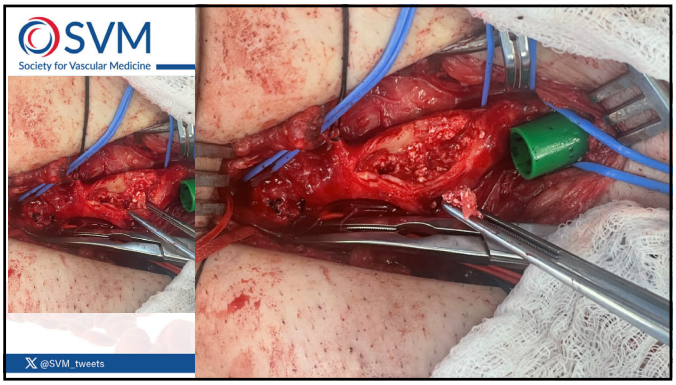


- Abi
- Lt Brachial: 118 mmHg
- Lt Posterior Tibial: 48 mmHg
- Lt Posterior Tibial: 0.41
- Lt Dorsalis Pedis: 50 mmHg
- Lt Dorsalis Pedis: 0.42

@SVM_tweets vascularmed.org @VascularMed

13

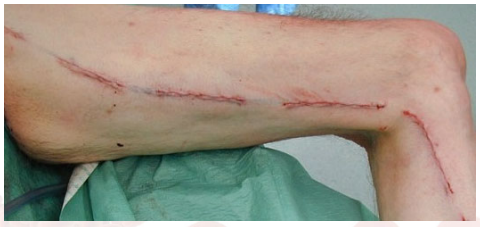
SVM Society for Vascular Medicine

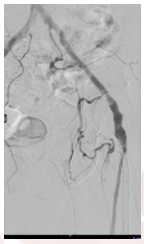


@SVM_tweets

14

SVM Society for Vascular Medicine





@SVM_tweets vascularmed.org @VascularMed

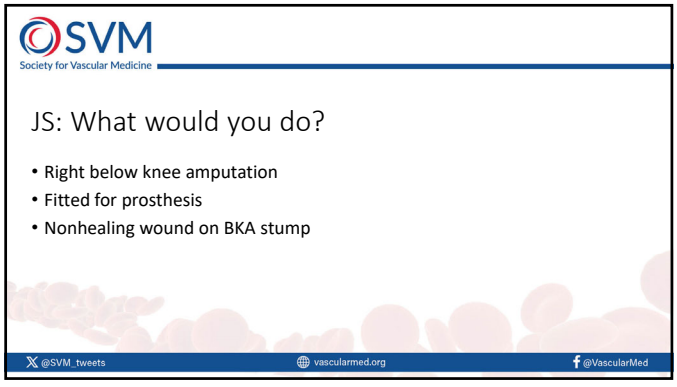
15


SVM
Society for Vascular Medicine
@SVM_tweets
vascularmed.org
@VascularMed

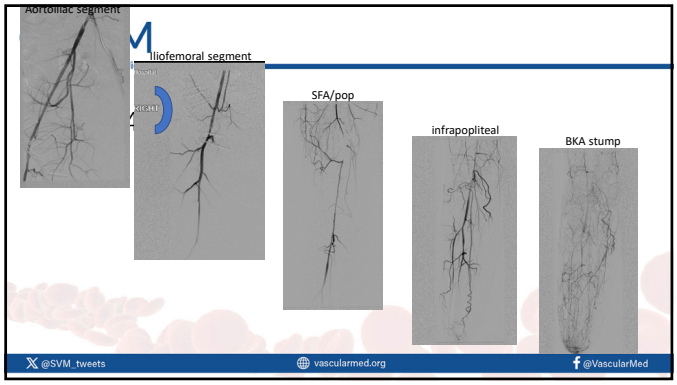
16


SVM
Society for Vascular Medicine
@SVM_tweets
vascularmed.org
@VascularMed

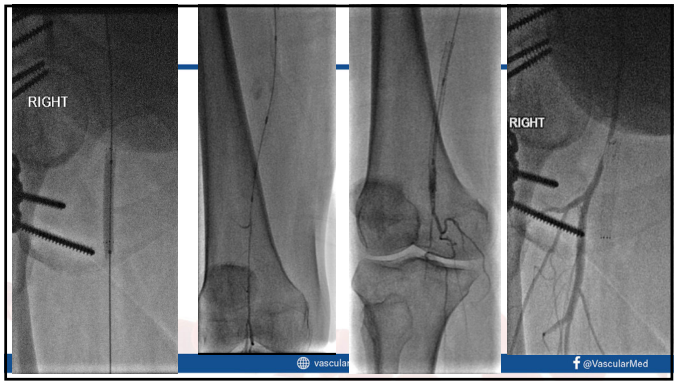
17


SVM
Society for Vascular Medicine
JS: What would you do?
• Right below knee amputation
• Fitted for prosthesis
• Nonhealing wound on BKA stump
@SVM_tweets
vascularmed.org
@VascularMed

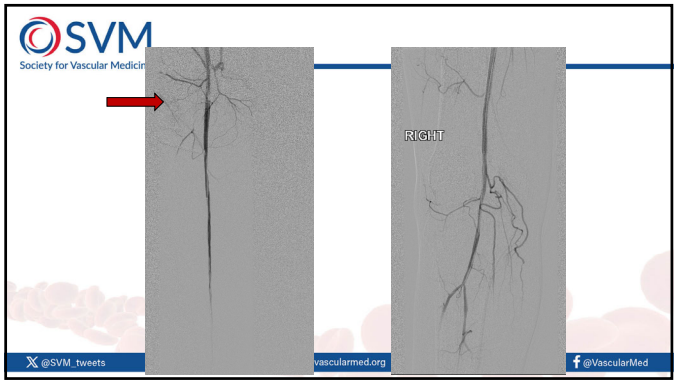
18


Aortoiliac segment
Iliofemoral segment
SFA/pop
infrapopliteal
BKA stump
@SVM_tweets
vascularmed.org
@VascularMed

19


RIGHT
RIGHT
@VascularMed

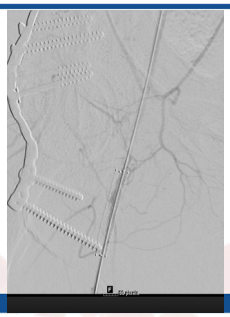
20


SVM
Society for Vascular Medicin
RIGHT
@SVM_tweets
vascularmed.org
@VascularMed

21

SVM Society for Vascular Medicine

Went to OR:



@SVM_tweets @VascularMed

22

SVM Society for Vascular Medicine

@SVM_tweets vascularmed.org @VascularMed

23

SVM Society for Vascular Medicine

@SVM_tweets vascularmed.org @VascularMed

24

SVM Society for Vascular Medicine

DH: What would you do?

- 3rd toe wound with underlying osteomyelitis
- No frank cellulitis
- Vein mapping: single segment vein present
- Angiogram

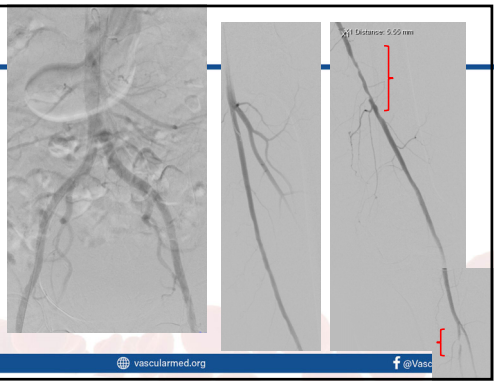
@SVM_tweets vascularmed.org @VascularMed

25

SVM Society for Vascular Medicine

DH

- Single segment vein present…



@SVM_tweets vascularmed.org @Vasc

26

SVM Society for Vascular Medicine

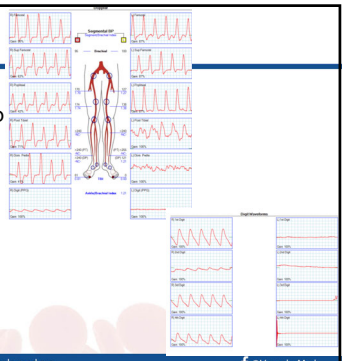
@SVM_tweets vascularmed.org @VascularMed

27

SVM Society for Vascular Medicine

CD: What would you do?

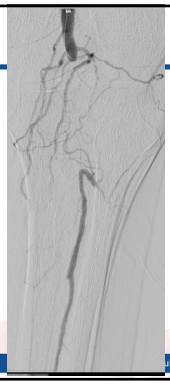
- Chronic emboli from mitral valve vegetation over time
- Developed CLTI with lateral 5th toe wound at base of toe

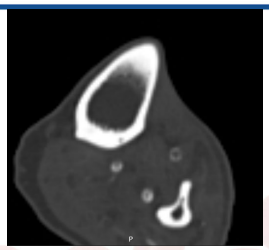


@SVM_tweets vascularmed.org @VascularMed

28

SVM Society for Vascular Medicine

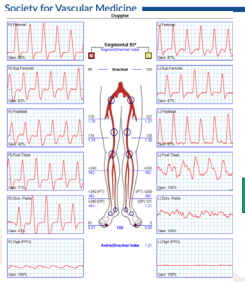


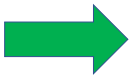


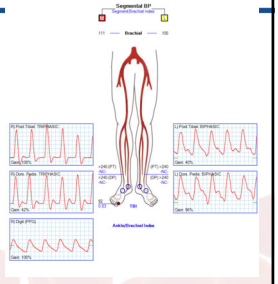
@SVM_tweets ularmed.org @VascularMed

29

SVM Society for Vascular Medicine

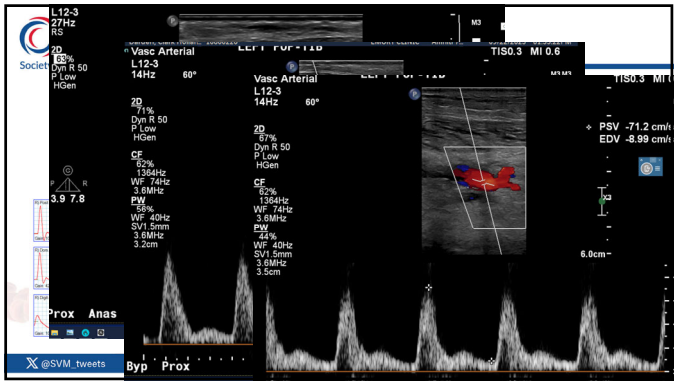






@SVM_tweets vascularmed.org @VascularMed

30



31

SVM
Society for Vascular Medicine

Open Surgical Revascularization

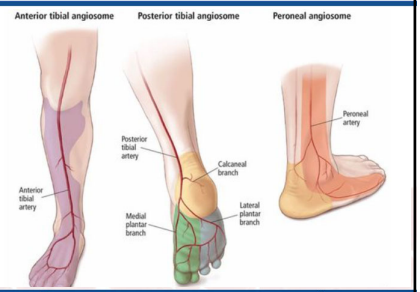
- ~~Open versus Endo~~ Complementary Therapies
- "No Stent Zones"
- Angiosome Concept

@SVM_tweets vascularmed.org @VascularMed

32

SVM
Society for Vascular Medicine

Angiosomes



@SVM_tweets vascularmed.org @VascularMed

33

Direct versus Indirect Revascularization

- Meta-analysis. 9 studies
  - 715 direct revascularization
  - 575 indirect revascularization
- Direct revascularization associated with:
  - Lower risk of unhealed wound (HR 0.64, 95% CI 0.52-0.8, I2 0%)
  - Lower risk of major amputation (0.44, 95% CI 0.26-0.75, I2 62%)
  - Limb salvage rates
    - 1 year: 86.2% direct; 77.8% indirect
    - 2 years: 84.9% direct; 70.1% indirect

Biancari F, Juvonen T. Angiosome-targeted lower limb revascularization for ischemic foot wounds: systematic review and meta-analysis. *Eur J Vasc Endovasc Surg*. 2014;47(5):517-522.

@SVM_tweets vascularmed.org @VascularMed

34

Open Surgical Revascularization

- ~~Open versus Endo~~ Complementary Therapies
- "No Stent Zones"
- Angiosome Concept

@SVM_tweets vascularmed.org @VascularMed

35

Questions

@SVM_tweets vascularmed.org @VascularMed

36

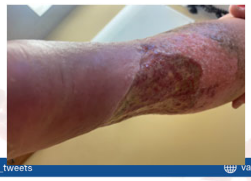
CLTI Management
Endovascular Revascularization

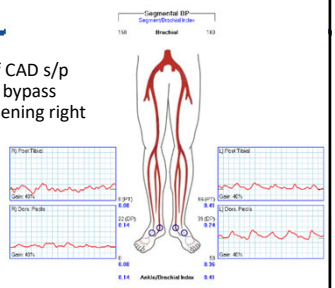
Yulanka Castro, MD
Clinical Assistant Professor of Medicine
University Hospitals Harrington Heart and Vascular Institute
Cleveland, OH
@YSCastroMD

1

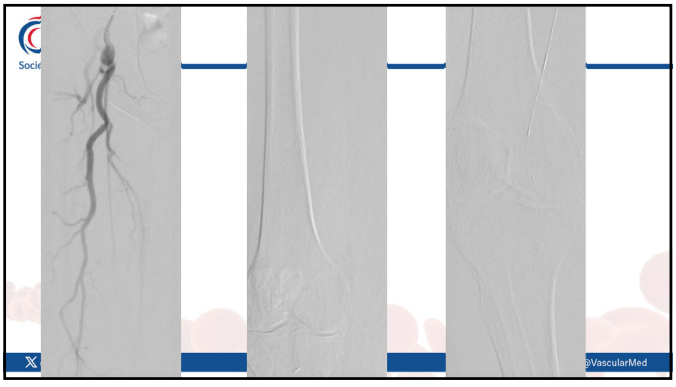
Case

- 79-year-old woman with history of CAD s/p CABG, PAD s/p PTFE right fem-pop bypass presenting with rest pain and worsening right posterior ankle ulcer

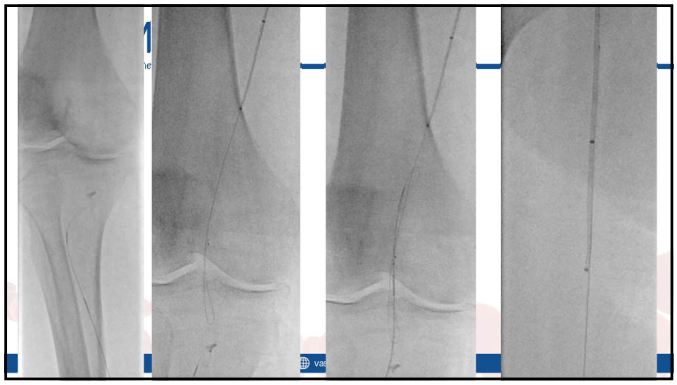




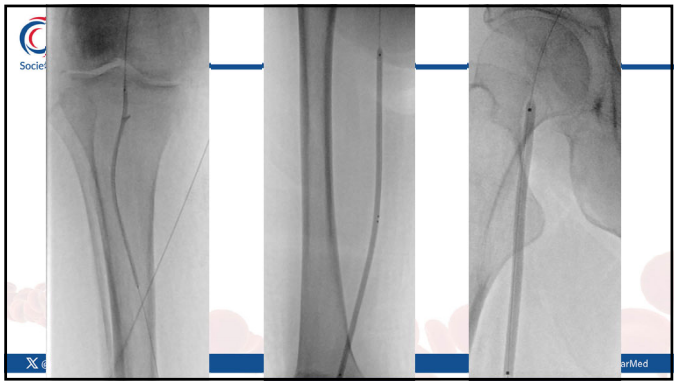
2



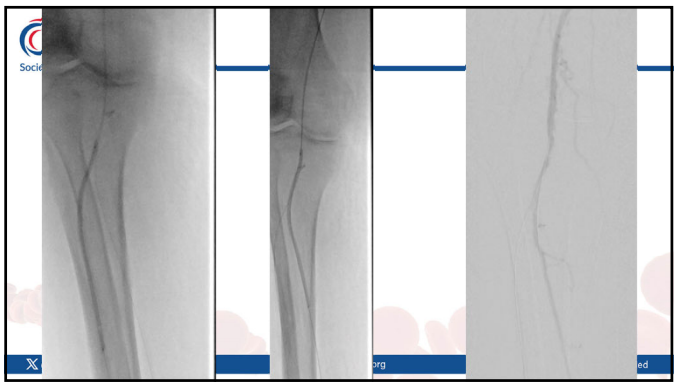
3



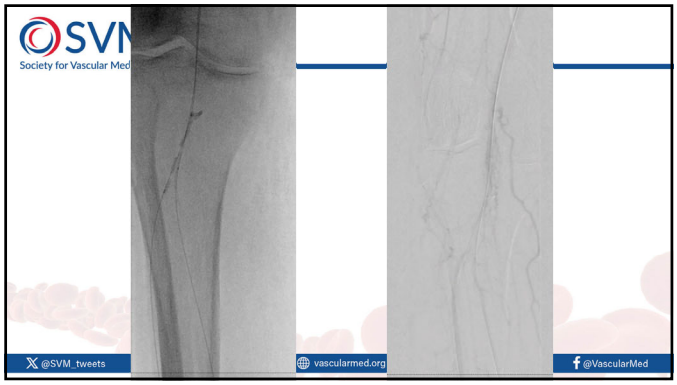
4



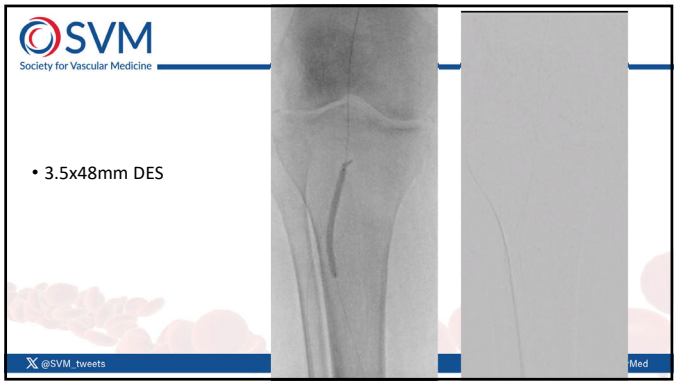
5



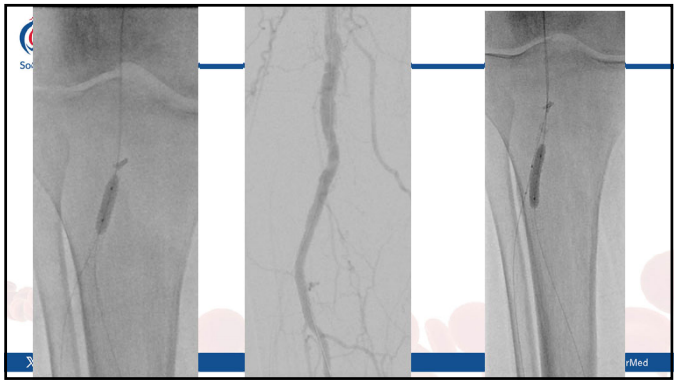
6


SVM
Society for Vascular Med
@SVM_tweets
vascularmed.org
@VascularMed

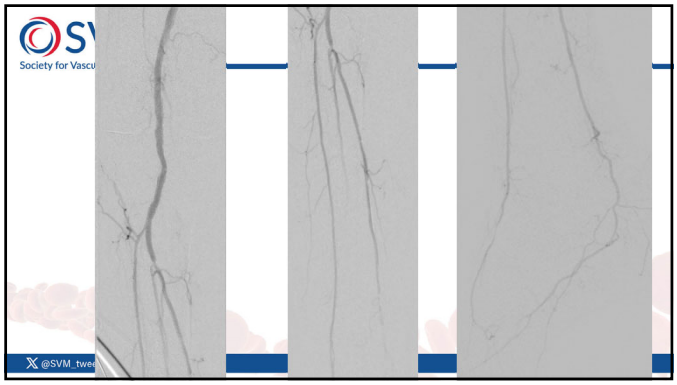
7


SVM
Society for Vascular Medicine
• 3.5x48mm DES
@SVM_tweets

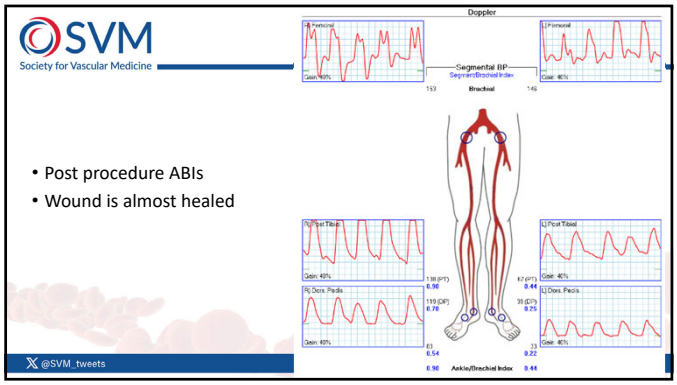
8



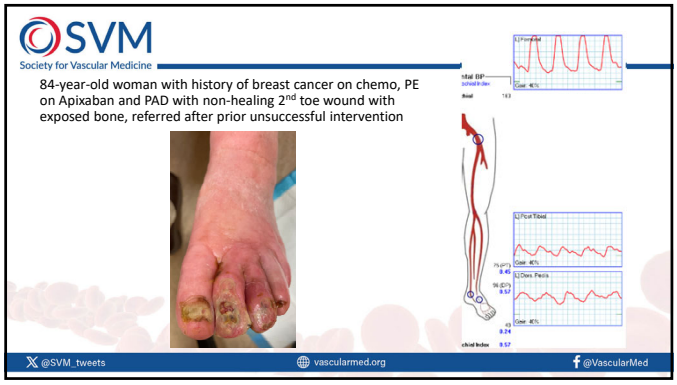
9


Society for Vascu
@SVM_twee

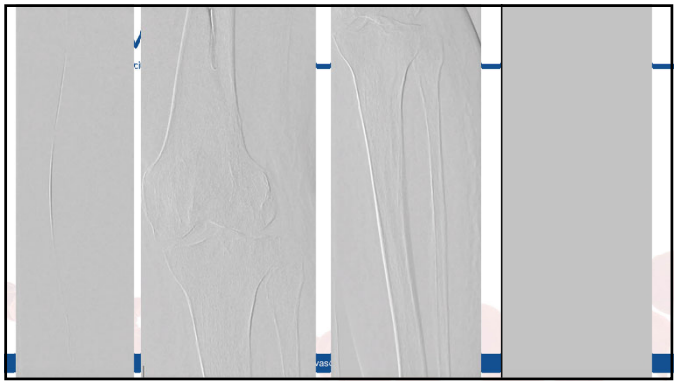
10


SVM
Society for Vascular Medicine
Doppler
Segmental BP
Brachial
• Post procedure ABIs
• Wound is almost healed
@SVM_tweets

