Updates in PAD and Vascular Surgery

Adel Barkat, MD

Oklahoma Heart Institute
Department of CardioVascular Surgery
Associate Professor of Surgery OU Medicine

Oklahoma Heart Institute

Conflict of Interest

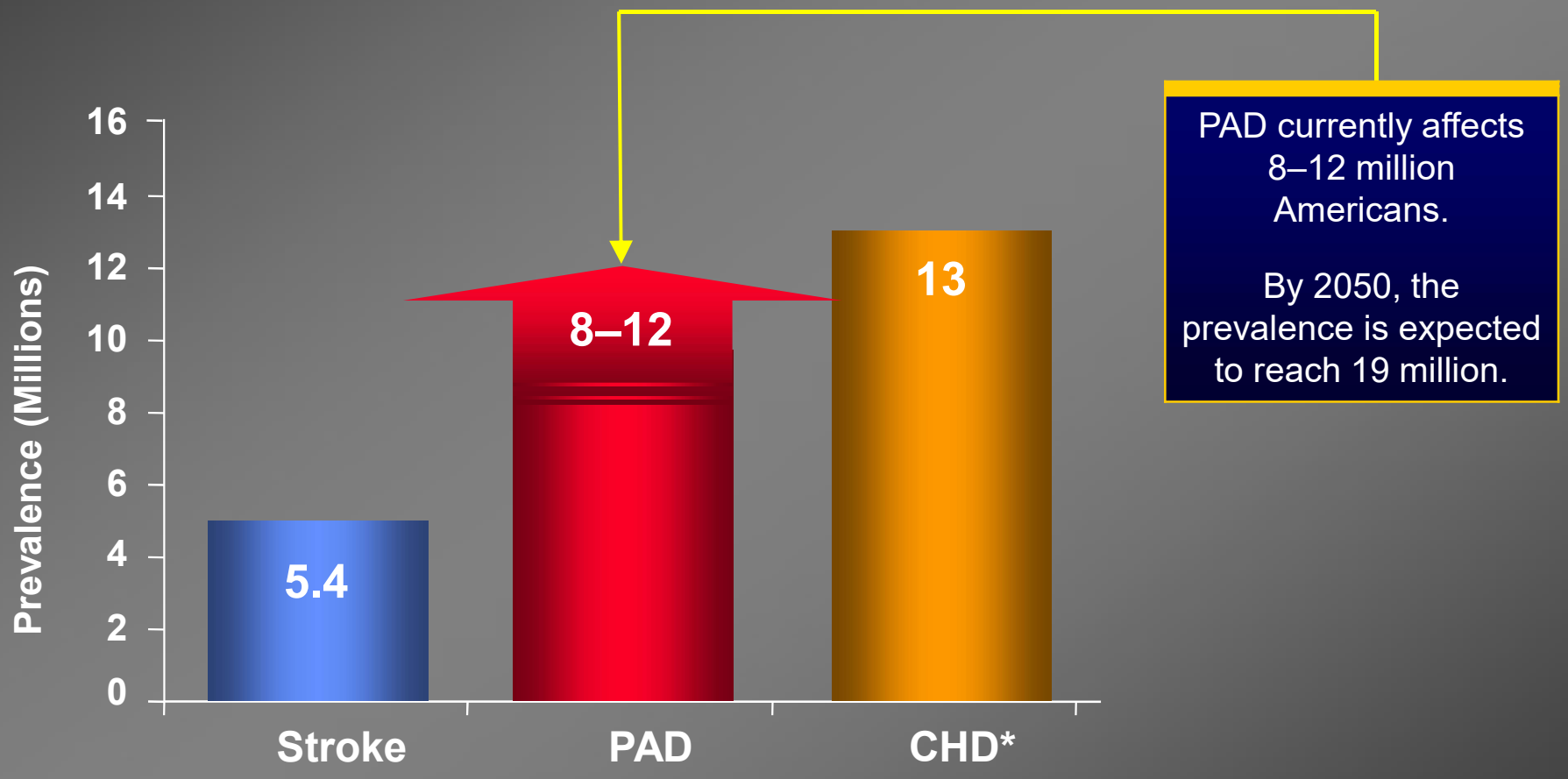
- Consulting for Silkroad

Vascular Surgery

- Approximately 3000 fellowship trained surgeons.
- Oklahoma
  - 12
    - Lowest per capita in the US
  - TULSA
    - 8

- Atherosclerosis affects up to 10% of the Western population older than 65 years.
- It is estimated that 2% of the population aged 40-60 years and 6% of the population older than 70 years are affected with PAD
- Most commonly manifests in men older than 50 years.