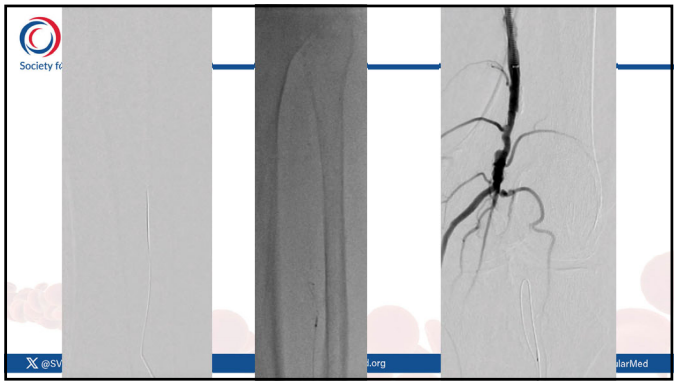
11


SVM
Society for Vascular Medicine
84-year-old woman with history of breast cancer on chemo, PE on Apixaban and PAD with non-healing 2nd toe wound with exposed bone, referred after prior unsuccessful intervention
@SVM_tweets
vascularmed.org
@VascularMed

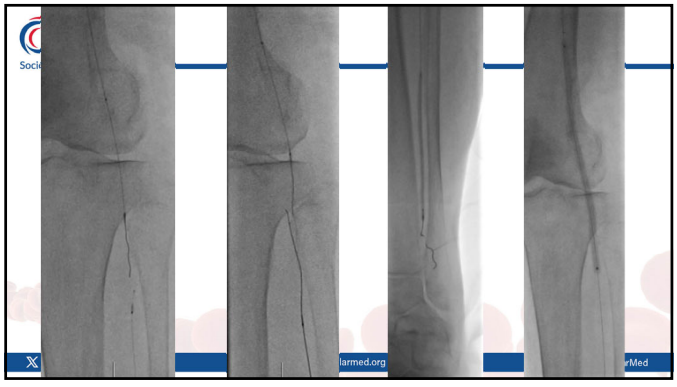
12



13



14



15

16

SVM Society for Vascular Medicine

BASIL-2 Trial

A vein bypass first versus a best endovascular treatment first revascularisation strategy for patients with chronic limb threatening ischaemia who required an infra-popliteal, with or without an additional more proximal infra-inguinal revascularisation procedure to restore limb perfusion (BASIL-2): an open-label, randomised, multicentre, phase 3 trial

Andrew W Bradbury, Catherine A Moakes, Matthew Popplewell, Lewis Meecham, Gareth R Bate, Lisa Kelly, Ian Chetter, Athanasios Diamantopoulos, Arul Ganeshan, Jack Hall, Simon Hobbs, Kim Houlind, Hugh Jarrett, Suzanne Lockyer, Jonas Malmstedt, Jai V Patel, Smitaa Patel, S Tawgeer Rashid, Athanasios Saratzis, Gemma Slinn, D Julian A Scott, Hany Zayed, Jonathan J Deeks, on behalf of the BASIL-2 Investigators

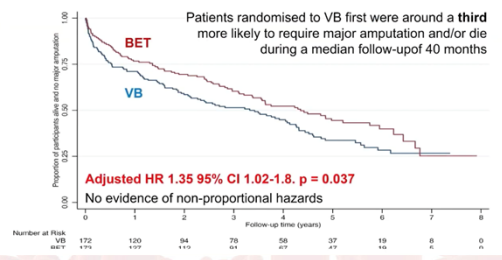
THE LANCET

University Hospitals Heart & Vascular Institute

17

SVM Society for Vascular Medicine

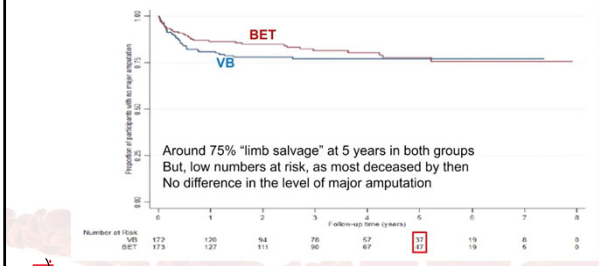
Amputation-free survival (ITT analysis)



University Hospitals Heart & Vascular Institute

18

BASIL-2 Time to First Major Amputation (ITT)



19

Outcomes

- Number of re-interventions was higher in BET (19%) than in the VB (5%) (0.27 [0.13-0.55])
- Crossover interventions – more common in VB (27%) than in the BET (19%) (1.43 [0.94-2.18])
- NO differences in 30-day morbidity and death, MALE, MACE, relief of ischemic pain, or QoL

	Vein bypass group (n=172)	Best endovascular treatment group (n=173)	Estimate (95% CI)
Subsequent intervention	50 (29%)	56 (32%)	RR 0·94† (0·68 to 1·28); uRD −0·03§ (−0·13 to 0·06)
Reintervention	9 (5%)	33 (19%)	RR 0·27† (0·13 to 0·55); uRD −0·14§ (−0·21 to −0·07)
Crossover intervention	46 (27%)	33 (19%)	RR 1·43† (0·94 to 2·18); uRD 0·08§ (−0·01 to 0·17)

20

Patient Characteristics: BASIL-2 and BEST-CLI

	BASIL-2	BEST-CLI (cohort 1)	BEST-CLI (cohort 2)
Enrolled participants	345	1434	396
Median age (yrs)	73	67	68
Diabetes	68%/69%	72%/72%	62%/58%
ESRD on HD	6%/3%	13%/14%	13%/10%
Previous intervention study leg	31%/39%	10%/10%	6%/5%
Antiplatelet use	76%/80%	ASA – 67%/67% Clopidogrel 19%/25%	ASA – 71%/71% Clopidogrel 25%/28%
Cholesterol lowering agent	75%/80%	71%/70%	79%/77%
Tissue loss	87%/89%	80%/80%	71%/70%
Tibial disease treated	100%	51%/51%	46%/43%

21

Primary Outcomes: BASIL-2 and BEST-CLI

- BEST-CLI
  - MALE – major amputation above ankle, major limb reintervention (new bypass graft, graft revision, thrombectomy, or thrombolysis) or death from any cause
- BASIL-2
  - Amputation-free survival – time to major amputation above ankle or death from any cause
    - What ultimately matters to patients – to avoid amputation and prolong life
    - Does not reflect burden of major reinterventions

22

Key Comparisons: BASIL-2 and BEST-CLI

	BASIL-2	BEST-CLI (cohort 1)
Endo technical success	87%	85%
Bypass technical success	96%	98%
Crossover (endo to bypass)	19%	23%
Major amputation/Death		
Bypass	63%	43%
Endovascular	53%	53%

Outcome	Surgery	Endovascular Therapy	Hazard Ratio (95% CI)††
Efficacy			
Primary outcome: major adverse limb event or death from any cause — no./total no. (%)‡	302/709 (42.6)	408/711 (57.4)	0.68 (0.59–0.79)
Secondary outcomes — no./total no. (%)			
Death from any cause	234/709 (33.0)	267/711 (37.6)	0.98 (0.82–1.17)
Above-ankle amputation of the index limb	74/709 (10.4)	106/711 (14.9)	0.73 (0.54–0.98)
Intervention in index limb			
Major	65/709 (9.2)	167/711 (23.5)	0.35 (0.27–0.47)

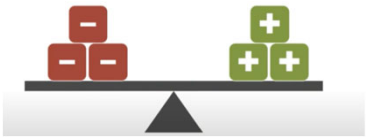
23

Data we need from BEST-CLI and BASIL-2

- Few patients with CLTI are deemed suitable and have an optimal vein for infra-popliteal bypass
  - Risk profiles of patients deemed not appropriate for surgery
- Angiographic lesion-level data and severity of disease morphology in both arms
- Registry data of patients that were treated during trial period but not enrolled – understand patients who BEST-CLI and BASIL-2 results does not apply to
  - No equipoise when disease morphology is straightforward for endo or patient unfit for open surgery

24

Individual Assessment



- Involvement of CFA/PFA
- Younger, low risk patient
- Suitable vein

- Extensive tibial disease with poor targets
- No suitable vein
- Older patient, poor surgical candidate

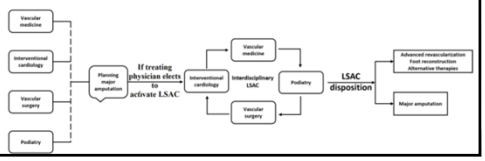
25

I | C-EO

An evaluation for revascularization options should be performed by an interdisciplinary care team (Table 9) before amputation in the patient with CLI.

Impact of Interdisciplinary System-Wide Limb Salvage Advisory Council on Lower Extremity Major Amputation

Mehdi H. Shishehbor, DO, MPH, PhD, Tarek A. Hammad, MD, Tonia J. Rhone, MS, Ahmad Younes, MD, Norman Kumins, MD, Abdullah Abdullah, MD, Jun Li, MD, Karem Harth, MD, Teresa L. Carman, MD, Heather L. Gornik, MD, Peter J. Pronovost, MD, PhD, and Vikram S. Kashyap, MD



26

Learning Points

- Reminder poor prognosis of patients with CLTI. ~ 50% of patients died by 5 years
- Primary prevention – early detection of PAD and institution of GDMT and lifestyle interventions
- Saphenous vein mapping and surgical risk assessment should be more regularly considered
- Management of patients with CLTI requires multidisciplinary expertise in limb salvage programs

27

Large Vessel Vasculitis

Alexandra Solomon, MD, RPVI

March 17th, 2024

1

Disclosures

- None, but any are welcome!

2

Learning Objectives

At the end of this session, participants will be able to:

1. Devise a differential diagnosis for large vessel vasculitis (LVV).
2. Complete a basic diagnostic workup for LVV.
3. Discuss the basics of LVV management.

3

SVM
Society for Vascular Medicine

Our Patient

- 32 yo woman
- No significant past medical history
- 1 year of progressive right arm and bilateral leg cramping with activity; 1 month of left neck tenderness, and intermittent dizziness

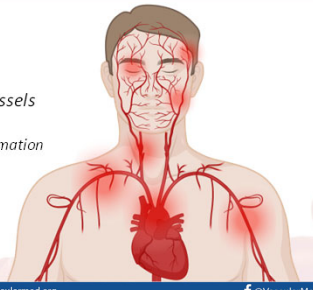
@SVM_tweets vascularmed.org @VascularMed

4

SVM
Society for Vascular Medicine

Large Vessel Vasculitis

- **Vasculitis**: *inflammation of blood vessels*
  - *WBC infiltration into vessel wall*
  - *Narrowing, obstruction, aneurysm formation*
- Large vessels (mostly)
- Aorta and its branches
  1. Giant cell arteritis
  2. Takayasu arteritis



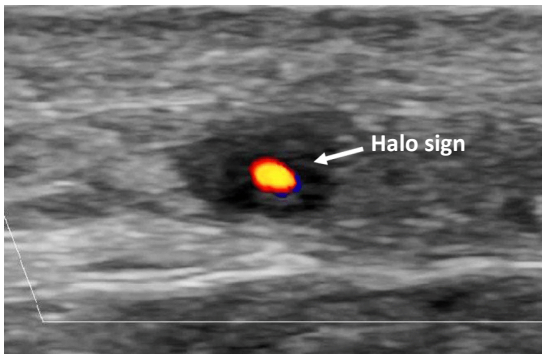
@SVM_tweets vascularmed.org @VascularMed

Image created with BioRender

5

Infectious causes (eg, endocarditis, HBV, HCV, HIV)
Atherosclerosis
Thromboembolic disease
Congenital causes (eg, aortic coarctation, middle aortic syndrome)
Hereditary disorders (eg, Marfan syndrome, Ehlers-Danlos syndrome)
Fibromuscular dysplasia
Hypercoagulable states (eg, APS, TTP)
Vasospastic disorders (eg, RCVS, drug exposures)
Other multisystem inflammatory disorders (eg, sarcoidosis, Susac syndrome)
Malignancy (eg, lymphoma, leukemia)
Iatrogenic (eg, postradiation therapy)
IgG4-related disease

6



7

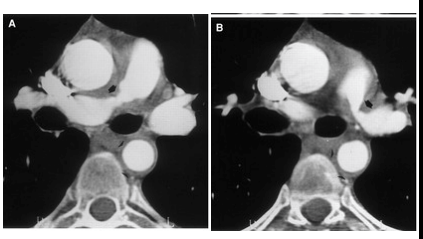
SVM
Society for Vascular Medicine

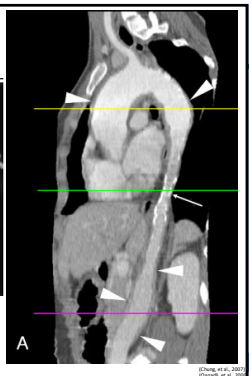
GCA Diagnostic Criteria (score ≥6)

ABSOLUTE REQUIREMENT	
Age ≥ 50 years at time of diagnosis	
ADDITIONAL CLINICAL CRITERIA	
Morning stiffness in shoulders/neck	+2
Sudden visual loss	+3
Jaw or tongue claudication	+2
New temporal headache	+2
Scalp tenderness	+2
Abnormal examination of the temporal artery[1]	+2
LABORATORY, IMAGING, AND BIOPSY CRITERIA	
Maximum ESR ≥ 50 mm/hour or maximum CRP ≥ 10 mg/liter[2]	+3
Positive temporal artery biopsy or halo sign on temporal artery ultrasound[3]	+5
Bilateral axillary involvement[4]	+2
FDG-PET activity throughout aorta[5]	+2

@SVM_tweets vascularmed.org @VascularMed

8





9

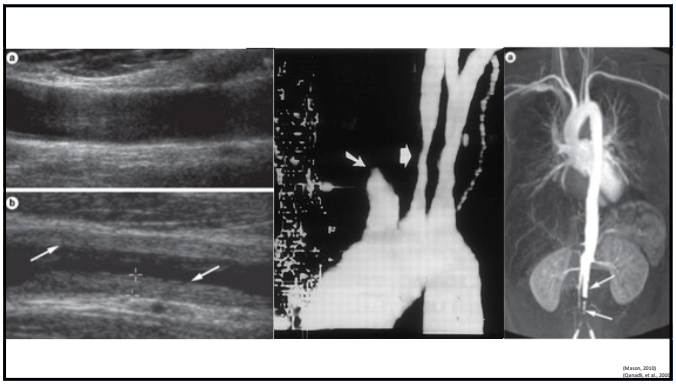
SVM
Society for Vascular Medicine

Takayasu Diagnostic Criteria (score ≥5)

ABSOLUTE REQUIREMENTS	
Age ≤ 60 years at time of diagnosis	
Evidence of vasculitis on imaging[1]	
ADDITIONAL CLINICAL CRITERIA	
Female sex	+1
Angina or ischemic cardiac pain	+2
Arm or leg claudication	+2
Vascular bruit[2]	+2
Reduced pulse in upper extremity[3]	+2
Carotid artery abnormality[4]	+2
Systolic blood pressure difference in arms ≥ 20 mm Hg	+1
ADDITIONAL IMAGING CRITERIA	
Number of affected arterial territories (select one)[5]	
One arterial territory	+1
Two arterial territories	+2
Three or more arterial territories	+3
Symmetric involvement of paired arteries[6]	+1
Abdominal aorta involvement with renal or mesenteric involvement[7]	+3

@SVM_tweets vascularmed.org @VascularMed

10



(Mason, 2010)
(Dasselli, et al., 2020)

11

SVM
Society for Vascular Medicine

Additional Management Considerations

- Blood pressure management: Always use the **HIGHEST** blood pressure
- Long-term effects of steroids:
  - Osteoporosis
  - Infections
  - Weight gain/metabolic syndrome
  - Gastritis
  - Psychiatric symptoms
- Pregnancy
- Medicine is a team sport…

@SVM_tweets vascularmed.org @VascularMed

12

Medicine is a team sport!

- Rheumatology
- Internal Medicine
- Cardiology
- Neurology
- Ophthalmology
- Vascular Medicine
- Vascular Surgery
- Dermatology
- Gynecology (high-risk OB)

@SVM_tweets vascularmed.org @VascularMed

13

Take Home Points

- Vasculitides have overlapping clinical features; making a diagnosis can be difficult!
- Evaluation includes history, physical exam, labs, vascular imaging (CTA, MRA, US), and sometimes biopsy (GCA).
- Steroids are generally the mainstay of treatment for LVV (significant side effects). Steroid-sparing agents are used as well. Surgical intervention sometimes needed.
- Take blood pressures in all 4 limbs; use **HIGHEST** reading and correlate with anatomy.
- The expertise of multiple specialties is often needed to care for these complex patients!

@SVM_tweets vascularmed.org @VascularMed

14

Thank you!

Alexandra Lauren Solomon, MD, RPVI
alsolomon181@gmail.com

@SVM_tweets vascularmed.org @VascularMed

15

SVM
Society for Vascular Medicine

References

- Chung JW, Kim HC, Choi YH, Kim SJ, Lee W, Park JH. Patterns of aortic involvement in Takayasu arteritis and its clinical implications: evaluation with spiral computed tomography angiography. J Vasc Surg. 2007 May;45(5):906-14. doi: 10.1016/j.jvs.2007.01.016. PMID: 17466787.
- Grayson PC, Ponte C, Suppiah R For the DCVAS Study Group, *et al.* 2022 American College of Rheumatology/EULAR classification criteria for Takayasu arteritis. *Annals of the Rheumatic Diseases* 2022;**81**:1654-1660.
- Jennette JC, Falk RJ, Bacon PA, et al. 2012 revised International Chapel Hill Consensus Conference Nomenclature of Vasculitides. Arthritis Rheum 2013; 65:1. Reproduced with permission from John Wiley & Sons, Inc. Copyright © 2013 by the American College of Rheumatology.
- Ponte C, Grayson PC, Robson JC For the DCVAS Study Group, *et al.* 2022 American College of Rheumatology/EULAR classification criteria for giant cell arteritis. *Annals of the Rheumatic Diseases* 2022;**81**:1647-1653.
- Qanadli SD, Sissakian JF, Rocha P, Piette AM, Lacombe P. Takayasu's arteritis : spiral CT angiography findings. Circulation. 2000 Jan 25;101(3):345-7. doi: 10.1161/01.cir.101.3.345. PMID: 10645933.
- Schäfer, V.S., Jin, L. & Schmidt, W.A. Imaging for Diagnosis, Monitoring, and Outcome Prediction of Large Vessel Vasculitides. Curr Rheumatol Rep 22, 76 (2020). https://doi.org/10.1007/s11926-020-00955-y
- UpToDate. (n.d.). https://www.uptodate.com/contents/overview-of-and-approach-to-the-vasculitides-in-adults?search=large+vessel+vasculitis&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1#H17

16

Fibromuscular Dysplasia

Bryan J Wells, MD, FACC, FSVM, FASE
Associate Professor of Medicine
Director of Vascular Medicine
Division of Cardiology
Emory University School of Medicine

1

Disclosures

- None

2

Objectives

- Identify under recognized vascular disorders
- Understand the evaluation and treatment of patients with known or suspected FMD/SCAD and other related arteriopathies
- Know the differential diagnosis for nonatherosclerotic vascular diseases

3

Case

- 43-year-old woman presents to clinic with severe HTN and headaches
- Past medical history significant for active smoking
- Family history of ? aneurysm in family
- Blood pressure remains >160's despite two medications

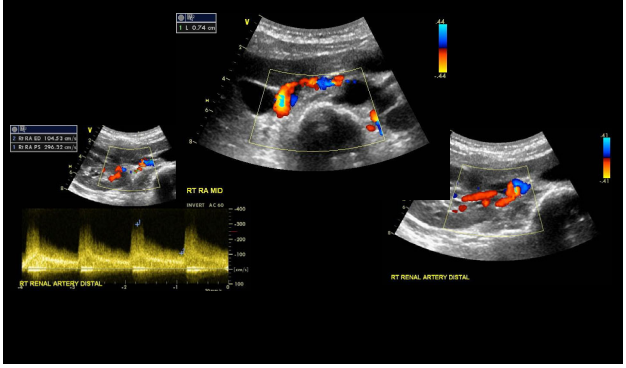
4

(continued)

- Referred to Emory vascular medicine for further evaluation
- Office blood pressure: 211/93 mmHg
- Renal duplex ultrasound was performed

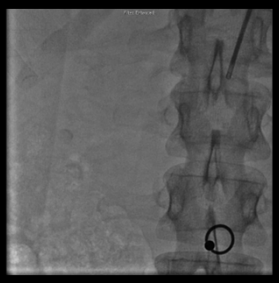
5

Renal duplex ultrasound



6

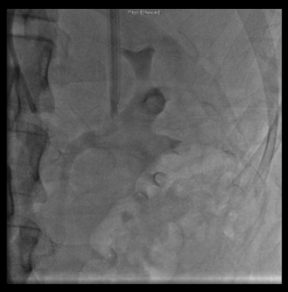
Right Renal Artery



Pd/Pa=0.51

7

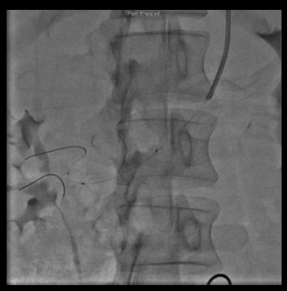
Left Renal Artery



Pd/Pa=0.92

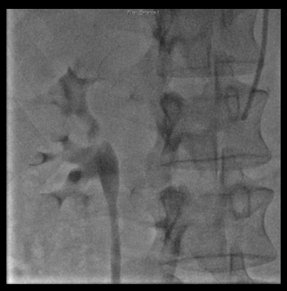
8

Right Renal Artery Angioplasty



9

Right Renal Artery Final Result



Pd/Pa=0.98

10

Clinical Follow-up

- Dramatic reduction in medication requirement
- Blood pressure stable on one medication
- Headaches resolved
- Follow-up renal duplex ultrasound demonstrates normal velocities

11

Fibromuscular dysplasia

- Nonatherosclerotic, noninflammatory disease
- Etiology is unknown, genetics unknown
- Causes stenosis, occlusion, aneurysm, dissection
- Most commonly involves renal and extracranial carotid arteries (65% of cases)
- More common in women and younger patients
- Average delay in first symptom to diagnosis of 4-9 years
- Hypertension, headache, pulsatile tinnitus

Olin, JW. *Circulation*, 2012.

12

Epidemiology

- The prevalence of FMD is unknown
- Renal FMD
  - 1% with autopsy data
  - 3-6% with angiographic data
- Carotid FMD
  - 4/20,244 in one autopsy series
  - 0.3-3.2% with angiographic data

Heffelfinger MK. *Am J Clin Pathol*, 1970.
Olin JW. *Circulation*, 2012.
Touze E. *Int J Stroke*, 2010.
Schievink WI. *N Engl J Med*, 2001.

13

Epidemiology

- The cause of FMD is unknown
- More common in women by a ratio of 9:1
- Dose dependent relationship with smoking
  - 30-37% of FMD patients are smokers
  - Compared with 18% of age/sex matched peers

Sang CN. *Hypertension*, 1989.
Savard S. *Hypertension*, 2013.

14

PHACTR1 and COL5A1 Variants

- *PHACTR1* rs9349379-A variant
  - Associated with cervical artery dissection (CeAD), hypertension, migraine headache, and FMD
  - First genetic susceptibility locus for FMD

PLOS Genet 2016; 12: e1006367

- *COL5A1* variant associated with an arteriopathy in 4 unrelated families
  - Associated with arterial aneurysms, dissections, tortuosity, and FMD

Arteriosclerosis, Thrombosis, and Vascular Biology. 2020;40:2686–2699

15

Classification of FMD

Table 1. Classification of Fibromuscular Dysplasia

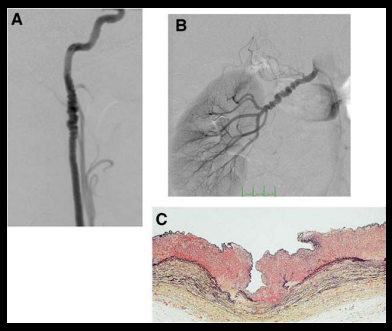
Histological	Angiographic	
Harrison and McCormack (1971)[13]	French/Belgian Consensus (2012)[2]	American Heart Association (2014)
Medial	Multifocal	Multifocal
Medial fibroplasia (60%–70%)		
Perimedial fibroplasia (15%–25%)		
Medial hyperplasia (5%–15%)		
Intimal fibroplasia (1%–2%)	Unifocal (<1 cm) Tubular (≥1 cm)	Focal*
Adventitial (<1%)		

*There may be multiple areas of focal disease (eg, renal artery and carotid artery in the same patient). Focal and multifocal disease can occur in the same patient.

Olin JW. *Circulation*, 2014.

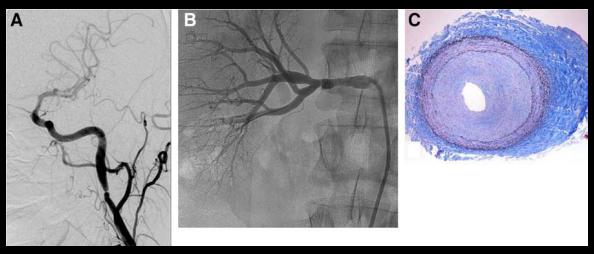
16

Multifocal FMD



17

Focal FMD



18

Presenting Signs and Symptoms from US FMD Registry (447 patients)

- Hypertension 285 (63.8)
- Headache 234 (52.4)
- Current headache 135 (30.2)
- History of headache 173 (38.7)
- Pulsatile tinnitus 123 (27.5)
- Dizziness 116 (26)
- Cervical bruit 99 (22.2)
- Neck pain 99 (22.2)
- Tinnitus 84 (18.8)
- Chest pain or shortness of breath 72 (16.1)
- Flank/abdominal pain 70 (15.7)
- Aneurysm 63 (14.1)
- Cervical dissection 54 (12.1)
- Epigastric bruit 42 (9.4)
- Hemispheric transient ischemic attack 39 (8.7)
- Postprandial abdominal pain 35 (7.8)
- Stroke 31 (6.9)
- Claudication 23 (5.2)
- Amaurosis fugax 23 (5.2)
- Weight loss 23 (5.2)
- Horner syndrome 21 (4.7)
- Renal artery dissection 14 (3.1)

Olin JW. *Circulation*, 2012.

19

Renal FMD presentation

- Most commonly presents with hypertension in a younger patient
  - Average age at presentation is 43 years
- Abdominal bruit is presenting sign in 9%
- Abdominal pain with renal artery dissection
- CKD and progression to ESRD is uncommon
- Headaches are common

Olin JW. *Circulation*, 2012.

20

Renal FMD diagnosis

- Renal duplex ultrasound
  - Vessel tortuosity, turbulent flow, and elevated velocities in the mid to distal renal arteries
  - Cannot see beading or quantify stenosis
- CTA
  - 100% correlation with angiogram in 1 study
  - May not see mild FMD or branch vessel FMD
- MRA
  - Good at detecting beading, less accurate with stenosis
  - Worse spatial resolution
  - Motion artifact
- Catheter angiography
  - Gold standard
  - <10 mmHg gradient is normal

Sabharwal R.*Eur J Radiol*, 2007.
Willoteaux S. *Radiology*, 2006.

21

Renal FMD revascularization

Indications

- Resistant hypertension
- Hypertension of short duration
- Renal artery dissection
- Renal artery aneurysm
- Branch renal artery disease and hypertension
- Preservation of renal function

Modality

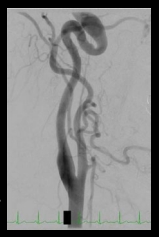
- PTA
  - Avoid stent
  - Approximately 50% cure, 30% improved, 10-20% not improved
- Surgery
  - Small arteries, branch disease, aneurysms
  - Bypass with reversed SVG
  - 30-70% cure rate

Olin JW. *Circulation*, 2014.

22

Carotid FMD presentation

- Bruit (22%), headache (60%), pulsatile tinnitus (presenting symptom in 37%), neck pain, dizziness
- TIA (13%), cervical artery dissection (12%), stroke (10%)
  - Stenosis, embolization, thrombosis, dissection, aneurysm
- Cerebral, carotid, vertebral and basilar aneurysms present in 7-10%
  - Intracranial hemorrhage in 1%



Olin JW. *Circulation*, 2012.

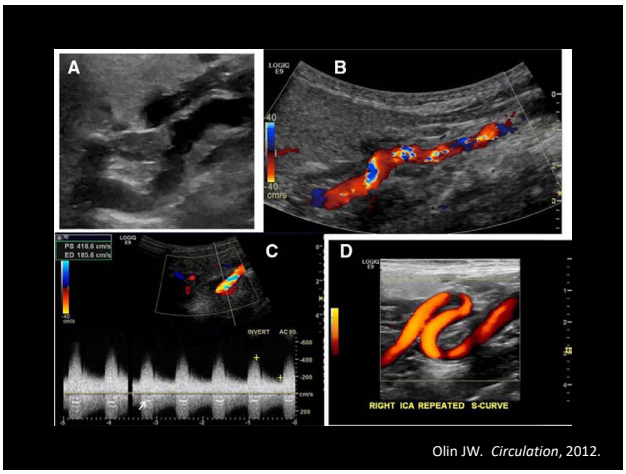
23

Carotid FMD carotid duplex

- Diagnosis
  - Vessel tortuosity, turbulent flow, and elevated velocities in the mid to distal carotid arteries
  - "S curve", marked tortuosity and elongation of vessels in 34% of FMD patients versus 3% general population
  - Older patients may have both atherosclerosis and FMD
  - No data on diagnostic accuracy
  - No velocity criteria for stenosis
- Surveillance
  - Duplex annually when stable (class 2a)
  - Medial FMD generally not progressive

Sethi S. *J Am Coll Cardiol*, 2012.
Brott TG. *Circulation*, 2011.

24

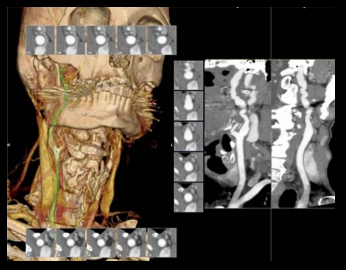


Olin JW. *Circulation*, 2012.

25

Carotid FMD CTA

- Image extracranial and intracranial vessels
- Accurately identify FMD, dissections, aneurysms (>3mm), atherosclerosis
- Difficult to quantify stenosis in beading segments
- Invasive angiogram reserved for intervention/diagnostic uncertainty

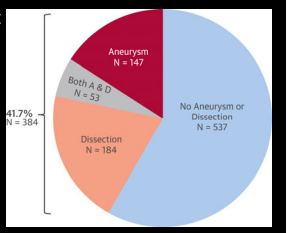


Donmez H. *Eur J Radiol*, 2011.

26

FMD and Aneurysms

- **21.6%** of US Registrants have at least 1 aortic or arterial aneurysm
  - Renal artery 32.1%
  - EC carotid 27.9%
  - Mesenteric/Celiac 16.4%
  - Aorta 12.1%
  - Cerebral 12.1%
  - Vert/basilar 11.4%
- 20-40% will have aneurysm and/or dissection
- One time brain to pelvis cross sectional imaging for *all* FMD patients is recommended



J Am Coll Cardiol. 2016 Jul 12;68(2):176-85.

27

FMD Management

- Avoid neck manipulation and heavy lifting
- Avoid tobacco, hormones, and stimulants
- No data or statins or OCPs
- Antiplatelet therapy
- Anti-hypertensives if needed
- Revascularization when necessary, typically not needed
- CTA/MRA brain to pelvis to evaluate for occult FMD, aneurysm, dissection
- Patients diagnosed as having FMD at an older age have a more benign disease process and less severe symptoms

JAMA Cardiol. 2018 Aug; 3(8): 756–760. Olin JW. *Circulation*, 2012.

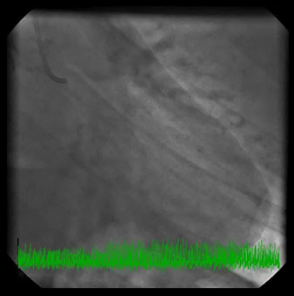
28

Case

- 42-year-old woman with no medical history notes new chest pain for 2-3 days
- She presented to the ED where abnormal troponins prompt urgent heart catheterization
- She denies any known family hx of heart disease, smoking history, oral contraceptives
- Pregnancy test negative

29

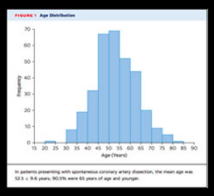
Left coronary angiography



30

Spontaneous Coronary Artery Dissection

- Nontraumatic/non-iatrogenic
- Estimated prevalence:
  - Autopsy 0.4%
  - Coronary angiography 0.2%-1.1%
  - ACS 0.1%-4%
- Average age 43 to 53 years
- Female
- Most common cause of pregnancy associated MI
- Recurrence 20-25% at 5 years



Circ J. 2014 Aug 25;78(9):2099-110. E2014
J Am Coll Cardiol. 2017 Aug 29;70(9):1148-1158.

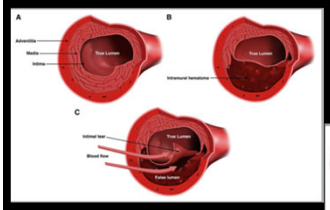
31

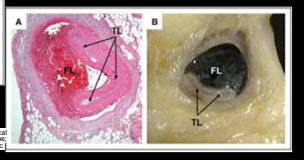
SCAD Pathophysiology

"Inside out" hypothesis
(intimal tear → blood enters sub-intimal space from true lumen → generates false lumen)

vs.

"Outside in" hypothesis
(spontaneous hematoma forms from vasa vasorum within vessel wall)





Hayes SN, et al; American Heart Association Council on Peripheral Vascular Disease; Council on Clinical Cardiology; Council on Cardiovascular and Stroke Nursing; Council on Genomic and Precision Medicine; and Stroke Council. Spontaneous Coronary Artery Dissection: Current State of the Science: A Scientific Statement From the American Heart Association. Circulation. 2018 May 8;137(19):e523-e557.

32

SCAD Precipitating Factors

Precipitating factors	>50% Patients recall a precipitating factor[1]
Intense exercise (isometric or aerobic)	
Intense Valsalva	
Retching, vomiting, bowel movement, coughing, lifting heavy objects	
Intense emotional stress	
Labor and delivery	
Recreational drugs (cocaine, methamphetamines)	
Exogenous hormones/hormone modulators	
β-hCG injections, corticosteroid injections, clomiphene	

Table 4 Precipitating stressors and potential predisposing conditions

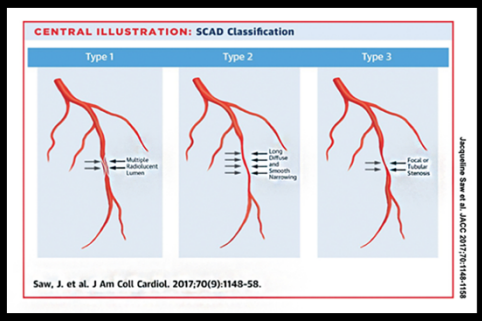
N (%)	N = 750
Precipitating stressors	
Emotional stress (rated high or severe)	377 (50.3)
Perceived stress scale ≥20	288 (41.2)
Unusually intense physical stress	216 (28.9)
Isometric stress >50 lb	74 (9.8)
Cocaine/amphetamine use	2 (0.3)
Valsalva-type stress	90 (12.0)
No precipitating factor	252 (33.6)

Hayes SN, et al; American Heart Association Council on Peripheral Vascular Disease; Council on Clinical Cardiology; Council on Cardiovascular and Stroke Nursing; Council on Genomic and Precision Medicine; and Stroke Council. Spontaneous Coronary Artery Dissection: Current State of the Science: A Scientific Statement From the American Heart Association. Circulation. 2018 May 8;137(19):e523-e557.

Saw J, et al. Canadian spontaneous coronary artery dissection cohort study: in-hospital and 30-day outcomes. Eur Heart J. 2019 Apr 14;40(15):1188-1197.

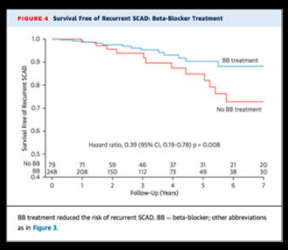
33

SCAD Classification



34

Acute SCAD Management



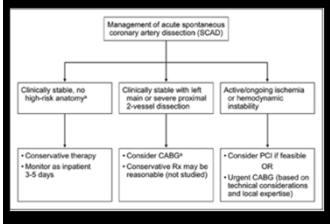
Heparin and DAPT: reduces thrombus burden vs theoretical risk of bleeding and intramural hematoma

Beta blockers – likely decreases risk of SCAD recurrence

Saw J, Humphries K, Aymong E, Sedlak T, Prakash R, Starovoytov A, Mancini GBJ. Spontaneous Coronary Artery Dissection: Clinical Outcomes and Risk of Recurrence. J Am Coll Cardiol. 2017 Aug 29;70(9):1148-1158.

35

Acute SCAD Management



"Healing" of SCAD lesions in 70-97% patients managed conservatively - within 1 month of index event

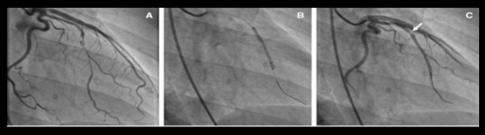
Prolonged in hospital monitoring (3-5 days) to observe for early dissection extension or new recurrent SCAD (in 5-10%)

Hayes SN, et al; American Heart Association Council on Peripheral Vascular Disease; Council on Clinical Cardiology; Council on Cardiovascular and Stroke Nursing; Council on Genomic and Precision Medicine; and Stroke Council. Spontaneous Coronary Artery Dissection: Current State of the Science: A Scientific Statement From the American Heart Association. Circulation. 2018 May 8;137(19):e523-e557.

36

SCAD Revascularization

- Catheter based angioplasty/stenting carries high risk of complications
  - 36% technical failure (including residual stenosis)
  - Iatrogenic dissection
  - False lumen propagation
  - Stent strut mal-apposition
  - 6% stent thrombosis
- 12% emergency CABG (high risk of graft failure)
- May be necessary for ongoing ischemia



Saw J, et al. Spontaneous coronary artery dissection: association with predisposing arteriopathies and precipitating stressors and cardiovascular outcomes.**Circ Cardiovasc Interv**. 2014.

Adlam D, Alfonso F, Maas A, Vrints C; Writing Committee. European Society of Cardiology, acute cardiovascular care association. SCAD study group: a position paper on spontaneous coronary artery dissection. Heart J. 2018 Sep 21;39(36):3353-3368.

37

Outpatient Management after SCAD

- Aspirin
- Beta blocker, HR 0.36
- Cardiac rehab, target HR ~70% max HR
- Lift less than 30 pounds
- Avoid isometrics / Valsalva
- Avoid stimulants, exogenous hormones
- Counseling about pregnancy / contraception
- CTA/MRA brain to pelvis
- Vasodilators for angina

J Am Coll Cardiol. 2017;70(9):1148.

38

Spontaneous Coronary Artery Dissection: Prevalence of Predisposing Conditions Including Fibromuscular Dysplasia in a Tertiary Center Cohort

J Am Coll Cardiol Intv. 2013;6(1):44-52. doi:10.1016/j.jcin.2012.08.017

FMD in ≥1 noncoronary territories	86.0% (43)
FMD in ≥2 noncoronary territories	42.0% (21)
FMD not observed	14.0% (7)
Incomplete screening	10.0% (5)
Screened cerebral, renal, iliac	4.0% (2)
FMD vascular involvement (n = 43)	
Renal arteries	58.1% (25)
Iliac arteries	48.8% (21)
Cerebrovasculature	46.5% (19)
Cerebral aneurysm	16.3% (7)

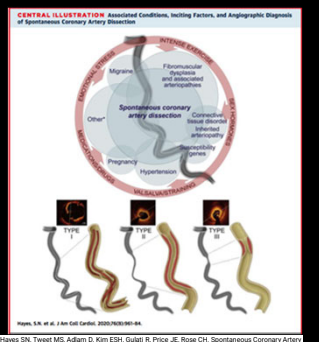
Involvement With Noncoronary FMD Among These Patients With SCAD (N = 50)

39

SCAD Associated conditions

Table 2. Conditions and Factors Associated With SCAD

Associated Condition or Factor	Reported Prevalence in Cohort Studies, %
Fibromuscular dysplasia	25–86[1,4,9,11,14]
Pregnancy	2–8[4,9,13,15]
Multiparity (≥4 births)	8.9–10[13,15]
Inherited arteriopathy and connective tissue disorder (see Table 4)	1.2–3.0[9,13]
Marfan syndrome, Loeys-Dietz syndrome, vascular Ehlers-Danlos syndrome, α-1-antitrypsin deficiency, polycystic kidney disease	
Exogenous hormones	10.7–12.6[9,15]
Oral contraceptives, postmenopausal therapy, infertility treatments, testosterone, corticosteroids	
Systemic inflammatory disease	<1–8.9[9,13]
Systemic lupus erythematosus, Crohn disease, ulcerative colitis, polyarteritis nodosa, sarcoidosis, Churg-Strauss syndrome, Wegener granulomatosis, rheumatoid arthritis, Kawasaki disease, celiac disease	
Migraine headache	NR
Coronary artery spasm	NR



Hayes SN, Tweet MS, Adlam D, Kim ESH, Gulati R, Price JE, Rose CH. Spontaneous Coronary Artery Dissection: JACC State-of-the-Art Review. J Am Coll Cardiol 2020 Aug 25;76(8):961-984

40

Thank you

- bjwells@emory.edu
- 404-686-8203

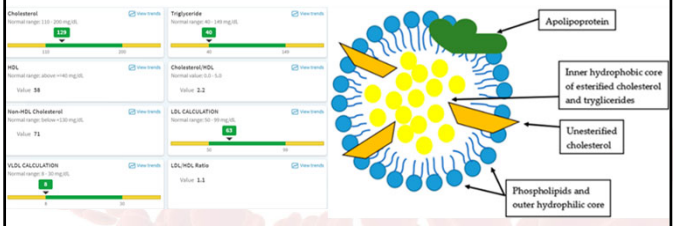
41

Lipid Management: Biomarkers & More

Merry Ellen Barnett, MD
2024 SVM Fellows/APP Course
University of Virginia
3/17/2024

1

Traditional Lipid Biomarkers



2

Traditional Lipid Biomarkers

- **LDL-c** is primary lipid target

Formula for LDL-C calculation	*r*	Reference
LDL-Cal = TC – HDL-C –TG/5	0.954	Friedewald et al. (1972)
LDL-Cal = 0.9TC – 0.9TG/5 - 28	0.898	Anandaraja et al. (2005)
LDL-Cal = TC – HDL-C –TG/6	0.970	Puavilai et al. (2009)
LDL-Cal = 90 %Non-HDL-C – 10 %TG	0.824	Chen et al. (2010)
LDL-Cal = TC – HDL-C – TG/3	0.954	Vujovic et al. (2010)
LDL-Cal = ¾(TC – HDL-C)	0.785	de Cordova and de Cordova (2013)

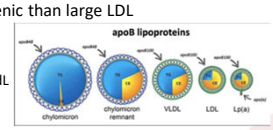
3

SVM Society for Vascular Medicine

Grundy et al. *Circ.* 2019;139:e1082-e1143.
Mocnik *Int J Mol Sci.* 2023; 24(3):2237.
Feingold. *Endotext.* 2023;3:2000.
Dansethakul. *Excli* 2015; 14:478-483.

New Lipid Biomarkers

- **LDL size** - small, dense LDL is more proatherogenic than large LDL
- **Apolipoprotein B - apo B**
  - Likely a better predictor of ASCVD
  - Consider measuring if TG > 200
  - Level > 130 mg/dL corresponds to LDL-C > 160 mg/dL
  - Carries extra expense, not always reliable
- **Lipoprotein (a) - Lp(a)**
  - Consider if unexplained prematures ASCVD, fam hx prematures ASCVD
  - Lp(a) > 50 mg/dL or > 125 nmol/L is considered risk enhancing
- **LDL Particle Number**



4

SVM Society for Vascular Medicine

Grundy et al. *Circ.* 2019;139:e1082-e1143.
Jones et al. *J Am Coll Cardiol.* 2022;80(14):1366-1418.