Prevalence of PAD in the US



CHD = coronary heart disease. PAD = peripheral arterial disease.

* Includes myocardial infarction and angina pectoris.

American Heart Association. *Heart Disease and Stroke Statistics—2005 Update*. 2005.

Comparison of global estimates of prevalence and risk factors for peripheral artery disease in 2000 and 2010: a systematic review and analysis

F Gerald R Fowkes, Diana Rudan*, Igor Rudan*, Victor Aboyans, Julie O Denenberg, Mary M McDermott, Paul E Norman, Uchechukwe K A Sampson, Linda J Williams, George A Mensah, Michael H Criqui*

PAD IS A MAJOR GLOBAL HEALTH PROBLEM

	People living with peripheral artery disease in year 2000 (thousands)			People living with peripheral artery disease in 2010 (thousands)			Rate of change (2000–10)		
	High-income countries	Low-income and middle-income countries	Worldwide	High-income countries	Low-income and middle-income countries	Worldwide	High-income countries	Low-income and middle-income countries	Worldwide
60–64 years	5342	9074	14 416	6242	11 787	18 029	16·85%	29·90%	25·06%
65–69 years	5287	8416	13 704	5547	10 124	15 670	4·90%	20·29%	14·35%
70–74 years	5594	6953	12 547	6043	9020	15 063	8·02%	29·73%	20·05%
75–79 years	4808	4960	9768	5370	7012	12 382	11·68%	41·36%	26·75%
80–84 years	3107	3015	6123	4723	4396	9118	51·98%	45·77%	48·92%
85–89 years	2246	1411	3658	3028	2087	5115	34·80%	47·86%	39·84%
≥90 years	1174	544	1717	1611	864	2474	37·22%	58·82%	44·09%
Total	54 195	109 405	163 600	61 287	140 775	202 062	13·08%	28·67%	23·51%

Additions in the table might deviate from the world total in the last digit due to rounding.

Table 2: **Estimated number of people living with peripheral artery disease in high-income countries, low-income and middle-income countries, and worldwide in the years 2000 and 2010, and the rate of change from 2000 to 2010**

THE HILL

Lawmakers are bringing Peripheral Artery Disease awareness to Congress

BY DR. JEFFREY G. CARR, OPINION CONTRIBUTOR — 09/04/19 02:30 PM EDT
THE VIEWS EXPRESSED BY CONTRIBUTORS ARE THEIR OWN AND NOT THE VIEW OF THE HILL

48 COMMENTS

© Getty Images

Knowledge is power. In the case of the nearly 20 million Americans affected by peripheral artery disease (PAD), something as simple as

Just In...

GOP senator: 'Whistleblowers should be protected'
SENATE — 1M 19S AGO

Maxine Waters: President Trump is 'setting some of us up to be killed'
HOUSE — 3M 45S AGO

What America's Thinking: October 3, 2019
WHAT AMERICA'S THINKING — 4M 4S AGO

Eric Trump: Hypocrisy creates unlevel playing field in politics
OPINION — 11M 39S AGO