Statin Adjuncts

- Ezetimibe - 10 mg po daily
- MOA: inhibits NPC1L1 protein & reduces cholesterol absorption in small intestine
- Trials: IMPROVE-IT & SHARP

5

SVM Society for Vascular Medicine

Grundy et al. *Circ.* 2019;139:e1082-e1143.
Jones et al. *J Am Coll Cardiol.* 2022;80(14):1366-1418.

Statin Adjuncts

- PCSK9i
  - Alirocumab - start 75 mg sq q14 days, can increase to 150 mg sq q14 days
  - Evolocumab - start 140 mg sq q14 days; can increase to 420 mg sq q14 days
- Trials: ODYSSEY, FOURIER

6

SVM Society for Vascular Medicine

Grundy et al. *Circ.* 2019;139:e1082-e1143.
Jones et al. *J Am Coll Cardiol.* 2022;80(14):1366-1418.

New Agents -

- Bempedoic Acid
- Inclisiran
- Evinacumab
- Lomitapide
- LDL apheresis

@SVM_tweets vascularmed.org @VascularMed

7

SVM Society for Vascular Medicine

Questions?

@SVM_tweets vascularmed.org @VascularMed

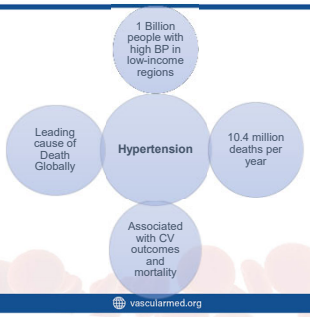
8

Hypertension Management
When the Basics Aren't Working

Ali Moran Baird, DNP, AGACNP
HCA Healthcare
Director of Cardiac and Vascular Service Line
Nashville, TN

1

Hypertension



2

Hypertension Definition(s)

Table 6. Categories of BP in Adults*

BP Category	SBP		DBP
Normal	<120 mm Hg	and	<80 mm Hg
Elevated	120–129 mm Hg	and	<80 mm Hg
Hypertension			
Stage 1	130–139 mm Hg	or	80–89 mm Hg
Stage 2	≥140 mm Hg	or	≥90 mm Hg

ACC/AHA Guideline for Prevention and Management of High Blood Pressure in Adults, 2017

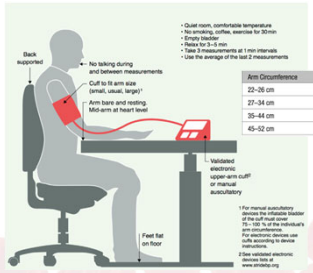
Table 2. Criteria for Hypertension Based on Office-, Ambulatory (ABPM)-, and Home Blood Pressure (HBPM) Measurement

	SBP/DBP, mm Hg
Office BP	≥140 and/or ≥90
ABPM	
24-h average	≥130 and/or ≥80
Day time (or awake) average	≥135 and/or ≥85
Night time (or asleep) average	≥120 and/or ≥70
HBPM	≥135 and/or ≥85

ISH Global Hypertension Guidelines, 2020

3

Accurate BP Measurement



Arm Circumference	Usual Cuff Size
22–26 cm	Small adult
27–34 cm	Adult
35–44 cm	Large adult
45–52 cm	Adult thigh

1 For manual auscultatory devices the inflatable bladder of the cuff must cover 75 – 100 % of the individual's mid-arm circumference. For electronic devices use cuffs according to device instructions.
2 See validated electronic devices lists at www.stridebp.org

ACC/AHA Guideline for Prevention and Management of High Blood Pressure in Adults, 2017 | ISH Global Hypertension Guidelines, 2020

@SVM_tweets | vascularmed.org | @VascularMed

4

Work-Up of Hypertension

- ❑Complete Medical, Family, Social, and Medication History
- ❑Assessment of CV risk
- ❑Signs and symptoms (blurred vision, palpitations, chest pain, edema)
- ❑Secondary HTN symptoms (snoring at night, headaches, muscle weakness/muscle cramps/arrythmias)
- ❑Physical Examination
- ❑Laboratory evaluation (CMP, lipid panel) & urinalysis
- ❑ECG

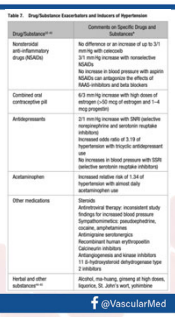


Table 7. Drug/Substance Exacerbators and Inducers of Hypertension

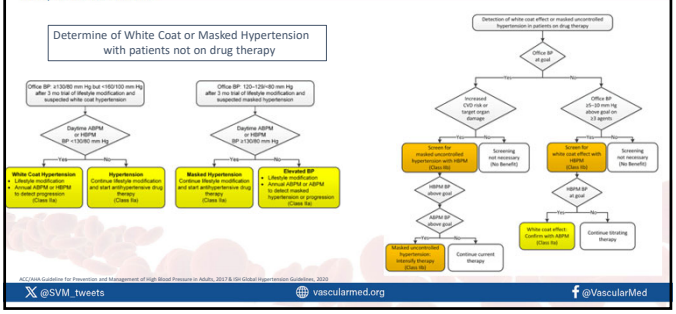
Drug/Substance[a–d]	Comments on Specific Drugs and Substances[a]
Nonsteroidal anti-inflammatory drugs (NSAIDs)	No difference or an increase of up to 3/1 mm Hg with celecoxib 3/1 mm Hg increase with nonselective NSAIDs No increase in blood pressure with aspirin NSAIDs can antagonize the effects of RAAS-inhibitors and beta blockers
Combined oral contraceptive pill	6/3 mm Hg increase with high doses of estrogen (>50 mcg of estrogen and 1–4 mcg progestin)
Antidepressants	2/1 mm Hg increase with SNRI (selective norepinephrine and serotonin reuptake inhibitors) Increased odds ratio of 3.19 of hypertension with tricyclic antidepressant use No increases in blood pressure with SSRI (selective serotonin reuptake inhibitors)
Acetaminophen	Increased relative risk of 1.34 of hypertension with almost daily acetaminophen use
Other medications	Steroids Adrenoceral therapy: inconsistent study findings for increased blood pressure Sympathomimetics: pseudoephedrine, cocaine, amphetamines Antineoplasm serotonergics Recombinant human erythropoietin Calcineurin inhibitors Antiangiogenesis and kinase inhibitors 11 ß-hydroxysteroid dehydrogenase type 2 inhibitors
Herbal and other substances[a–d]	Alcohol, ma-huang, ginseng at high doses, liquorice, St. John's wort, yohimbine

ACC/AHA Guideline for Prevention and Management of High Blood Pressure in Adults, 2017 & ISH Global Hypertension Guidelines, 2020

@SVM_tweets | vascularmed.org | @VascularMed

5

Hypertension: White Coat or Masked?



ACC/AHA Guideline for Prevention and Management of High Blood Pressure in Adults, 2017 & ISH Global Hypertension Guidelines, 2020

@SVM_tweets | vascularmed.org | @VascularMed

6

Causes of Hypertension

Environmental Risk Factors	Non Environmental Risk Factors
1. Sodium intake	1. Genetics
2. Sedentary lifestyle	
3. Alcohol	
4. Medications	

Screen for CVD Risk Factors

Recommendation for Coexistence of Hypertension and Related Chronic Conditions		
References that support the recommendation are summarized in Online Data Supplement 1.		
COR	LOE	Recommendation
I	B-NR	1. Screening for and management of other modifiable CVD risk factors are recommended in adults with hypertension.

Modifiable Risk Factors*	Relatively Fixed Risk Factors†
Current cigarette smoking, secondhand smoking	CKD
	Family history
Diabetes mellitus	Increased age
Dyslipidemia/hypercholesterolemia	Low socioeconomic/educational status
Overweight/obesity	Male sex
Physical inactivity/low fitness	Obstructive sleep apnea
Unhealthy diet	Psychosocial stress

ACC/AHA Guideline for Prevention and Management of High Blood Pressure in Adults, 2017 & ISH Global Hypertension Guidelines, 2020

@SVM_tweets vascularmed.org @VascularMed

7

Management of Hypertension: Lifestyle Modifications

Lifestyle Modifications

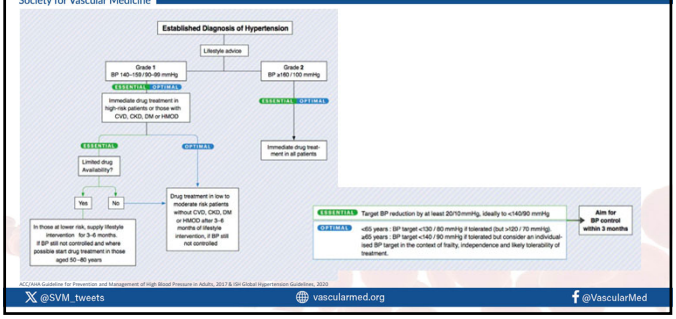
Salt reduction	There is strong evidence for a relationship between high salt intake and increased blood pressure.[4] Reduce salt added when preparing foods, and at the table. Avoid or limit consumption of high salt foods such as soy sauce, fast foods and processed food including breads and cereals high in salt.
Healthy diet	Eating a diet that is rich in whole grains, fruits, vegetables, polyunsaturated fats and dairy products and reducing food high in sugar, saturated fat and trans fats, such as the DASH diet (http://www.dashforhealth.com),[4] increase intake of vegetables high in nitrates known to reduce BP, such as leafy vegetables and beetroot. Other beneficial foods and nutrients include those high in magnesium, calcium and potassium such as avocados, nuts, seeds, legumes and tofu.[4]
Healthy drinks	Moderate consumption of coffee, green and black tea.[4] Other beverages that can be beneficial include karkadé (hibiscus) tea, pomegranate juice, beetroot juice and cocoa.[4]
Moderation of alcohol consumption	Positive linear association exists between alcohol consumption, blood pressure, the prevalence of hypertension, and CVD risk.[4] The recommended daily limit for alcohol consumptions is 2 standard drinks for men and 1.5 for women (10 g alcohol/standard drink). Avoid binge drinking.
Weight reduction	Body weight control is indicated to avoid obesity. Particularly abdominal obesity should be managed. Ethnic-specific cut-offs for BMI and waist circumference should be used.[4] Alternatively, a waist-to-height ratio <0.5 is recommended for all populations.[5,24]
Smoking cessation	Smoking is a major risk factor for CVD, COPD and cancer. Smoking cessation and referral to smoking cessation programs are advised.[4]
Regular physical activity	Studies suggest that regular aerobic and resistance exercise may be beneficial for both the prevention and treatment of hypertension.[4,25] Moderate intensity aerobic exercise (walking, jogging, cycling, yoga, or swimming) for 30 minutes on 5–7 days per week or HIIT (high intensity interval training) which involves alternating short bursts of intense activity with subsequent recovery periods of lighter activity. Strength training also can help reduce blood pressure. Performance of resistance/strength exercises on 2–3 days per week.
Reduce stress and induce mindfulness	Chronic stress has been associated to high blood pressure later in life.[4] Although more research is needed to determine the effects of chronic stress on blood pressure, randomized clinical trials examining the effects of transcendental meditation/mindfulness on blood pressure suggest that this practice lowers blood pressure.[26] Stress should be reduced and mindfulness or meditation introduced into the daily routine.
Complementary, alternative or traditional medicines	Large proportions of hypertensive patients use complementary, alternative or traditional medicines (in regions such as Africa and China)[27,28] yet large-scale and appropriate clinical trials are required to evaluate the efficacy and safety of these medicines. Thus, use of such treatment is not yet supported.
Reduce exposure to air pollution and cold temperature	Evidence from studies support a negative effect of air pollution on blood pressure in the long-term.[29,30]

ACC/AHA Guideline for Prevention and Management of High Blood Pressure in Adults, 2017 & ISH

@SVM_tweets vascularmed.org @VascularMed

8

Management of Hypertension: Pharmacological Treatment

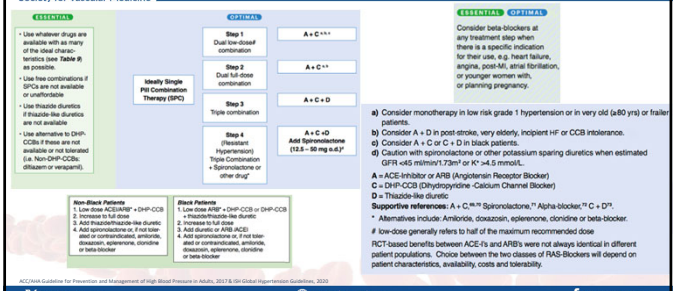


ACC/AHA Guideline for Prevention and Management of High Blood Pressure in Adults, 2017 & ISH Global Hypertension Guidelines, 2020

@SVM_tweets vascularmed.org @VascularMed

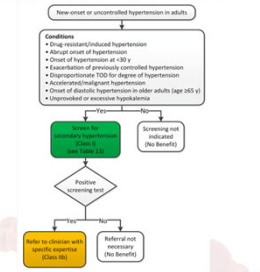
9

Management of Hypertension: Pharmacological Treatment



10

When the Basics Aren't Working….



Secondary Hypertension Causes

Common Causes	Uncommon Causes
Renal Artery Stenosis	Pheochromocytoma
Renal Parenchymal Disease (1-2%)	Cushing's Syndrome
Renovascular Disease (5-34%)	Thyroid Disease
Primary Aldosteronism (8-20%)	Aortic Coarctation
Obstructive Sleep Apnea (20-50%)	Congenital Adrenal Hyperplasia
Drug or Alcohol Induced (2-4%)	

ACC/AHA Guideline for Prevention and Management of High Blood Pressure in Adults, 2017 & ISH Global Hypertension Guidelines, 2020
@SVM_tweets
vascularmed.org
@VascularMed

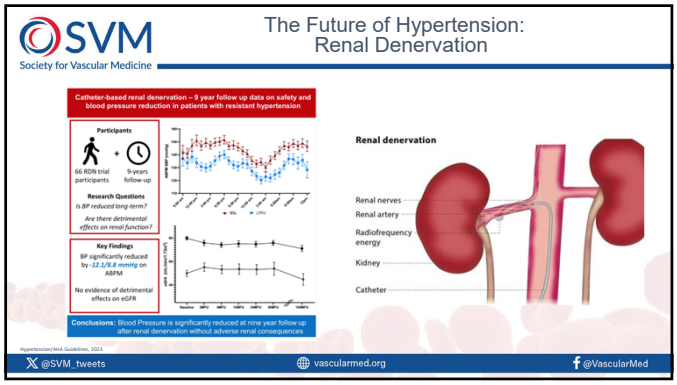
11

When the Basics Aren't Working….

- Once you get to this point, consider referral to Hypertension specialist
- Treat underlying primary condition for BP control

ACC/AHA Guideline for Prevention and Management of High Blood Pressure in Adults, 2017 & ISH Global Hypertension Guidelines, 2020
@SVM_tweets
vascularmed.org
@VascularMed

12


SVM
Society for Vascular Medicine
The Future of Hypertension:
Renal Denervation
Catheter-based renal denervation – 9 year follow up data on safety and blood pressure reduction in patients with resistant hypertension
Participants
66 RDN trial participants
9-years follow-up
Research Questions
Is BP reduced long-term?
Are there detrimental effects on renal function?
Key Findings
BP significantly reduced by -12.1/8.8 mmHg on ABPM
No evidence of detrimental effects on eGFR
Conclusions: Blood Pressure is significantly reduced at nine year follow up after renal denervation without adverse renal consequences
Hypertension/AHA Guidelines, 2023
Renal denervation
Renal nerves
Renal artery
Radiofrequency energy
Kidney
Catheter
@SVM_tweets
vascularmed.org
@VascularMed

13

PAD Non-pharmacological Therapies: Supervised Exercise Therapy

Diane Treat-Jacobson, PhD, RN, FAHA, MSVM
Professor, School of Nursing
University of Minnesota

1

Data related to access to SET in PAD are limited

- SET coverage by Medicare began in October of 2017
- Few programs existed prior to that coverage decision
- Objectives:
  - Describe the evidence we have about SET uptake thus far.
  - Discuss the Minnesota experience with developing SET for PAD in one health system
  - Discuss barriers and potential solutions

2

Current evidence for SET referral

- 1,735 (1.3%) of 129,699 patients diagnosed with claudication were referred for SET in the first year of Medicare coverage (June 2017-Dec, 2018)
- Median # sessions attended 16; 5.1% Completed 36 sessions (required within 12 weeks)
- Those enrolled more likely to be older, white, male, and not dually enrolled in Medicare/Medicaid
- Majority from the Midwest (48.1%) and Northeast (16.1%). Those from the South and Middle Atlantic areas were proportionately under-enrolled.

Divakaran, et al, Circ Cardiovasc Qual Outcomes, 2021

3

Structure of CMS-Reimbursed SET program

- Symptomatic PAD patients eligible
  - 36 sessions within 12 weeks
  - Patients can be referred for an additional 36 sessions if they continue to be symptomatic
  - 72 session lifetime cap
  - Asymptomatic patients (including post revascularization) are not eligible despite significant continued disability
  - Primary mode is treadmill walking but other modes are acceptable including total body recumbent stepping and aerobic arm or leg cycling

4

SET for PAD in Minnesota

- SET for symptomatic PAD has been available in the Twin Cities within the MHealth Fairview health system since 2013
- Prior to the Medicare coverage determination, SET occurred through a hybrid phase III cardiac rehabilitation Wellness and Exercise for Life programs across 7 hospitals in one health system
- Since October 2017 SET has been implemented through a stand-alone Medicare reimbursed SET program
- Early adoption allowed for the development of infrastructure to quickly launch the CMS-reimbursed program in 2017
  - This included creating a SET referral order in the EHR
  - Training cardiac rehabilitation therapists how to implement SET
  - Increasing provider awareness of program availability

5

Uptake and outcomes of supervised exercise therapy for peripheral artery disease: The importance of vascular medicine specialists at a large midwestern health care system during the first 5 years of CMS reimbursement

Mary O Whipple, Marsha A Burt, Aaron L Pergolski, Paige McArthur, Diane Treat-Jacobson, and Dereck L Salisbury;

VMJ, 2013

6

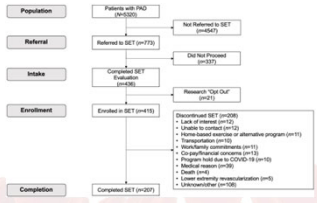
Structure of MN SET program

- Intake evaluation completed to obtain a medical history, set exercise goals, do treadmill familiarization to ensure safety and set initial speed and grade of exercise
- Outcome measures are not required by CMS but are recommended to document effectiveness of programs
- Evaluation is performed at initial evaluation and after completion of 12 weeks of therapy
  - 6-minute walk test (6MWT)
  - Timed up and go (TUG test)
  - Vascular Quality of Life Questionnaire (VASCUQOL-6)
  - Treadmill metabolic equivalent of task (MET) achieved during exercise using grade and speed initially and after 12 weeks

@SVM_tweets vascularmed.org @VascularMed

7

Outcomes for MHealth Fairview from 2017-2022



Whipple, et al, VMJ, 2023

@SVM_tweets vascularmed.org @VascularMed

8

Characteristics

Patients who completed an intake visit (n=415)

- White - 88%
- Male - 63%
- Mean ABI - 0.67
- Prior revascularization - 24%
- Ever smoker - 83%
- Diabetes – 44%
- Hypertension – 89%
- Dyslipidemia – 86%
- Coronary artery disease – 57%

Referring provider specialty

- Cardiology – 12%
- Vascular medicine – 31%
- Vascular Surgery/IR – 52%
- Other - 6%

@SVM_tweets vascularmed.org @VascularMed

9

Attendance

Supervised exercise therapy session attendance and adherence among all patients (N = 415) and those who completed the supervised exercise therapy (n = 207)

Characteristic	Overall (*N* = 415)			Completed SET (*n=207)*		
	Mean (SD)	Range	*n* (%)	Mean (SD)	Range	*n* (%)
No. of sessions completed	17.6 (11.3)	1–36		25.8 (7.4)	7–36	
Completed ≥ 24 sessions			136 (32.8)			125 (59.8)
Completed ≥ 30 sessions			87 (21.0)			82 (39.2)

10

Changes in physical function outcomes following 12 weeks of supervised exercise therapy (n = 207)

Characteristic	Mean (SD)		t value	p
	Baseline	12 Weeks		
Claudication onset distance, m (*n* = 167)	118.1 (73.8)	174.4 (83.3)	9.70	< 0.001
Claudication onset time, sec (*n* = 75)	127 (68)	172 (68)	5.02	< 0.001
Total distance, m (*n* = 204)	298.6 (99.3)	352.1 (91.8)	11.97	< 0.001
TUG, sec (*n* = 171)	9.1 (2.8)	8.6 (2.6)	−4.69	< 0.001
Treadmill METs (*n* = 184)	2.7 (0.9)	3.9 (1.5)	17.16	< 0.001
VascuQoL-6 (*n* = 112)	14.0 (3.3)	16.9 (3.1)	9.46	< 0.001

11

Takeaways from the MN experience

- Referral rates are quite low overall (14.5%), although higher than in the earlier national sample
- Enrollment of those referred was 56%
- Completion of those referred was 27%
- So, despite getting a 'head start', we still have much work to do.

12

Barriers to access and maximization of SET

- Provider factors:
  - Lack of awareness of this therapeutic option and of available programs
  - Lack of ease of referral
  - Need to change practice patterns
- Patient factors:
  - Work conflicts
  - Distance
  - $11.00 co-pay/session ($396 for 12 weeks)
  - Lack of understanding of etiology of PAD, preventing activity avoidance due to fear of pain.
  - Lack of access in underserved rural and urban communities

@SVM_tweets vascularmed.org @VascularMed

13

Barriers to access and maximization of SET

- System factors- Opportunities to influence policy
  - Slow development of new programs
  - Requirement to complete 36 sessions in 12 weeks – You do the math!
  - Exclusion of SET following revascularization despite robust evidence supporting benefit of combination therapy
  - Lack of mechanisms to track programs and referrals
  - No reimbursement for hybrid or community-based structured exercise programs

@SVM_tweets vascularmed.org @VascularMed

14

Addressing the barriers to access to SET programs

- Track and publicize available programs
- Improve awareness of program availability to providers and patients
- Adapt EHR to make referral to SET a therapeutic option – Make it easy for providers to prescribe
- Develop guidelines for hybrid models that combine some in-person sessions with remote coaching and monitoring using technology developed and refined over the past 2 years – Capitalize on our creative adaptation.
- Minimize the co-pay burden on our patients
- Model post-revascularization program options after cardiac rehabilitation programs.
- Get creative about how to offer SET in rural communities.