Most Popular

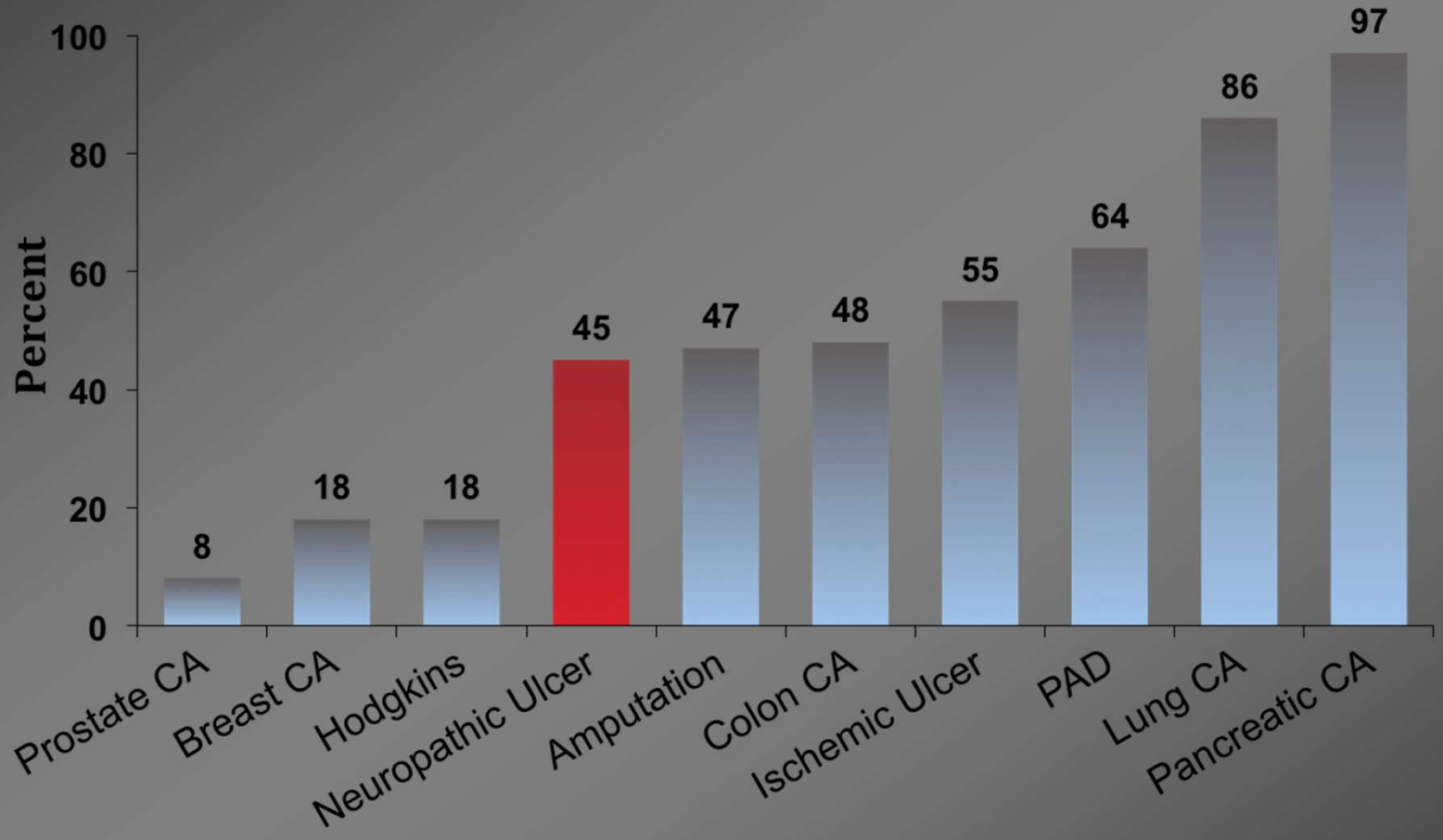
1 Ignore the hype — this is not an...
1,467 SHARES

2 Texas woman says potential...
619 SHARES

3 Top diplomat to Ukraine reportedly...
593 SHARES

4 Trump urges China to investigate...

5-Year Mortality Rates



Armstrong et al. *Int Wound J.* 2007;Dec;4(4):286.

CA = Carcinoma.
PAD = Peripheral artery disease

What is PAD:

Progressive restriction of peripheral blood flow

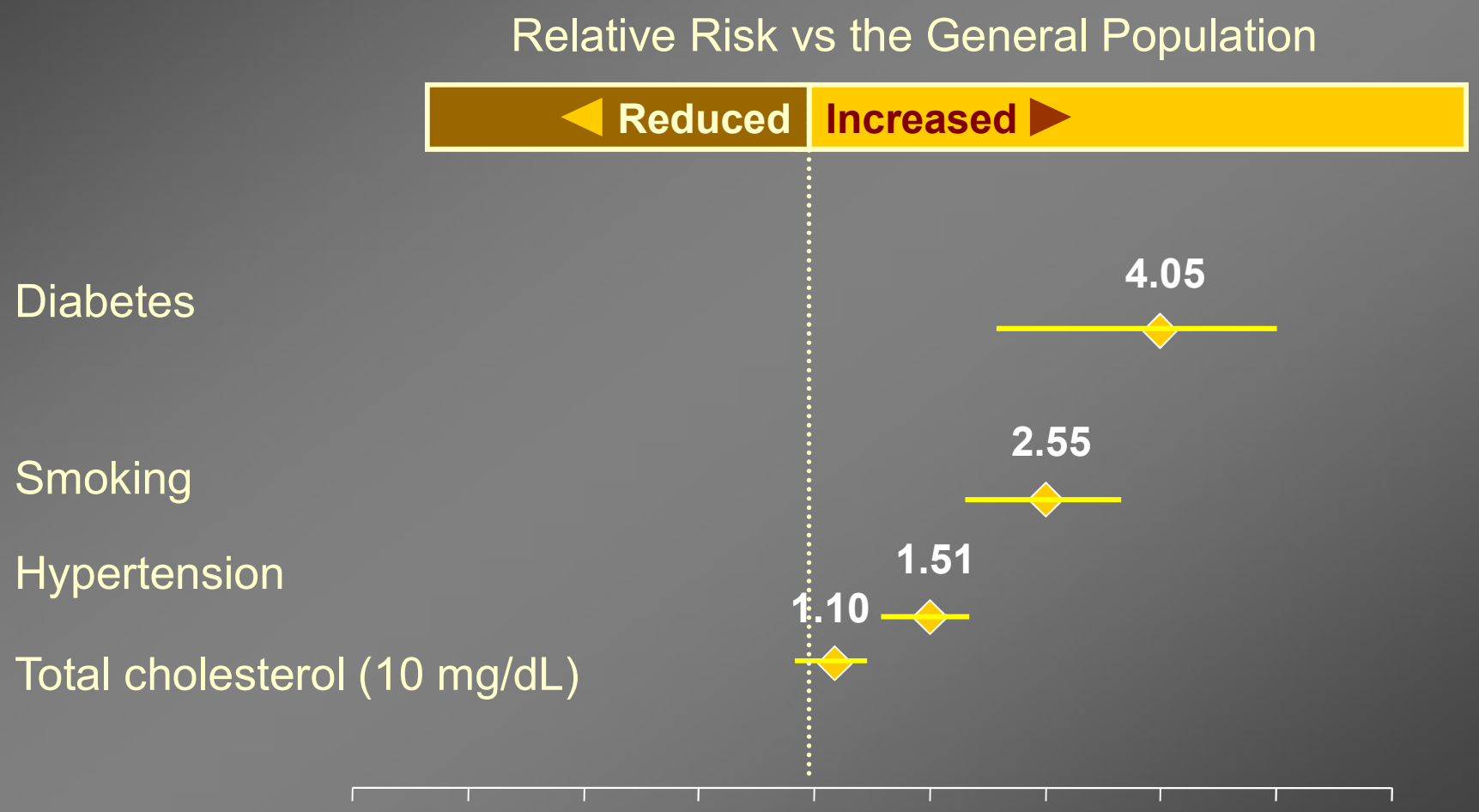
Clinical Presentation
The Spectrum of Manifestations of PAD

- Asymptomatic
- Atypical symptoms
- Intermittent claudication
- Critical limb ischemia
  - Rest Pain
  - Ulceration
  - Necrosis/Gangrene
- Acute limb ischemia

Does the Patient Have Intermittent Claudication?