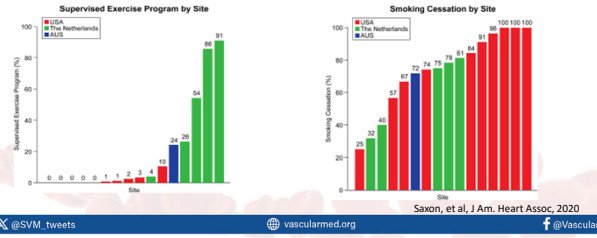
@SVM_tweets vascularmed.org @VascularMed

15

SVM
Society for Vascular Medicine

We can learn from the experience of other countries

PORTRAIT Registry: PAD Specialty Clinic Adherence to Guideline-Recommended Therapy



Saxon, et al, J Am. Heart Assoc, 2020

16

SVM
Society for Vascular Medicine

Thank you!

17

SVM
Society for Vascular Medicine

Post-thrombotic and Post-Intervention Imaging

Eri Fukaya MD, PhD
Vascular Medicine, Division of Vascular Surgery
Stanford University School of Medicine

@SVM_tweets vascularmed.org @VascularMed

1

Post Thrombotic Imaging

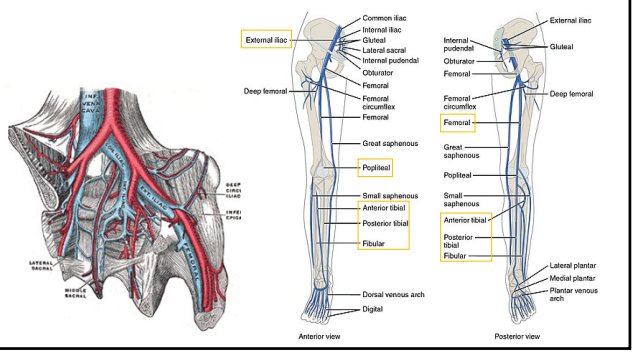
GOAL:

Detection of the anatomical cause of post thrombotic syndrome symptoms

Detect intravascular vs extravascular causes of PTS.

Detect the flow irregularity causing venous hypertension (reflux, stenosis, obstruction)

2



3

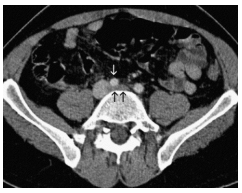
Case 1: 57F

CC: left leg swelling

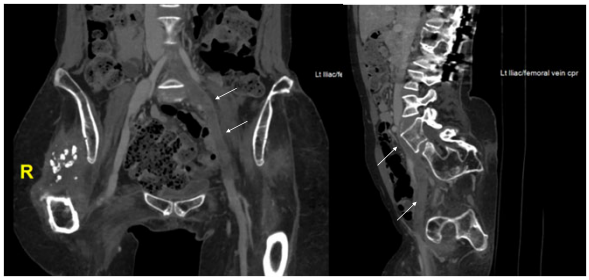
HPI: Developed leg swelling s/p 5 hrs sit ski.
Acute occlusive DVT in proximal left CIV, EIV, CFV and FV.
May Thurner Syndrome

PMH: T11 Paraplegia due to MVA (1992)
Breast cancer (2014)- no recurrence

FH: Father DVTx3



4

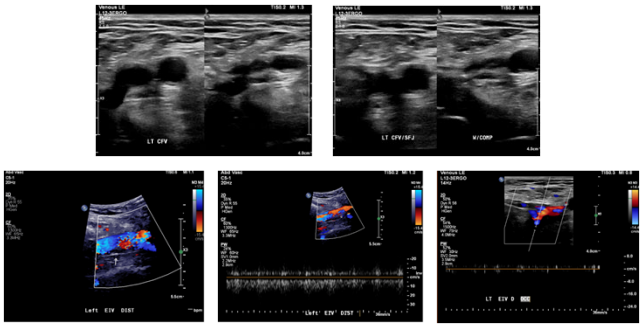


5

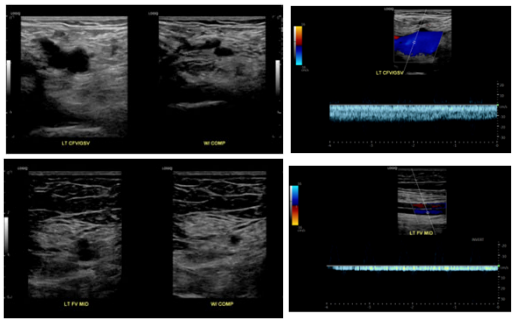
Case 1 (continued)

- Patient returns after 8 months.
- Completed anticoagulation with rivaroxaban 20mg daily.
- Swelling much improved.
- Wearing 30-40mmHg compression daily.
- *Chronic changes in CFV and EIV.*

6



7



8

Case 2: 60M

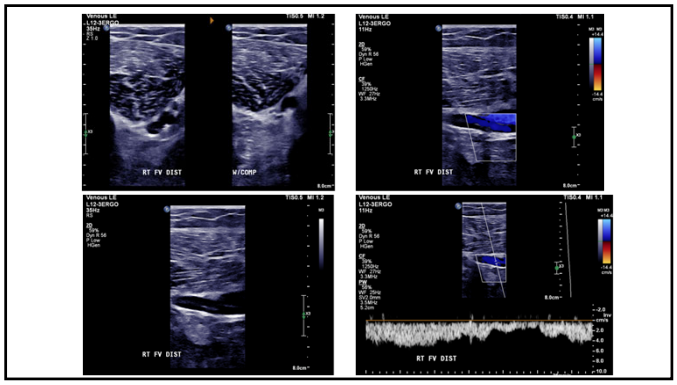
CC: consult regarding duration of anticoagulation therapy

HPI: 6/2018: Acute *PE* during Afghanistan convoy. Sitting in vehicle with heavy gear.
Completed 3 months of anticoagulation with rivaroxaban.
12/2019: Returned to Afghanistan. Developed right foot swelling.
Occlusive DVT in right POPV, PTV and peroneal V.
Non occlusive thrombus in right FV.
Currently taking rivaroxaban 20mg daily

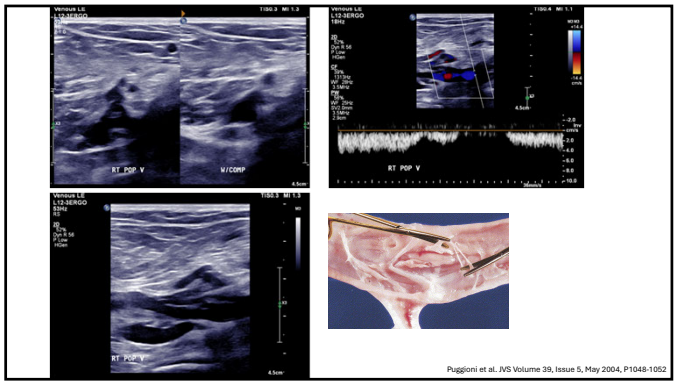
PMH: DVT, PE

FH: No VTE

9



10



11

Post Intervention Imaging

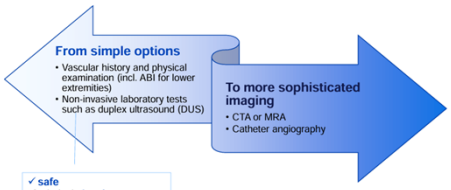
GOAL:

Detection of recurrent disease and other complications (stenosis, occlusion).

Detect significant problems at an early stage when they can be managed most safely and effectively, even before clinical signs and symptoms are evident.

12

Follow-up and surveillance methods



✓ **safe**
✓ relatively **low in cost**
✓ provide **objective** anatomic and physiologic information that can be used to **assess the durability of an intervention over time**

2018 SVS Practice Guidelines

13

Post Intervention Imaging

Open surgical and endovascular arterial revascularization procedures:

- extracranial carotid artery
- thoracic and abdominal aorta → *Christine Owen, ACNP*
- mesenteric and renal arteries
- lower extremity artery

14

Modes of Failure

- neointimal hyperplasia
- distal embolization
- graft thrombosis
- anatomic stenosis
- progressive atherosclerosis

15

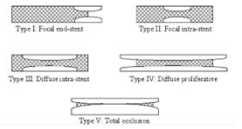
Extracranial Carotid Artery

Recommendation	Strength of recommendation	Quality of evidence
1. After CEA or CAS, we recommend surveillance with DUS at baseline and every 6 months for 2 years and annually thereafter until stable (i.e., until no restenosis or ISR is observed in 2 consecutive annual scans). The first or baseline DUS should occur soon after the procedure, preferably within 3 months, with the goal of establishing a post-treatment baseline. Considering the small risk of delayed restenosis or ISR, some interval of regular surveillance (e.g. every 2 years) should be maintained for the life of the patient.	1 (Strong)	B (Moderate)
2. For patients undergoing CAS with diabetes, aggressive patterns of ISR (Type IV), prior treatment for ISR, prior cervical radiation, or heavy calcification, in addition to the baseline DUS we recommend surveillance with DUS every 6 months until a stable clinical pattern is established and annually thereafter.	1 (Strong)	B (Moderate)
3. We recommend that DUS after CAS include at least the following assessments: A. Doppler measurement of PSV and EDV in the native CCA, in the proximal, mid, and distal stent, and in the distal native ICA. Modified threshold velocity criteria should be used to interpret the significance of these velocity measurements after CAS. B. B-mode imaging should be used to supplement and to enhance the accuracy of velocity criteria to estimate the severity of luminal narrowing.	1 (Strong)	C (Low)

2018 SVS Practice Guidelines

Mode of failure:
- Early: neointimal hyperplasia
- Late: progressive atherosclerosis

Incidence:
- CEA- 7.6% (3-18 months, >60%)
- CAS- 6.4 % (5 year, >80%)



Morphological patterns of in-stent stenosis

16

Mesenteric and Renal Arteries

Recommendation	Strength of recommendation	Quality of evidence
1. There are no prospective reports documenting the efficacy of a surveillance protocol after mesenteric artery stenting or bypass grafts; however, recurrent mesenteric ischemia is potentially life-threatening. Therefore, after mesenteric artery (celiac, superior mesenteric, and inferior mesenteric) angioplasty with or without stenting, or mesenteric artery bypass grafting, we recommend the following: A. Clinical follow-up and baseline DUS within 1 month of the procedure; B. Clinical follow-up and DUS at 6 months, 12 months, and then annually thereafter.	1 (Strong)	C (Low)
2. We suggest contrast imaging for patients with symptoms of recurrent mesenteric ischemia after mesenteric artery stents or bypass grafts, or for the following duplex findings: A. Celiac axis: PSV >370 cm/s or a substantial increase from the post-treatment baseline PSV (what constitutes a substantial increase has not been defined); B. Superior mesenteric artery: PSV >420 cm/s, or a substantial increase from the post-treatment baseline PSV (what constitutes a substantial increase has not been defined); C. Inferior mesenteric artery: Substantial increase from the post-treatment baseline PSV (what constitutes a substantial increase has not been defined).	2 (Weak)	C (Low)

Recommendation	Strength of recommendation	Quality of evidence
1. There are no prospective reports documenting the efficacy of a surveillance protocol after renal artery interventions. After renal artery angioplasty with or without stenting, or renal artery bypass or endarterectomy, we suggest the following: A. Clinical follow-up and baseline DUS within 1 month of the procedure; B. Clinical follow-up and DUS at 6 months, 12 months, and then annually thereafter.	2 (Weak)	C (Low)
2. We suggest contrast imaging for loss of renal parenchyma (a decrease in kidney length of >1 cm) or for the following duplex findings: A. Renal artery - PSV ≥280 cm/s, or a substantial increase from the post-treatment baseline PSV (what constitutes a substantial increase has not been defined); B. RAR of ≥4.5	2 (Weak)	B (Moderate)

2018 SVS Practice Guidelines

17

Lower Extremity Arteries (Open)

Recommendation	Strength of recommendation	Quality of evidence
1. We recommend clinical examination and ABI, with or without the addition of DUS, in the early postoperative period to provide a baseline for further follow-up after aortobifemoral bypass. This evaluation should be repeated at 6 and 12 months and then annually as long as there are no new signs or symptoms.	1 (Strong)	C (Low)
2. We recommend clinical examination and ABI, with or without the addition of DUS, in the early postoperative period to provide a baseline for further follow-up after iliofemoral bypass. This evaluation should be repeated at 6 and 12 months and then annually as long as there are no new signs or symptoms.	1 (Strong)	C (Low)
3. We recommend clinical examination and ABI, with or without the addition of DUS, in the early postoperative period to provide a baseline for further follow-up after femoral-femoral bypass. This evaluation should be repeated at 6 and 12 months and then annually as long as there are no new signs or symptoms.	1 (Strong)	C (Low)
4. We recommend clinical examination and ABI, with or without the addition of DUS, in the early postoperative period to provide a baseline for further follow-up after axillo-bifemoral bypass. This evaluation should be repeated at 6 and 12 months and then annually as long as there are no new signs or symptoms.	1 (Strong)	C (Low)

Recommendation	Strength of recommendation	Quality of evidence
5. Based on the high prevalence of abnormalities detected by DUS, as well as the relatively low associated cost and risks, we recommend clinical examination, ABI, and DUS for infrainguinal vein graft surveillance. This should include an early postoperative baseline evaluation and follow-up at 3, 6, and 12 months and at least annually thereafter. More frequent surveillance may be considered when uncorrected abnormalities are identified on DUS or when alternative vein conduits (other than great saphenous vein) are used.	1 (Strong)	B (Moderate)
6. After prosthetic infrainguinal bypass grafts we recommend clinical examination and ABI, with or without the addition of DUS, in the early postoperative period to provide a baseline for further follow-up. This evaluation should be repeated at 6 and 12 months and then annually as long as there are no new signs or symptoms.	1 (Strong)	B (Moderate)

2018 SVS Practice Guidelines

18

Lower Extremity Arteries (Endovascular)

Recommendation	Strength of recommendation	Quality of evidence
1. We recommend clinical examination, ABI, and DUS within the first month following aorto-iliac segment EVT to provide a post-treatment baseline and evaluate for residual stenosis. Clinical examination and ABI, with or without the addition of DUS, should be performed at 6 and 12 months and then annually as long as there are no new signs or symptoms.	1 (Strong)	C (Low)
2. We suggest clinical examination, ABI, and DUS within the first month following femoropopliteal artery EVT to provide a post-treatment baseline and evaluate for residual stenosis. Continued surveillance at 3 months and then every 6 months is indicated for the following: A. Patients with interventions utilizing stents, due to the potential increased difficulty of treating an occlusive versus stenotic in-stent lesion; B. Patients undergoing angioplasty or atherectomy for critical limb ischemia, due to increased risk of recurrent critical limb ischemia should the intervention fail.	2 (Weak)	C (Low)
3. We suggest clinical examination, ABI, and DUS within the first month following tibial artery EVT to provide a post-treatment baseline and evaluate for residual stenosis. Continued surveillance at 3 months and then every 6 months should be considered. Those patients with a deteriorating clinical vascular examination, return of rest pain, non-healing wounds, or new tissue loss, should undergo repeat DUS.	2 (Weak)	C (Low)

2018 SVS Practice Guidelines

19

Case 3: 78F

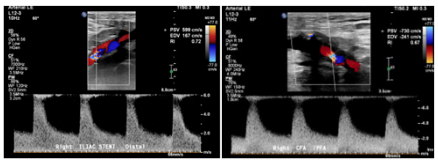
CC: Right foot gangrene

HPI: Polyvascular disease patient. DM, HTN, HL
6/2018: Right iliac stenting for peripheral artery disease
Lost to follow up fo 3 years.

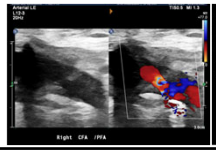
Presents to ER with right foot gangrene.

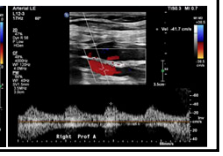
20

High grade in-stent restenosis of the RIGHT common and external iliac artery stents, common femoral endarterectomy site and proximal profunda.

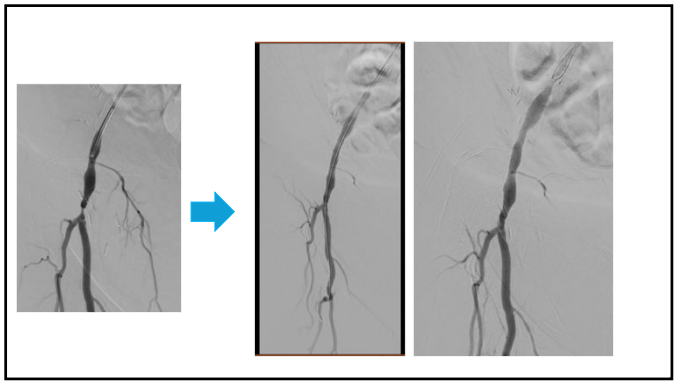


Distal iliac stent: 599cm/s within hyperplasia
PFA 730cm/s (prior 347cm/s)
PFA 42cm/s

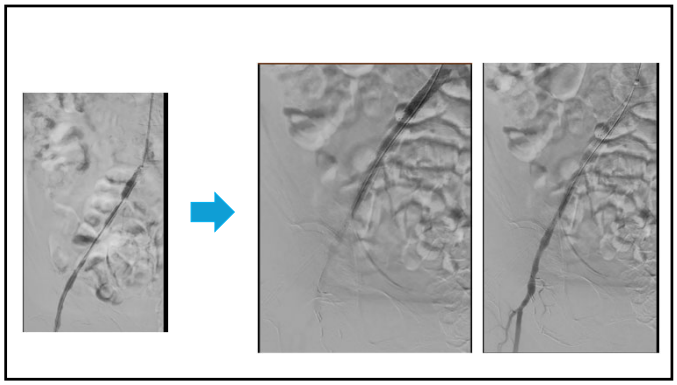




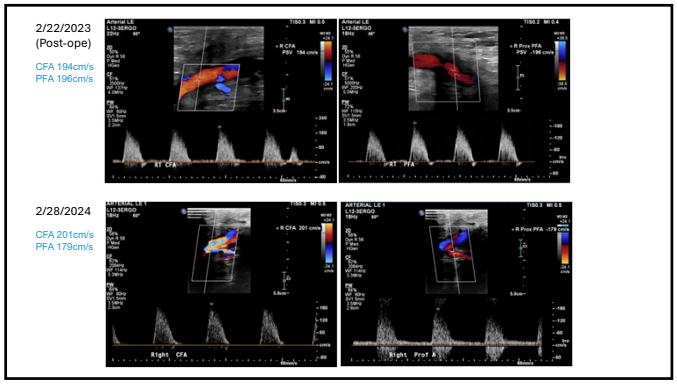
21



22



23

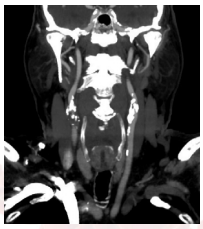

2/22/2023
(Post-ope)
CFA 194cm/s
PFA 196cm/s
2/28/2024
CFA 201cm/s
PFA 179cm/s

24

Thank you!

25

Asymptomatic High Grade Carotid Lesion



SVM APP Course – Imaging & Vascular Cases
March 17, 2024

Deborah Hornacek, MD, FSVM
Cleveland Clinic, Section of Vascular Medicine

1

Asymptomatic Carotid Stenosis

- "Asymptomatic": adults without history of ischemic stroke, transient ischemic attack, or neurologic signs
- Screening Guidelines for the asymptomatic patient -or- "No, No, and Sometimes Yes"
- Carotid duplex ultrasound assessment
- Deciding revascularization -> What is a high grade lesion, high risk features

2

2012 Choosing Wisely – "No"

AAFP

All Clinical Recommendations

Choosing Wisely®

Screening for Carotid Artery Stenosis in Asymptomatic Adult Patients

Recommendation

Don't screen for carotid artery stenosis (CAS) in asymptomatic adult patients.

- There is good evidence that for adult patients with no symptoms of carotid artery stenosis, the harms of screening outweigh the benefits.
- Screening could lead to non-indicated surgeries that result in serious harms, including death, stroke and myocardial infarction.

3

2021 USPSTF – "No"

Society for Vascular Medicine

U.S. Preventive Services Task Force – 40 Years of Improving Health

Recommendation Summary

Population	Recommendation	Grade
Asymptomatic adults	The USPSTF recommends against screening for asymptomatic carotid artery stenosis in the general adult population. See the Practice Considerations section for a description of adults at increased risk.	D

"Although screening for asymptomatic carotid artery stenosis is not recommended for the general adult population, several factors increase risk for carotid artery stenosis, including older age, male sex, hypertension, smoking, hypercholesterolemia, diabetes, and heart disease. However, there are no externally validated, reliable methods to determine who is at increased risk for carotid artery stenosis or who is at increased risk of stroke when carotid artery stenosis is present."

…More on that later…

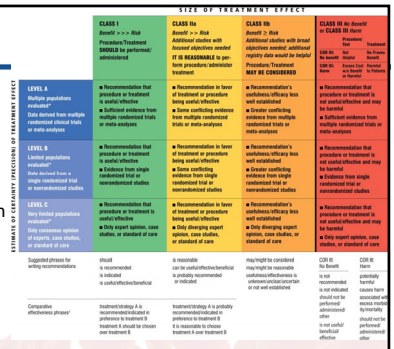
@SVM_tweets vascularmed.org @VascularMed

4

ACC AHA guidelines classification scheme

Society for Vascular Medicine

- Class: benefit > risk > harm
- Level: strength of data available, RCT>>expert opinion



@SVM_tweets vascularmed.org @VascularMed

5

2011 *Circulation* – "Sometimes Yes"

Society for Vascular Medicine

- Class IIa: It is reasonable to perform duplex ultrasonography to detect hemodynamically significant carotid stenosis in asymptomatic patients with carotid bruit. (Level of Evidence: C)
- Class IIb
  - Consider screening asymptomatic patients with **symptomatic peripheral arterial disease (PAD), coronary artery disease, or atherosclerotic aortic aneurysm**, but because such patients already have an indication for medical therapy to prevent ischemic symptoms, it is unclear whether establishing the additional diagnosis of ECVD in those without carotid bruit would justify actions that affect clinical outcomes. (Level of Evidence: C)
  - Consider screening asymptomatic patients without clinical evidence of atherosclerosis **who have 2 or more of the following risk factors: hypertension, hyperlipidemia, tobacco smoking, a family history in a first-degree relative of atherosclerosis manifested before age 60 years, or a family history of ischemic stroke**. However, it is unclear whether establishing a diagnosis of ECVD would justify actions that affect clinical outcomes. (Level of Evidence: C)
- Class III (No Benefit): Carotid duplex ultrasonography is not recommended for routine screening of asymptomatic patients who have no clinical manifestations of or risk factors for atherosclerosis. (Level of Evidence: C)

2011 ASA/ACCF/AHA/AANN/AANS/ACR/ASNR/CNS/SAIP/SCAI/SIR/SNIS/SVM/SVS Guideline on the Management of Patients With Extracranial Carotid and Vertebral Artery Disease: Executive Summary

Circulation. 2011;124:489–532

@SVM_tweets vascularmed.org @VascularMed

6

2011 *Circulation* – "Sometimes Yes"

- First line screening test: carotid duplex ultrasound (Class I, LOE: C)
- Note: auscultation for carotid bruit has poor sensitivity, not recommended as a screening exam (ie do not substitute for an ultrasound).