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

Independent Risk Factors for PAD*

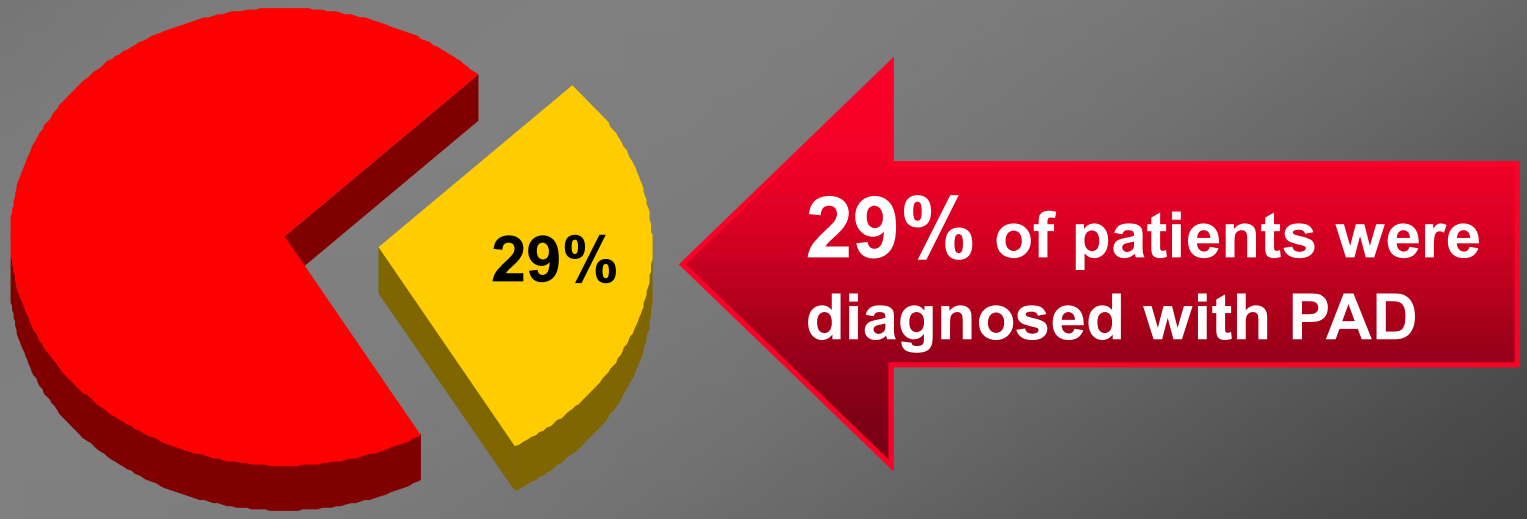


* PAD diagnosis based on ABI <0.90.

Newman AB, et al. *Circulation.* 1993;88:837-845

Prevalence of PAD in At-Risk Patients

- The PARTNERS* program evaluated 6,979 patients in physicians' offices.
- Patient criteria:
  - ≥70 years, or
  - 50–69 years with a history of smoking and/or diabetes



* PARTNERS=PAD Awareness, Risk, and Treatment: New Resources for Survival. Hirsch AT, et al. *JAMA.* 2001;286:1317-1324.

Diabetes and PAD: A Global Epidemic

- >23 million diabetics in US; 300+ million worldwide
- Age-adjusted risk for amputation is 28-fold higher
- A diabetic is undergoing a lower extremity amputation every 20-30 seconds
- Diabetic foot ulcer is a strong predictor for limb loss
- 1 out of 3 diabetics older than age 50 have PAD
- Diabetics with PAD are at significantly increased risk for mortality and limb loss
- Major public health expenditures and growing rapidly

PAD in Diabetic Patients: Cardiovascular Morbidity

- 82% of amputations in the US related to diabetes*
- DM + foot ulcer + PAD = 50% mortality in 5 years!

Typical vs Atypical Symptoms in Patients With Symptomatic PAD

Typical Symptoms[1]

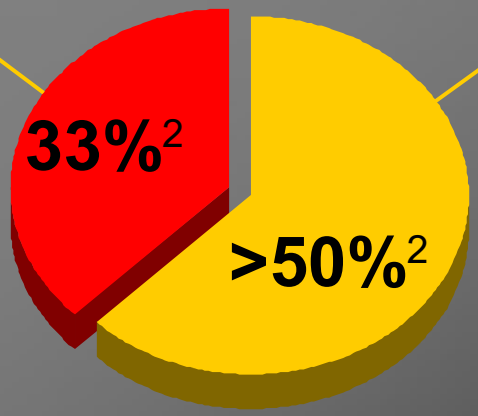
Intermittent claudication

- Exertional calf pain that
  - causes the patient to stop walking
  - resolves within 10 minutes of rest

Other nonspecific leg symptoms that may be indicative of PAD

Atypical Symptoms[1]

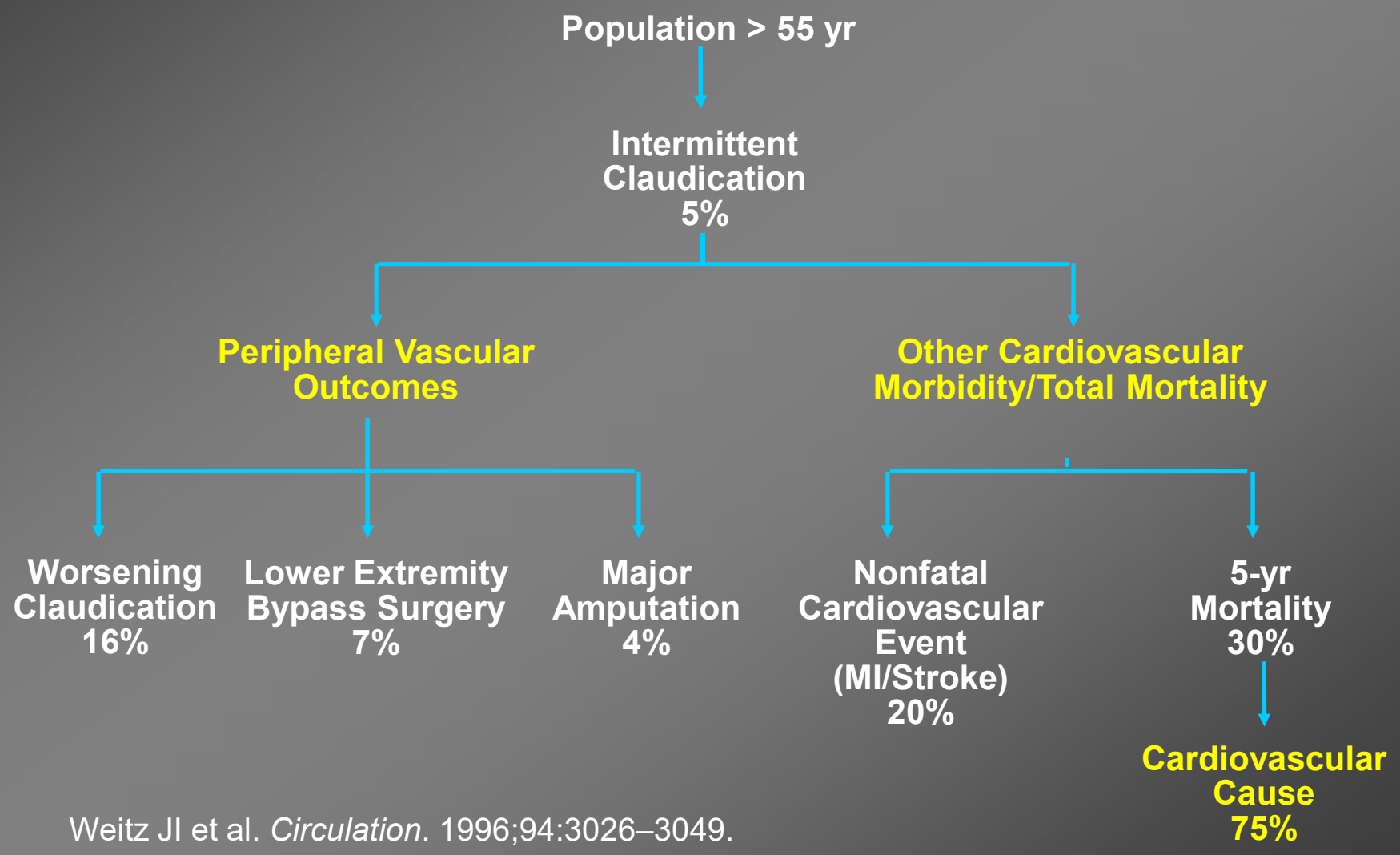
- Exertional leg pain that
  - may involve areas other than the calves
  - may not stop the patient from walking
  - may not resolve within 10 minutes of rest