2011 ASA/ACCF/AHA/AANN/AANS/ACR/ASNR/CNS/SAIP/SCAI/SIR/SNIS/SVM/SVS Guideline on the Management of Patients With Extracranial Carotid and Vertebral Artery Disease: Executive Summary
Circulation. 2011;124:489–532

7

Ultrasound Basics: 4 Characteristics

- Grayscale visualization of lesion: does it look narrow? Can you see what is causing the flow disturbance?
- Color aliasing: loss of smooth laminar flow, creates speckling color that "wraps around" the color Doppler map
- Velocity elevations: going from an area of normal velocities to high
  - Velocity criteria: Society of Radiologists in Ultrasound (SRU) Consensus
- Turbulent waveforms: change from a normal Doppler waveform to abnormal "spikey" waveforms. Correlates with areas of elevated velocities.

- Note on types of arterial waveforms:
  - High resistive: little to no forward flow in diastole, normal for vessels supplying muscle tissue or the fasting gut
  - Low resistive: continuous flow through diastole, normal and essential for organs like the brain, kidneys, post-prandial gut

8

Determining Degree of Stenosis

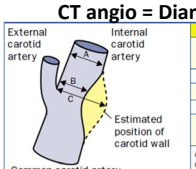
Ultrasound = Velocity Criteria

Degree of Stenosis, %	Primary Parameters: ICA PSV, cm/sec	Primary Parameters: Plaque Estimate, %*	Additional Parameters: ICA/CCA PSV Ratio	Additional Parameters: ICA EDV, cm/sec
Normal	<180	None	<2.0	<40
<50	<180	<50	<2.0	<40
50-69%**	180–230	>50	2.0–4.0	40–100
>70 but less than near occlusion	>230	>50	>4.0	>100
Near occlusion	High, low, or undetectable	Visible	Variable	Variable
Total occlusion	Undetectable	Visible, no detectable lumen	Not applicable	Not applicable

*Plaque estimate (diameter reduction) with grayscale and color Doppler US.
**PSV 125-188 cm/sec and ICA/CCA PSV Ratio ≥ 2.0 is also consistent with 50-69% stenosis
Modified from diagnostic criteria proposed by Society of Radiologists in Ultrasound (SRU) Consensus Conference[1]

SRU Consensus Conference criteria, update 11/2023

CT angio = Diameter



NASCET $\frac{A-B}{A}$ ECST $\frac{C-B}{C}$

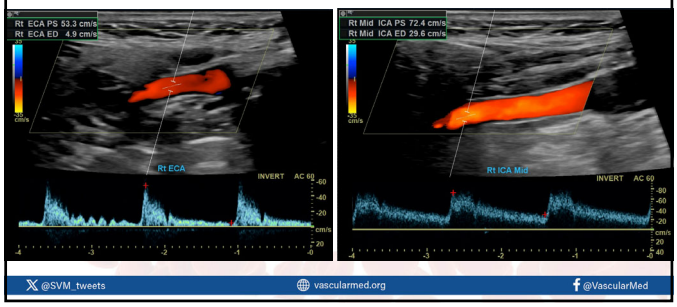
NASCET	ECST
30	65
40	70
50	75
60	80
70	85
80	91
90	97

Approximate equivalent degrees of internal carotid artery stenosis used in NASCET and ESCT according to recent direct comparisons

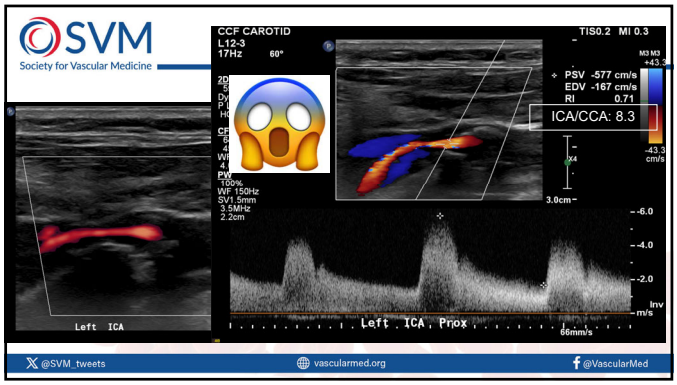
North American Symptomatic Carotid Endarterectomy Trial (NASCET) study group 1991

9

Duplex ultrasound: Normal Carotid



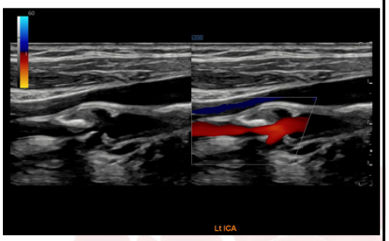
10



11

Plaque types

- Heterogenous: mixed fibrous, calcific and lipid-rich plaque
- Homogenous: echolucent, soft lipid-rich plaque, only a thin fibrous cap
- Ulcerated: eroded surface, luminal blood flow comes in contact with lipid core (shown)



12

Case 1: "Mr. T"

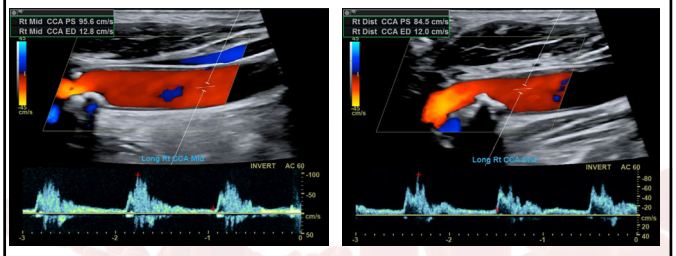
- 73yo M referred after routine eye doctor exam with right eye finding (shown).
- No change in visual acuity.

- PMHx: DM type 2 complicated by neuropathy and proteinuria, HTN, PAD, CKD 3b. Remote tobacco use.
- Normal exam. BP 126/78.
- A1c 7.2%, LDL 63 on atorvastatin 80mg, on aspirin 81mg and losartan 50mg.

@SVM_tweets vascularmed.org @VascularMed

13

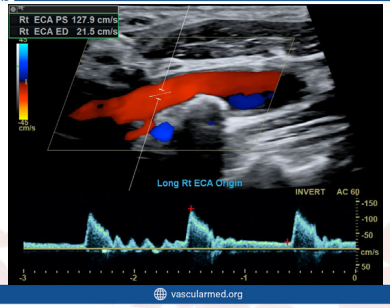
Right CCA



@SVM_tweets vascularmed.org @VascularMed

14

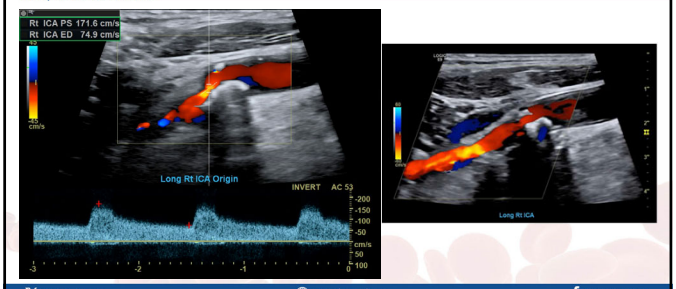
Right ECA



@SVM_tweets vascularmed.org @VascularMed

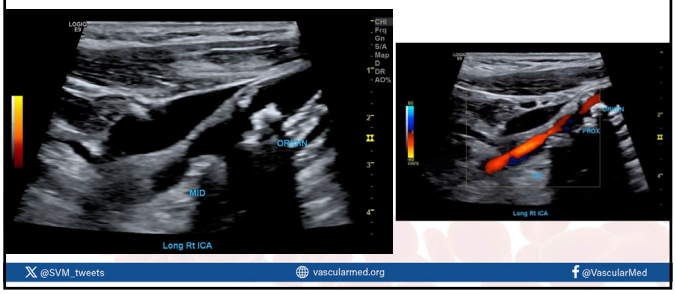
15

Right ICA



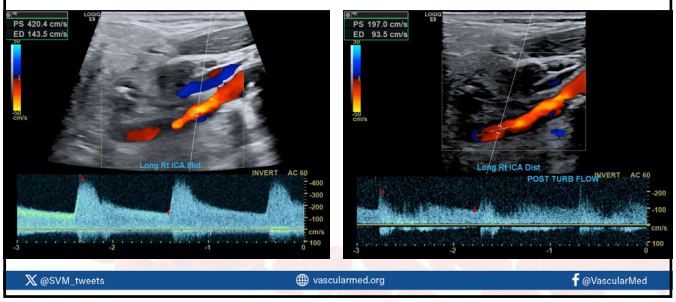
16

Right ICA



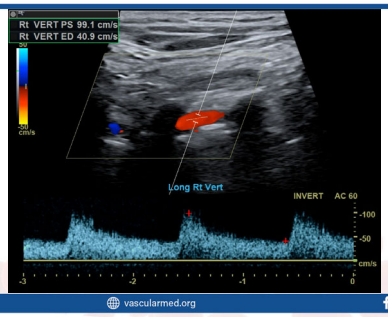
17

Right ICA



18

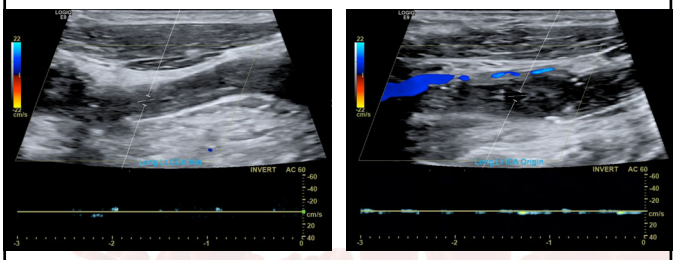
Right Vertebral Artery



@SVM_tweets vascularmed.org @VascularMed

19

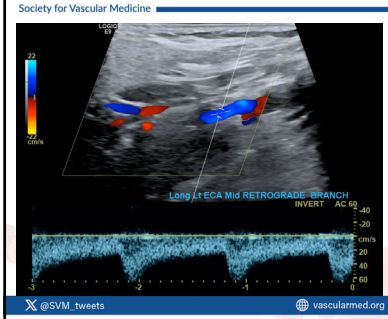
Left CCA and ICA



@SVM_tweets vascularmed.org @VascularMed

20

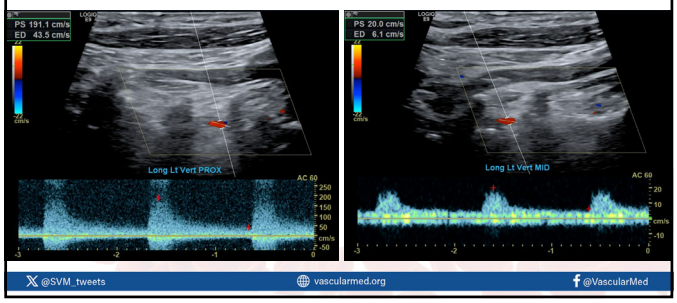
Left ECA



@SVM_tweets vascularmed.org @VascularMed

21

Left Vertebral Artery



@SVM_tweets vascularmed.org @VascularMed

22

Carotid Ultrasound: final report

- RIGHT SIDE
  Common carotid artery:
  Origin: PSV: 118 cm/s. EDV: 18 cm/s.
  Proximal: PSV: 142 cm/s. EDV: 12 cm/s.
  Mid: PSV: 96 cm/s. EDV: 13 cm/s.
  Distal: PSV: 85 cm/s. EDV: 12 cm/s.
  Moderate heterogeneous calcified plaque at dista

  Internal carotid artery:
  Origin: PSV: 172 cm/s. EDV: 75 cm/s.
  Proximal: PSV: 119 cm/s. EDV: 57 cm/s.
  Mid: PSV: 420 cm/s. EDV: 143 cm/s.
  Distal: PSV: 281 cm/s. EDV: 126 cm/s.
  Moderate heterogeneous irregular and calcified plaque from origin to proximal.
  Severe heterogeneous calcified plaque at mid.

  ICA/CCA Ratio: 5.0

  External carotid artery: PSV: 128 cm/s. EDV: 21 cm/s.

  Subclavian artery: PSV: 128 cm/s. EDV: 6 cm/s.
  Moderate heterogeneous calcified plaque from origin to proximal.

  Innominate artery: PSV: 132 cm/s. EDV: 0 cm/s.
  Moderate heterogeneous calcified plaque at dista

  Vertebral artery: PSV: 99 cm/s. EDV: 41 cm/s.

- LEFT SIDE
  Common carotid artery:
  Proximal: PSV: 0 cm/s. EDV: 0 cm/s.
  Mid: PSV: 0 cm/s. EDV: 0 cm/s.
  Distal: PSV: 0 cm/s. EDV: 0 cm/s.
  Severe heterogeneous plaque from proximal t distal.

  Internal carotid artery:
  Origin: PSV: 0 cm/s. EDV: 0 cm/s.
  Proximal: PSV: 0 cm/s. EDV: 0 cm/s.
  Mid: PSV: 0 cm/s. EDV: 0 cm/s.
  Distal: PSV: 0 cm/s. EDV: 0 cm/s.
  Severe heterogeneous plaque throughout.

  External carotid artery:
  Origin: PSV: 0 cm/s. EDV: 0 cm/s.
  Mid: PSV: 23 cm/s. EDV: 7 cm/s.
  Severe heterogeneous plaque from origin to proximal.

  Subclavian artery:
  Proximal: PSV: 96 cm/s. EDV: 0 cm/s.

  Vertebral artery:
  Proximal: PSV: 197 cm/s. EDV: 44 cm/s.
  Mid: PSV: 20 cm/s. EDV: 6 cm/s.

- IMPRESSION: Provider notified with results.

  RIGHT SIDE
  Common carotid artery: Plaque visualized without evidence of hemodynamically significant stenosis.

  Internal carotid artery: 80-99% stenosis.
  Lesion from origin to proximal : 1.88 cm.
  Tandem lesion at mid : 0.87 cm.
  80-99% stenosis noted mid vessel.

  Vertebral artery: Patent and antegrade flow noted.

  Innominate artery: Plaque visualized without evidence of hemodynamically significant stenosis.

  Subclavian artery: Plaque visualized without evidence of hemodynamically significant stenosis.

  LEFT SIDE
  Common carotid artery: Occluded.

  Internal carotid artery: Occluded.

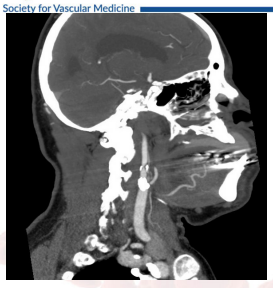
  External carotid artery: Occluded at origin, reconstituted at mid. Reconstituted via retrograde branch.

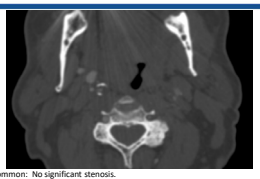
  Vertebral artery: Patent and antegrade flow, evidence of stenosis.

@SVM_tweets vascularmed.org @VascularMed

23

CTA head and neck



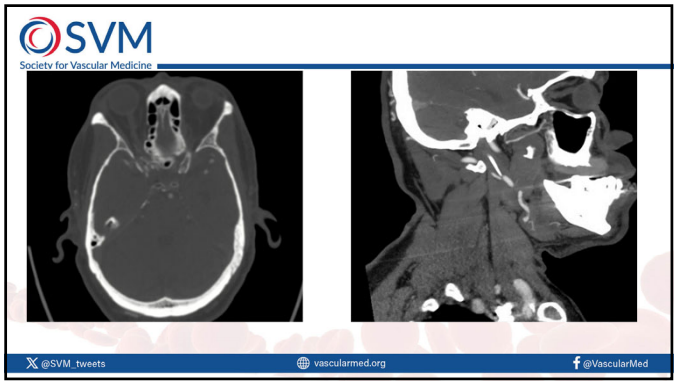


Right Common: No significant stenosis.
Right Internal Carotid: Significant calcified and noncalcified atherosclerotic plaques at the bifurcation causing tandem severe stenoses at the bifurcation and just distal to the bifurcation.
Right Internal Carotid Stenosis (% by NASCET Criteria): 80%

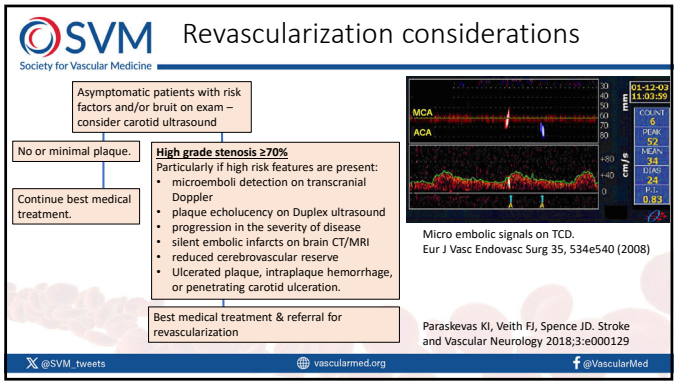
Left Common: Occluded just at the takeoff from the aortic arch.
Left Internal Carotid: Occluded.
Left Internal Carotid Stenosis (% by NASCET Criteria): 100%
Cervical Vertebral Arteries: Scattered calcified plaques along the course of the cervical right vertebral artery.
Patency: Bilateral
Dominance: Right. The left intracranial vertebral artery is markedly diminutive throughout its cervical course and intermittently poorly seen, most likely congenital/developmental.

@SVM_tweets vascularmed.org @VascularMed

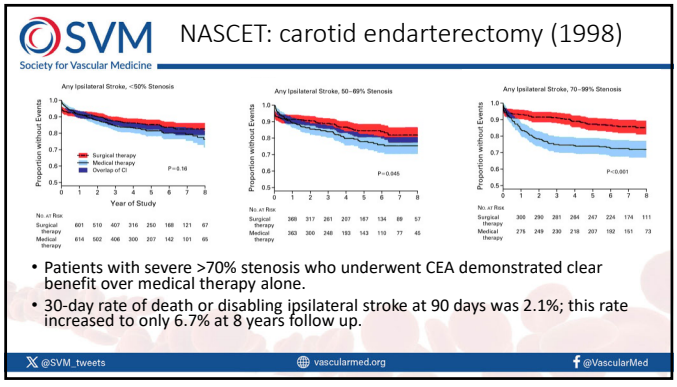
24


SVM
Society for Vascular Medicine
@SVM_tweets
vascularmed.org
@VascularMed

25

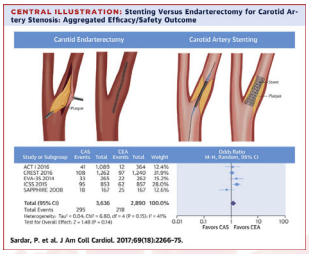

SVM
Society for Vascular Medicine
Revascularization considerations
Asymptomatic patients with risk factors and/or bruit on exam – consider carotid ultrasound
No or minimal plaque.
Continue best medical treatment.
High grade stenosis ≥70%
Particularly if high risk features are present:
• microemboli detection on transcranial Doppler
• plaque echolucency on Duplex ultrasound
• progression in the severity of disease
• silent embolic infarcts on brain CT/MRI
• reduced cerebrovascular reserve
• Ulcerated plaque, intraplaque hemorrhage, or penetrating carotid ulceration.
Best medical treatment & referral for revascularization
MCA
ACA
Micro embolic signals on TCD.
Eur J Vasc Endovasc Surg 35, 534e540 (2008)
Paraskevas KI, Veith FJ, Spence JD. Stroke and Vascular Neurology 2018;3:e000129
@SVM_tweets
vascularmed.org
@VascularMed

26


SVM
Society for Vascular Medicine
NASCET: carotid endarterectomy (1998)
Any Ipsilateral Stroke, <50% Stenosis
Any Ipsilateral Stroke, 50–69% Stenosis
Any Ipsilateral Stroke, 70–99% Stenosis
Proportion without Events
Year of Study
Surgical therapy
Medical therapy
Overlap of CI
P=0.16
P=0.045
P<0.001
• Patients with severe >70% stenosis who underwent CEA demonstrated clear benefit over medical therapy alone.
• 30-day rate of death or disabling ipsilateral stroke at 90 days was 2.1%; this rate increased to only 6.7% at 8 years follow up.
@SVM_tweets
vascularmed.org
@VascularMed

27

Carotid Endarterectomy vs Stent



Sardar, P. et al. J Am Coll Cardiol. 2017;69(18):2266-75.