1. McDermott MM et al. *JAMA*. 2001;286:1599-1606.
2. Hiatt WR. *N Engl J Med.* 2001;344:1608-1621.

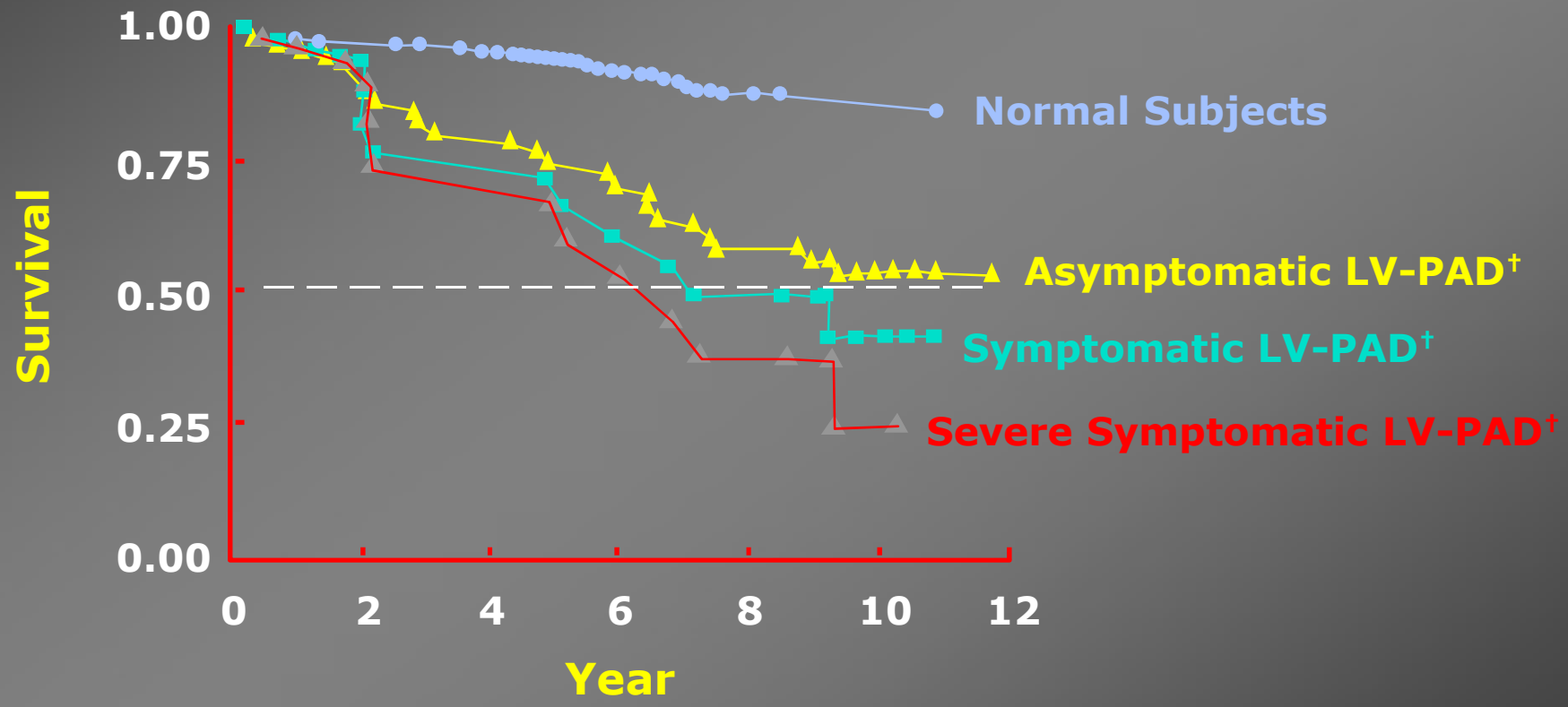
- 50-90% of patients with definite intermittent claudication do not report their symptom to clinician.
- Most patients appear to accept a decrease in walking distance as a part of aging.