@SVM_tweets vascularmed.org @VascularMed

28

Carotid Endarterectomy vs Stent

Carotid Artery Stenting (CAS) vs Carotid Endarterectomy (CEA)

Retrospective, single center study 1853 CEA, 478 CAS

CEA Symptomatic: 29.1%	Outcomes	CAS Symptomatic: 32.2%
	at 30 days	
1.1%	Stroke	1.3%
2.2%	Acute MI	1.7%
0.7%	Death	0.6%
	at 5.4 years	
6.8%	Stroke	7.7%
22.7%	Acute MI	21.0%
28.4%	Death	28.2%
	P = NS	

CONCLUSION

CEA and CAS can be performed with excellent outcomes by vascular surgeons at a large-volume hospital

JVS Journal of Vascular Surgery

Garvin et al. *J Vasc Surg October 2018*

@JVascSurg @TheJVascSurg

@SVM_tweets vascularmed.org @VascularMed

29

TCAR = the new kid on the block

Impact of Age on In-Hospital Outcomes After Transcarotid Artery Revascularization (TCAR), Transfemoral Carotid Artery Stenting (TFCAS) and Carotid Endarterectomy (CEA)

Retrospective non-randomized study using the Vascular Quality Initiative database

TCAR N=3152 VS:

CEA N=61,650

No significant difference in outcomes except:

- TCAR was associated with significant decrease in **cranial nerve injury**

TFCAS N=10,381

In patients ≥ 80 years, TCAR was associated with:

- 72% Reduction in **stroke risk**
- 65% Reduction in **risk of stroke/death**

JVS Journal of Vascular Surgery

Dakour-Aridi et al. *J Vasc Surg September 2020*

LinkedIn @TheJVascSurg @JVascSurg

@SVM_tweets vascularmed.org @VascularMed

30

Patient factors which favor CEA vs CAS

Table 2: Risk Factors to Consider When Choosing Procedures

High Risk for CEA		High Risk for CAS	
Surgical Anatomy	**Comorbidities**	**Vessel Anatomy**	**Plaque Characteristics**
Previous CEA or neck surgery	Severe CHF	Type II or III aortic arch	Lipid rich plaque
Presence of tracheostomy	Severe CAD	Aortic arch disease	Intraplaque haemorrhage
Previous radiation	Severe pulmonary disease	Tortuosity of ICA or CCA	Calcified plaque
Contralateral occlusion	Renal Failure	Occlusive disease of access vessels	Thin fibrous cap
Laryngeal nerve palsy			Lesion located at a curve
Lesion extending above C2 vertebra			Extensive plaque

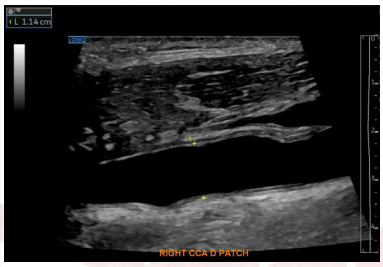
CAD = coronary artery disease; CAS = carotid artery stenting; CCA = common carotid artery; CEA = carotid endarterectomy; CHF = coronary heart failure; ICA = internal carotid artery.

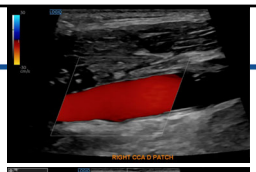
Vascular & Endovascular Review 2019;2(1):40–4

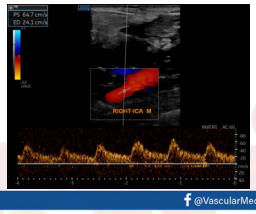
@SVM_tweets vascularmed.org @VascularMed

31

Mr. T: Post-CEA



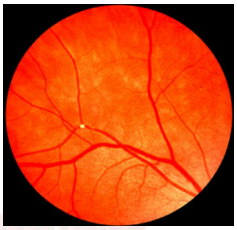


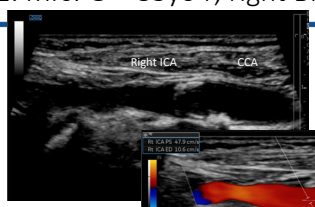


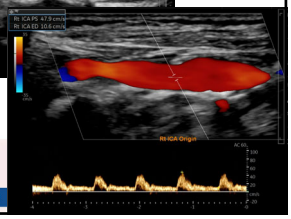
@SVM_tweets vascularmed.org @VascularMed

32

Case 2: Mrs. G – 83yo F, right BRAO





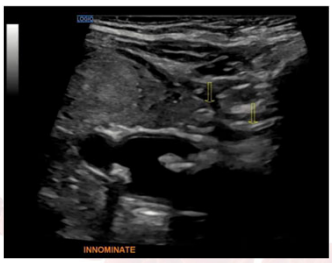


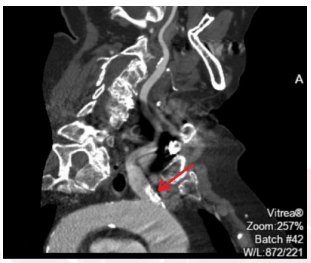
Hollenhorst plaque.
Image from JVS. 2007;46(6):1125-1129

@SVM_tweets vascularmed.org

33

Case 2: Mrs. G – 83yo F, right BRAO





@SVM_tweets vascularmed.org @VascularMed

34

SVM Society for Vascular Medicine

Resistant Hypertension

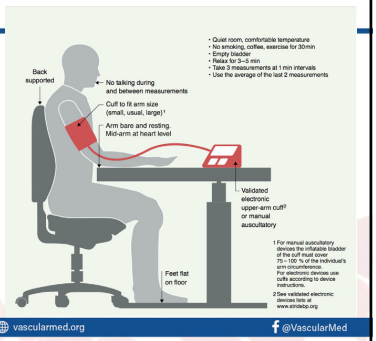
Daniella Kadian-Dodov, MD
Associate Professor of Medicine
Program Director, Vascular Medicine Fellowship
Mount Sinai Fuster Heart Hospital

1

SVM Society for Vascular Medicine

Principles of Accurate BP Measurement

- Bare arm at heart level
- Relax several minutes
- Accurate sized ARM cuff
- If elevated, measure twice and average

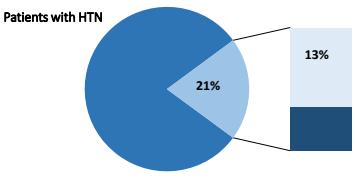


Hypertension 2020;75:1334-1357

2

SVM Society for Vascular Medicine

Resistant Hypertension



Blood pressure above goal (≥ 140/90 mm Hg) despite maximally tolerated 3 agents of differing mechanisms of action (including a diuretic)

OR patients requiring ≥ 4 agents regardless of level of control

10% may have *pseudoresistance:*

- Improper measurement, medication non-adherence, drug induced or secondary HTN

Hypertension 2018;72:e53-90
Hypertension 2020;75:1334-1357

3

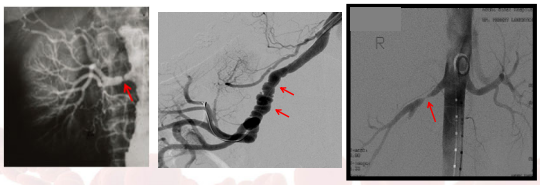
The Long Road to Diagnosis

1. **Confirm Treatment Resistance**
   - Uncontrolled BP despite 3 agents (including diuretic), or on ≥ 4 agents regardless of control
2. **Exclude Pseudoresistance**
   - Appropriate measurement (cuff size)
   - Medication non-adherence
   - White-Coat Effect
3. **Identify and Reverse Contributing Lifestyle Factors**
   - Salt intake, alcohol
   - Drugs: ephedrine, NSAIDs, OCPs, etc
4. **Screen for Secondary Causes of HTN**
   - OSA
   - Primary aldosteronism
   - Renal artery stenosis
   - Rare : pheochromocytoma, aortic coarctation, Cushing's, thyroid dysfunction

4

Renovascular Hypertension

- Most common cause of secondary HTN (2 – 5%)
- Renal artery stenosis causing activation of the RAAS system
- Most often due to (1) Atherosclerosis (2) Fibromuscular Dysplasia



5

When to Consider Renovascular HTN

- HTN onset < 30 years of age, or severe HTN > age 55 years
- Accelerated, resistant or malignant HTN
- Unexplained atrophy of the kidney or size discrepancy (> 1.5 cm difference)
- Unexplained renal dysfunction, including patients starting renal replacement therapy
- Multivessel coronary or peripheral artery disease
- Unexplained congestive heart failure or refractory angina
- Flash pulmonary edema
- Acute kidney failure with institution of ACEi/ARB
- Abdominal bruit

6

Guidelines for Renal Revascularization

Clinically, consider if renal artery stenosis > 70% (by visual assessment) and one of the following:

1. Resistant or uncontrolled hypertension
2. Acute renal failure with the addition of an ACE inhibitor or ARB
3. Recurrent flash pulmonary edema or CHF with no other identifiable cause
4. CKD with no other identifiable cause and a viable kidney (normal kidney size)

Favorable characteristics for revascularization:

- Absence of proteinuria
- Younger age

Hypertension 2022;79:e128-e143

@SVM_tweets vascularmed.org @VascularMed

7

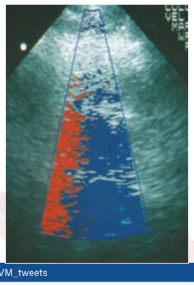
Renal Artery Duplex

Duplex Criteria	Stenosis
RAR < 3.5 and PSV < 200 cm/sec	0-59%
RAR ≥ 3.5 and PSV > 200 cm/sec	60-99%
RAR > 3.5 and EDV ≥ 150 cm/sec	80-99%
Absence of flow and low amplitude parenchymal signal	Occluded

@SVM_tweets vascularmed.org @VascularMed

8

Make Sure the Patient is NPO!



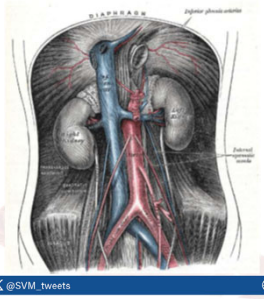
If the patient images are like this:

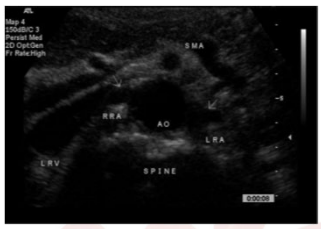
- STOP
- Do not fight it
- You will get a technically suboptimal study
- This is especially true for hospitalized patients

@SVM_tweets vascularmed.org @VascularMed

9

Anatomy – Anterior View

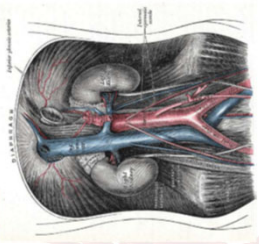


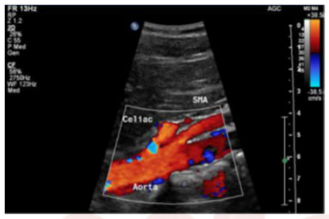


@SVM_tweets vascularmed.org @VascularMed

10

Anatomy – Long View

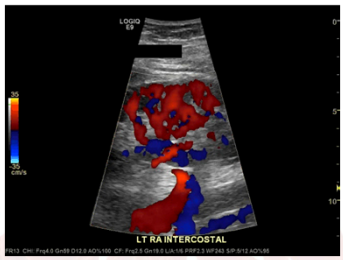




@SVM_tweets vascularmed.org @VascularMed

11

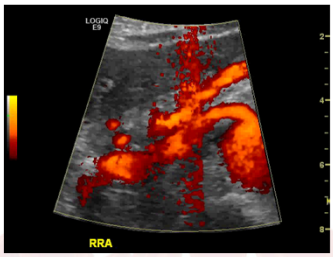
Inter-Costal Long View



@SVM_tweets vascularmed.org @VascularMed

12

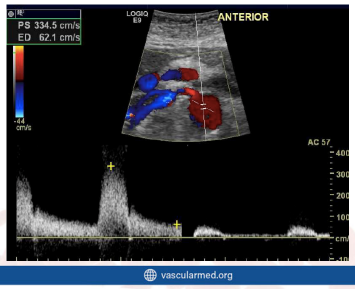
Show the Entire Renal Artery



@SVM_tweets vascularmed.org @VascularMed

13

Make Sure You Get the Origin



@SVM_tweets vascularmed.org @VascularMed

14

How Our Reports Are Read

- Normal Study for Atherosclerosis
  - Findings consistent with a 0- 59% stenosis. Patent without evidence for significant renal artery stenosis.
- More than 60% Stenosis
  - Findings consistent with a 60 - 99% stenosis within the proximal vessel.
- More than 80% stenosis
  - Findings consistent with a 60 - 99% stenosis within the proximal vessel. The end diastolic velocity > 150 cm/sec suggest stenosis is greater than 80%.

@SVM_tweets vascularmed.org @VascularMed

15

Case Summary

73 year old female was transferred from an outside hospital to the CCU

- She was in acute pulmonary edema and on an FiO2 of 50%
- The blood pressure was 180/104 mmHg on:
  - Furosemide 120 mg BID
  - Metolazone 5 mg daily
  - Atenolol 100 mg daily
  - Hydralazine 100 mg TID
  - Clonidine patch 0.3 mg weekly
  - Isosorbide mononitrate 90 mg daily

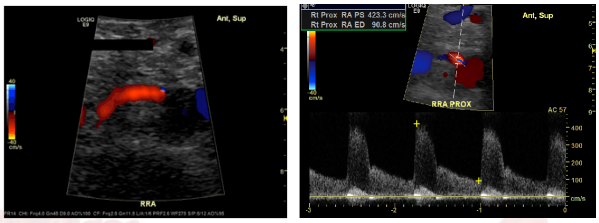
16

Case Summary (continued)

- Despite large doses of diuretics, her urine output over the last several days was 250 cc/24 hours
- The serum creatinine 4 weeks ago was 1.6 mg/dL and on transfer to the CCU it was 3.9 mg/dL.
  - She underwent hemodialysis and ultrafiltration
- Four weeks ago she had a nuclear stress test that was negative for ischemia and an echocardiogram with LVH, normal systolic LV function and diastolic dysfunction.

17

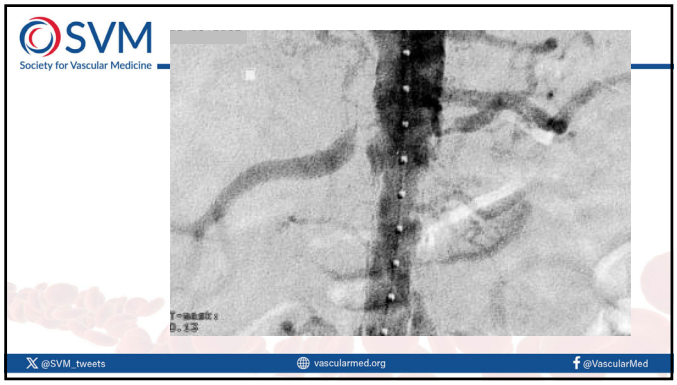
Renal Artery Duplex, Bilateral 60-99%



Juxtarenal Aorta PSV 80 cm/sec

Renal-Aortic Ratio = 5.1

18



19

20

Case Summary (continued)

- Post stenting she required no dialysis
- The serum creatinine was 1.2 mg/dL four days after renal artery stent implantation
- The blood pressure was 130/70 mmHg on:
  - HCTZ 25 mg daily
  - Lisinopril 20 mg BID
  - Atenolol 100 mg daily
- She returned in 2 weeks for the first surveillance duplex ultrasound which was normal

@SVM_tweets vascularmed.org @VascularMed

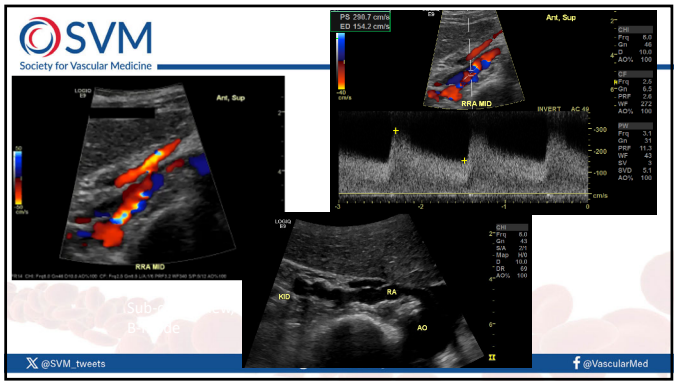
21

Fibromuscular Dysplasia

- Cannot use same criteria used for atherosclerosis
  - Velocity criteria have never been validated in FMD
  - Multiple sequential stenoses; the velocities are not focused on a single area
  - Affects the mid-distal artery
- We use:
  - There is turbulence/tortuosity/increased velocities in the mid and distal renal artery. This is consistent (or may be seen with) FMD.

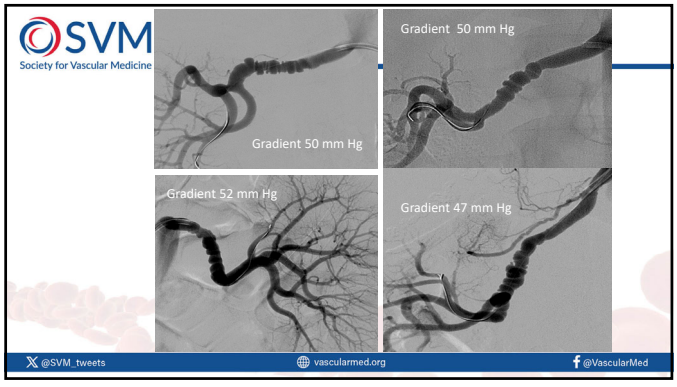
@SVM_tweets vascularmed.org @VascularMed

22



@SVM_tweets @VascularMed

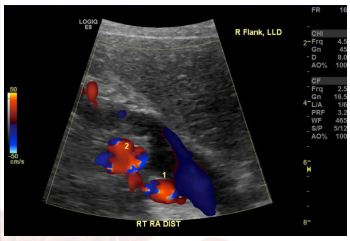
23

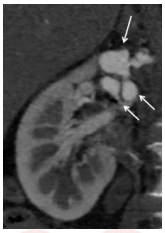


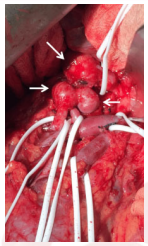
@SVM_tweets vascularmed.org @VascularMed

24

Renal Artery Aneurysm







@SVM_tweets vascularmed.org @VascularMed

25

THANK YOU!

@SVM_tweets vascularmed.org @VascularMed

26

When Walking Isn't Enough

Intermittent Claudication

Sunday, March 17th, 2024

Danielle Vlazny, PA-C, MS, FSVM, CWS

1

Case

- A 66 year old male presents with pain and heaviness in the left calf when walking. This is described as tightening and cramping that occurs at less than 1 block.
- Past medical history: T2DM, GERD, HLD, HTN, prostate cancer s/p resection and radiation. Tobacco use, currently 1 pack per day (58 year pack history).
- Medications: ASA 81 mg daily, amlodipine 5mg daily, atorvastatin 40mg daily, losartan 25mg daily, omeprazole 20mg daily, multivitamin

2

What is claudication?

- Reproducible discomfort in the buttock, thigh, calf, or foot associated with exertion and resolves within 10 minutes of rest regardless of position. Often recurs at the same distance once walking is resumed.
- Often described in the number of blocks able to ambulate before requiring rest
- With atypical claudication, lower extremity discomfort may occur with walking but may not consistently occur at the same distance walked and may require a longer duration to resolve or require the patient to sit down or change body position to alleviate the symptoms.
- First line management is medical management with supervised exercise programs
- But what do we do when that fails?

3

How do we classify PAD?

Rutherford Classification for Chronic Limb Ischemia

- Stage (
- Stage 1
- Stage 2 and se mentic
- Stage 3
- Stage 4
- Stage 5
- Stage 6

Fontaine Classification	
Stage	**Clinical Presentation**
I	Asymptomatic
IIa	Intermittent claudication after more than 200 meters of pain free walking
IIb	Intermittent claudication after less than 200 meters of walking
III	Ischemic rest pain
IV	Ischemic ulceration or gangrene

4

Claudication Evaluation

- Unresolved claudication requires further evaluation to confirm arterial disease as the etiology and determine the level and degree of disease
- Non-invasive imaging is often completed first
  - Ankle Brachial Index and arterial ultrasound imaging
- Second line imaging further delineates disease location and severity
  - CT angiogram or conventional angiography

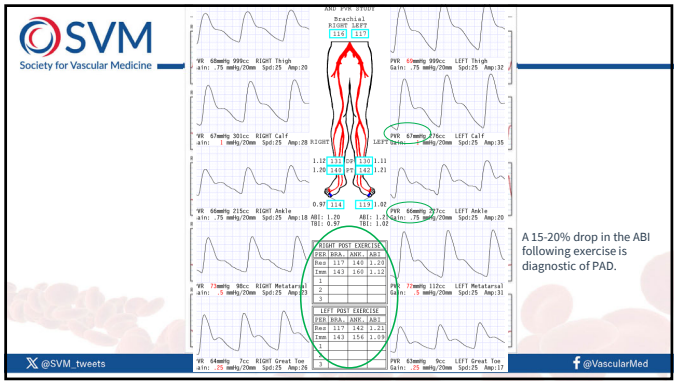
5

Ankle Brachial Index (ABI)

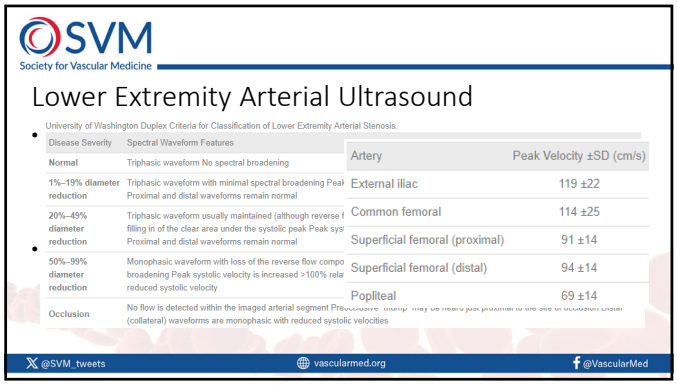
Measurement of the ankle systolic pressure against the brachial systolic pressure at rest

- ABI Values
  - > 1.00
  - 0.90 – 0.99
  - 0.80 – 0.89
  - 0.50 – 0.79
  - < 0.50
- Classification
  - Normal
  - Borderline
  - Mild
  - Moderate
  - Severe

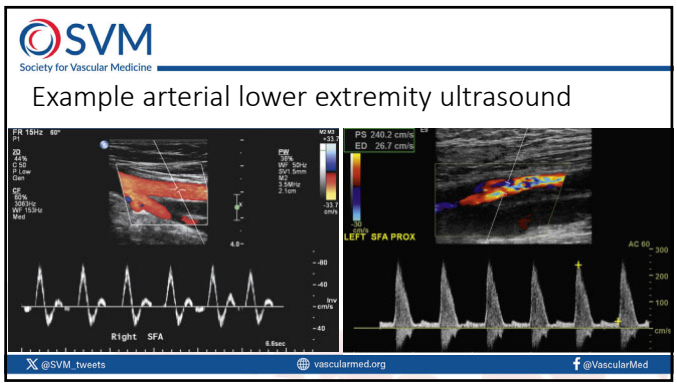
6


SVM
Society for Vascular Medicine
A 15-20% drop in the ABI following exercise is diagnostic of PAD.
@SVM_tweets
@VascularMed

7


SVM
Society for Vascular Medicine
Lower Extremity Arterial Ultrasound
University of Washington Duplex Criteria for Classification of Lower Extremity Arterial Stenosis.
Disease Severity
Spectral Waveform Features
Normal
Triphasic waveform No spectral broadening
1%–19% diameter reduction
Triphasic waveform with minimal spectral broadening Peak
Proximal and distal waveforms remain normal
20%–49% diameter reduction
Triphasic waveform usually maintained (although reverse f
filling in of the clear area under the systolic peak Peak syst
Proximal and distal waveforms remain normal
50%–99% diameter reduction
Monophasic waveform with loss of the reverse flow compo
broadening Peak systolic velocity is increased >100% rela
reduced systolic velocity
Occlusion
No flow is detected within the imaged arterial segment Pre
(collateral) waveforms are monophasic with reduced systolic velocities
Artery
Peak Velocity ±SD (cm/s)
External iliac
119 ±22
Common femoral
114 ±25
Superficial femoral (proximal)
91 ±14
Superficial femoral (distal)
94 ±14
Popliteal
69 ±14
@SVM_tweets
vascularmed.org
@VascularMed

8


SVM
Society for Vascular Medicine
Example arterial lower extremity ultrasound
PS 240.2 cm/s
ED 26.7 cm/s
LEFT SFA PROX
Right SFA
@SVM_tweets
vascularmed.org
@VascularMed

9

SVM Society for Vascular Medicine

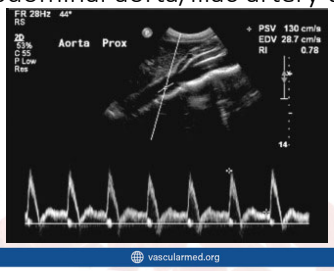
Aortoiliac Ultrasound

- Investigates presence and degree of proximal disease
- Assess internal and external iliac arteries and abdominal aorta
- No pressures but doppler signals, velocities, and patency reported

10

SVM Society for Vascular Medicine

Example abdominal aorta/iliac artery ultrasound



11

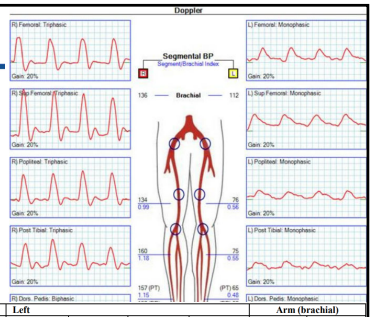
SVM Society for Vascular Medicine

Case Imaging – ABI

Common femoral	Triphasic	Monophasic
Superfical femoral	Triphasic	Monophasic
Popliteal	Triphasic	Monophasic
Posterior tibial	Triphasic	Monophasic
Dorsalis pedis	Biphasic	Monophasic

Systolic Pressures

	Right		Left	
Arm: brachial	136/ 66	Index	112 / 56	Index
Arm Simultaneous	146 /		138 /	
Thigh (lower)	134	0.99	76	0.56
Calf	160	1.18	75	0.55
Ankle PT	157	1.15	65	0.48
Ankle DP	150	1.10	66	0.49
Digit 1	111	0.82	57	0.42



Exercise

	Right				Left				Arm (brachial)	
Minutes	Systolic	Index	Absent	Pallor	Systolic	Index	Absent	Pallor	Systolic	Diastolic
1	218	1.09			24	0.12		X	200	80
3	210	1.18			30	0.17			178	70
5	180	1.18			36	0.24			152	62
10	172	1.16			70	0.47			148	70

12

SVM Society for Vascular Medicine

Case Intervention

- Left femoral endarterectomy of the external iliac, femoral artery and superficial femoral artery with 10-cm bovine pericardial patch angioplasty
- Left common iliac artery stenting (Viabahn VBX 8 x 59 postdilated to 12 mm)
- Left external iliac artery stenting (8 x 60 Innova postdilated to 8 mm)

13

SVM Society for Vascular Medicine

Post-revascularization follow-up

- Follow-up with surgical team 3 months after procedure
- Repeat imaging with ABI and LE Duplex US

14

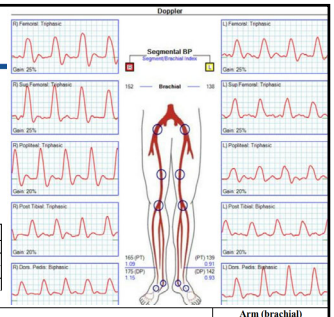
SVM Society for Vascular Medicine

Doppler Signal

	Right	Left
Common femoral	Triphasic	Triphasic
Superfical femoral	Triphasic	Triphasic
Popliteal	Triphasic	Triphasic
Posterior tibial	Triphasic	Biphasic
Dorsalis pedis	Biphasic	Biphasic
Post ex CF	Triphasic	Biphasic

Systolic Pressures

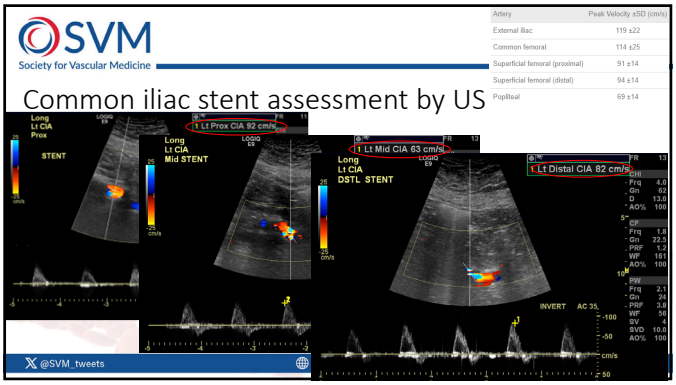
	Right		Left	
Arm: brachial	152/ 76	Index	138 / 78	Index
Ankle PT	165	1.09	139	0.91
Ankle DP	175	1.15	142	0.93
Digit 1	136	0.89	131	0.86



	Right				Left				Arm (brachial)	
Minutes	Systolic	Index	Absent	Pallor	Systolic	Index	Absent	Pallor	Systolic	Diastolic
1	162	0.95			180	1.06			170	74
3	208	1.11			198	1.05			188	78
5	170	1.01			168	1.00			168	78

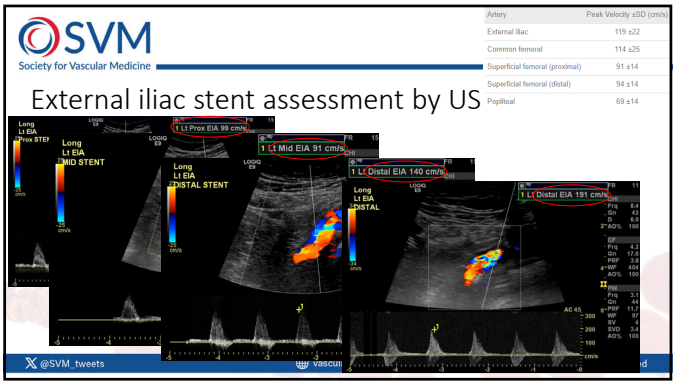
15

Common iliac stent assessment by US



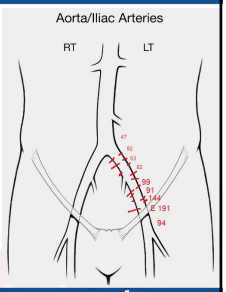
16

External iliac stent assessment by US



17

- Patent stents in common and external iliac arteries
- Mildly elevated velocities at the distal end point of the external iliac artery stent (191 cm/s) may be due to vessel angulation or change in caliber
- Could be mild stenosis, but there does not appear to be significant luminal narrowing with color Doppler
- Remainder of stents are patent, without stenosis
- Common femoral, upper deep femoral, and superficial femoral arteries are patent, without evidence of stenosis
- Normal waveforms throughout

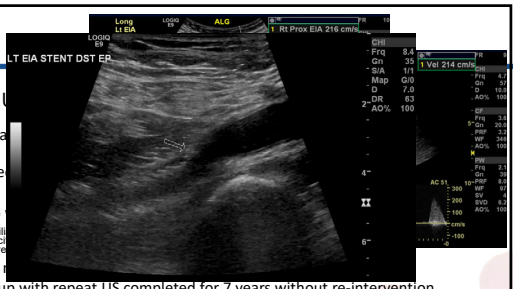


18

Society for Vascular Medicine

Case Resolu

- Improved claudica
  - ABI 0.86 on left
- Plavix discontinue
- Second follow-up
- Stent in the left common ili
  stent with increased veloci
  level with moderately incre
- Third follow-up 6 m
- In person follow-up with repeat US completed for 7 years without re-intervention needed despite early stenosis.
  - The stented left common iliac artery is patent without stenosis. The left internal iliac artery origin is widely patent. Unchanged blood flow velocity elevation up to 260 cm/s. The left common femoral artery, including its bifurcation site, is patent without stenosis.



@SVM_tweets vascularmed.org @VascularMed

19

Society for Vascular Medicine

Questions?

- Thank you!
- Vlazny.danielle@mayo.edu

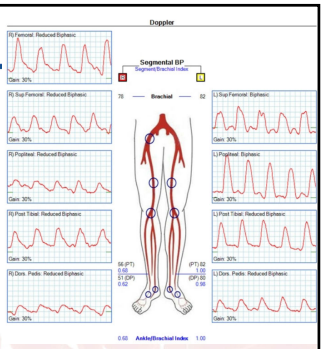
@SVM_tweets vascularmed.org @VascularMed

20

Society for Vascular Medicine

Education Question

- A patient presents with increasing leg pain and this study is completed. What is your next study?
- 1) Aorta/iliac artery ultrasound
- 2) Left Popliteal artery ultrasound
- 3) Right popliteal artery ultrasound
- 4) Carotid ultrasound



@SVM_tweets vascularmed.org @VascularMed

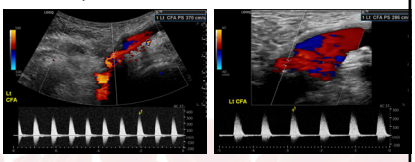
21

SVM
Society for Vascular Medicine

Education Question

- A patient has been followed by the vascular clinic for yearly follow-up of known lower extremity PAD. This year the arterial ultrasound is different as shown below. What are your next steps?

1 - If worsening symptoms, continue with supervised exercise program
2 - If asymptomatic, refer to vascular surgery
3 - If worsening symptoms, refer to vascular surgery
4 - If asymptomatic, admit patient immediately



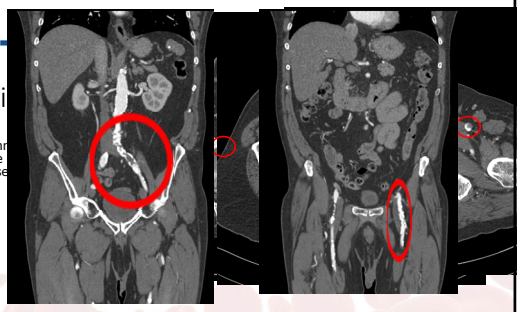
@SVM_tweets vascularmed.org @VascularMed

22

SVM
Society for Vascular Medicine

Case Imagi

- Occlusion left comm
arteries. Moderate
arteries. Two-vesse



@SVM_tweets vascularmed.org @VascularMed

23

AAA Pre and Post-EVAR

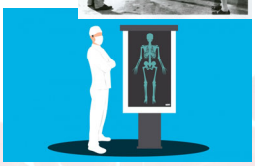
CT vs. US, post-EVAR, endoleaks

Chris Owen, MS, ACNP, RNFA
MedStar Heart and Vascular Institute
Annapolis, MD

1

Disclosures

- I am not a diagnostic or interventional radiologist.
- I am Irish, **Sláinte!**



2

Objectives

At the end of this presentation, you will have received tools to understand:

- Screening, risk factors and routine surveillance for AAA
- When and what treatment is appropriate for AAA
- Vascular lab studies associated with AAA
- Endovascular leaks post EVAR

3

SVM
Society for Vascular Medicine

Screening, risk factors and routine surveillance for AAA

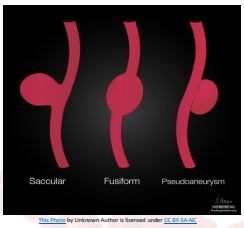
Screening	Risk Factors	Surveillance
Men & women age 65-75 h/o smoking	**Age**	3.0 - 3.9cm 3 - year interval US
Men & women w/family history	**Sex**	4.0 - 4.9cm annual US
US w/ aortic diameter measuring >2.5 cm but <3.0 cm again in 10 years	**Race**	5.0 - 5.4cm 6 - month US
	Family history	
	Smoking	

SOCIETY FOR VASCULAR SURGERY DOCUMENT
The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm
Elliot L. Chaikof, MD, PhD,a Ronald L. Dalman, MD,b Mark K. Eskandari, MD,c Benjamin M. Jackson, MD,d W. Anthony Lee, MD,e M. Ashraf Mansour, MD,f Tara M. Mastracci, MD,g Matthew Mell, MD,b M. Hassan Murad, MD, MPH,h Louis L. Nguyen, MD, MBA, MPH,i Gustavo S. Oderich, MD,j Madhukar S. Patel, MD, MBA, ScM,a,k Marc L. Schermerhorn, MD, MPH,a and Benjamin W. Starnes, MD,l Boston, Mass; Palo Alto, Calif; Chicago, Ill; Philadelphia, Pa; Boca Raton, Fla; Grand Rapids, Mich; London, United Kingdom; Rochester, Minn; and Seattle, Was

4

SVM
Society for Vascular Medicine

AAA



True Aneurysm
Saccular – sack-like, unilateral outpouching
Fusiform – circumferential dilatation (most common)

False Aneurysm
Pseudoaneurysm – hematoma that communicates with an artery but forms outside the arterial wall

5

SVM
Society for Vascular Medicine

When and what treatment is appropriate for AAA

- Symptomatic AAA: abdominal/back pain or rupture
- Fusiform AAA >5.4 cm in otherwise healthy patient
- Saccular AAA repair recommended at smaller diameter
- Young, women w/AAA 5.0- 5.4cm
- Rapid expansion of small fusiform AAA

- Open
- Endovascular
  - 80% of all AAAs are treated by EVAR in USA

6

SVM Society for Vascular Medicine

Vascular lab studies associated with AAA

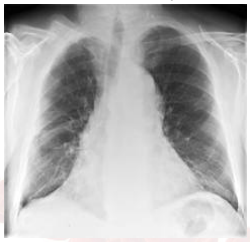
- **Non-invasive**
  - X-ray
  - Ultrasound
- **Invasive**
  - CT/CTA
  - MRI/A
  - Angiography
  - IVUS

@SVM_tweets vascularmed.org @VascularMed

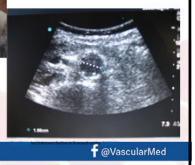
7

SVM Society for Vascular Medicine

Chest X-Ray



Ultrasound



@SVM_tweets vascularmed.org @VascularMed

8

SVM Society for Vascular Medicine

Invasive Testing

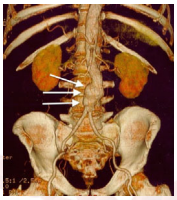
- CT Scan or CTA are imaging studies utilizing non-contrast and/or IV contrast to identify specific anatomy.
- MRI/MRA create images of blood vessels using strong magnets that sends out radio waves to create the images with or without contrast.
- Angiogram/Arteriogram is an x-ray of the arteries using contrast to highlight the blood vessel.
- IVUS(Intravascular Ultrasound) sends high frequency sound waves into the blood vessel from a catheter inside the artery forming an image.

@SVM_tweets vascularmed.org @VascularMed

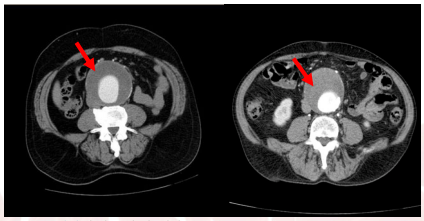
9

SVM Society for Vascular Medicine

CT



CTA

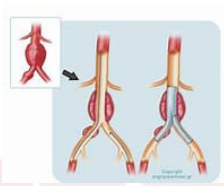


10

SVM Society for Vascular Medicine

EVAR: Endovascular Aneurysm Repair

- Minimally invasive procedure used to treat pathology of the aorta
  - Femoral cut down or percutaneous
  - Contrast, fluoroscopy
  - 24 hours stay
  - Follow up with US/CTA



https://th.bing.com/th?id=OIP.jETMweG4rJVzGT79TXGtAAAAAA&w=200&h=160&rs=1&qft=+808o=6&pid=3.1

11

SVM Society for Vascular Medicine

TYPES OF ENDOLEAKS

ENDOLEAK		
TYPE I Inadequate seal at graft ends	1A (Proximal) 1B (Distal) 1C (Iliac)	Contrast extravasation in continuity with the site of the graft attachment
TYPE II Retroleak. Aneurysm sac filling via branch vessel. 80 %	2A (1vessel) 2B (2 or more vessels)	Retrograde flow through branch vessels (lumbar arteries or inferior mesenteric artery)
TYPE III Leak through defect in graft	3A (functional separation of the modular components) 3B (fractures or holes involving the endograft)	Contrast extravasation: central or distal to the graft attachment
TYPE IV Graft porosity	Contrast extravasation anywhere of the aneurysmal sac without evidence of clear leak origin	
TYPE V Endotension	Continued expansion of aneurysm sac without demonstrable leak on imaging	

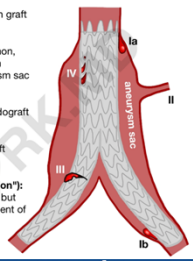
Type I: gap between graft and vessel

Type II: most common, flow through branch vessels into aneurysm sac

Type III: defect/ misalignment of endograft materials

Type IV: porous graft material

Type V ("endotension"): no evidence of leak but continued enlargement of aneurysm



Case courtesy of Gerard Carbo, Radiopaedia.org, rID: 32126

12

SVM Society for Vascular Medicine

Case Study

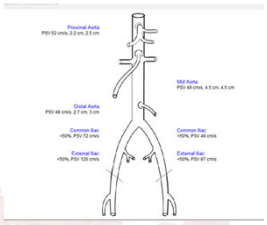
79 yoF with finding of infrarenal fusiform AAA on screening, BLE popliteal arterial duplex negative for aneurysm

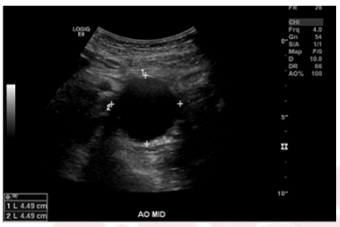
- PMH significant for:
  - HLD, HTN, CVA, CKD, Contact dermatitis, Sinusitis
- Meds:
  - ASA, Amlodipine, Atorvastatin, Levetiracetam, losartan, multivitamin
- Allergies: No known Drug Allergies
- Social Hx: previous smoker
- PSH: Colonoscopy x3, tubal ligation, hysterectomy, right knee meniscus tear, s/p EVAR 3/2022 known Type II endoleak

@SVM_tweets vascularmed.org @VascularMed

13

SVM Society for Vascular Medicine



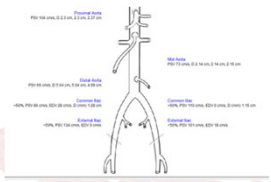


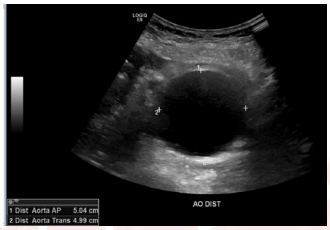
@SVM_tweets vascularmed.org @VascularMed

14

SVM Society for Vascular Medicine

Growth





@SVM_tweets vascularmed.org @VascularMed

15

SVM Society for Vascular Medicine

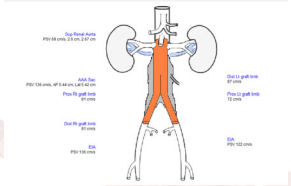
Video of initial CTA

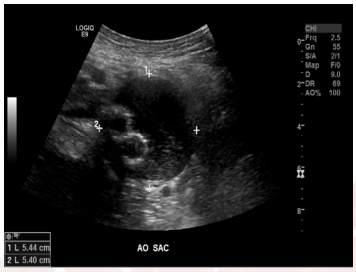
@SVM_tweets vascularmed.org @VascularMed

16

SVM Society for Vascular Medicine

Post EVAR

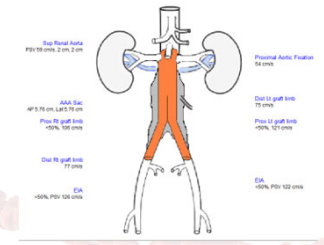


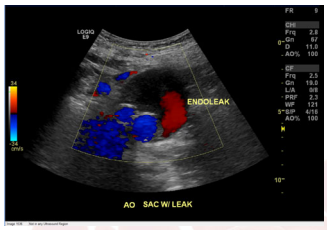


@SVM_tweets vascularmed.org @VascularMed

17

SVM Society for Vascular Medicine





@SVM_tweets vascularmed.org @VascularMed

18

SVM Society for Vascular Medicine

Video of endoleak on CTA

@SVM_tweets vascularmed.org @VascularMed

19

SVM Society for Vascular Medicine

Blushing on angiogram demonstrating leak

@SVM_tweets vascularmed.org @VascularMed

20

SVM Society for Vascular Medicine

Video of Angiogram & Intervention Attempt

@SVM_tweets vascularmed.org @VascularMed

21

SVM Society for Vascular Medicine

Routine Surveillance Post

- CTA/US 1 month post EVAR
- 6 months thereafter with the most reliable and safe study
- Once stability and SAC shrinkage is demonstrated over time may move to annual surveillance

@SVM_tweets vascularmed.org @VascularMed

22

SVM Society for Vascular Medicine

Question

- After AAA has been identified what is the best way to follow and why?

@SVM_tweets vascularmed.org @VascularMed

23

SVM Society for Vascular Medicine

Question

- When we are following Post EVAR what are we looking for and why? When would we use US and when would we use CTA?

@SVM_tweets vascularmed.org @VascularMed

24

SVM Society for Vascular Medicine

Summary

Identification AAA
- CTA/US

Size or rate of growth
- EVAR vs. Open

Routine surveillance CTA/US
- Goals – sack shrinkage

25

SVM Society for Vascular Medicine

References

- https://radiopaedia.org/cases/how-to-read-a-ct-of-the-abdomen-and-pelvis
  Hartung M, How to read a CT of the abdomen and pelvis. Case study, Radiopaedia.org (Accessed on 05 Feb 2024) https://doi.org/10.53347/rID-66174 **DOI:** https://doi.org/10.53347/rID-66174

26