Natural History
Intermittent Claudication



Weitz JI et al. *Circulation*. 1996;94:3026–3049.

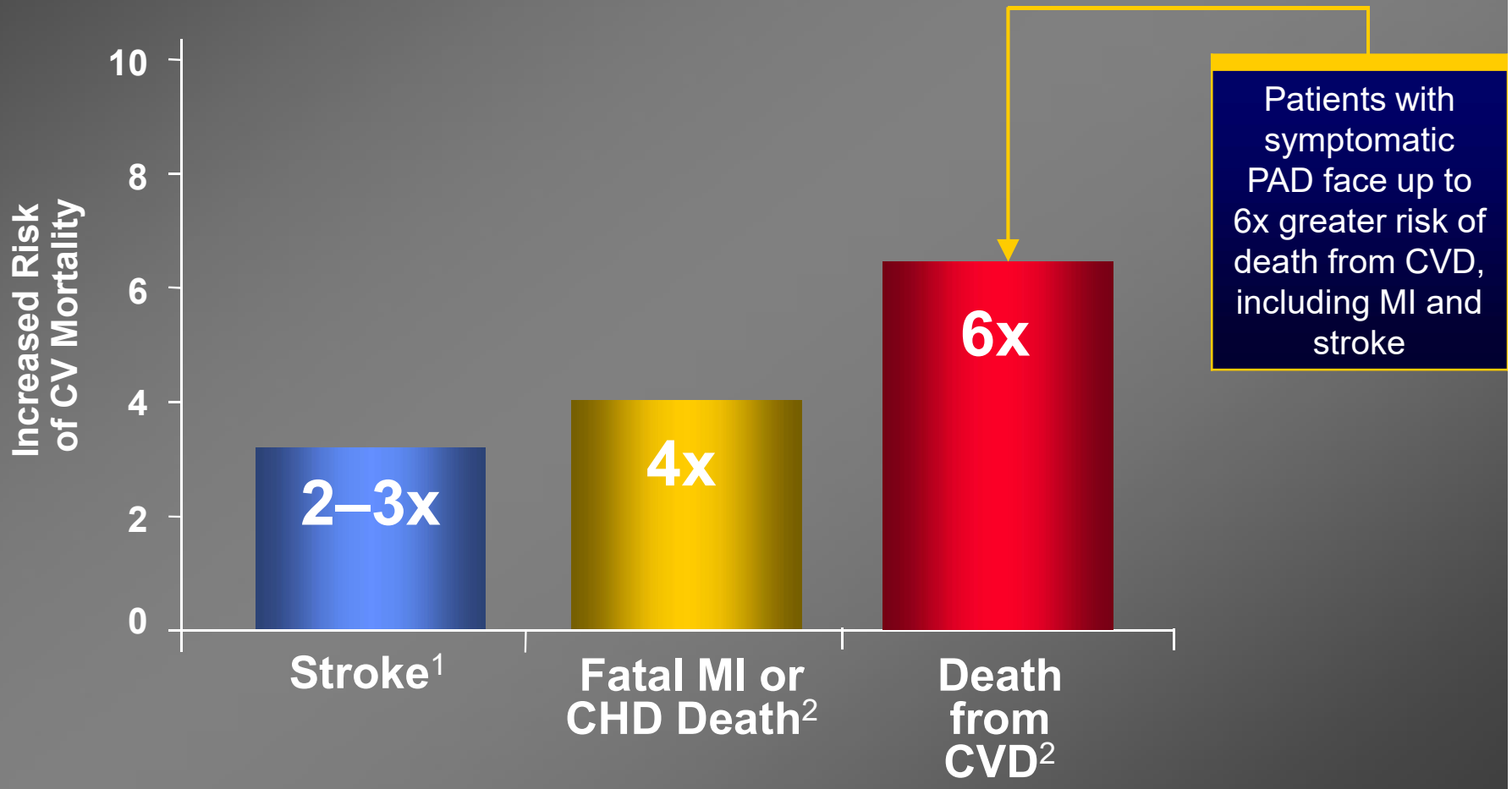
Impact of PAD on Mortality



*Kaplan-Meier survival curves based on mortality from all causes.
†Large-vessel PAD.

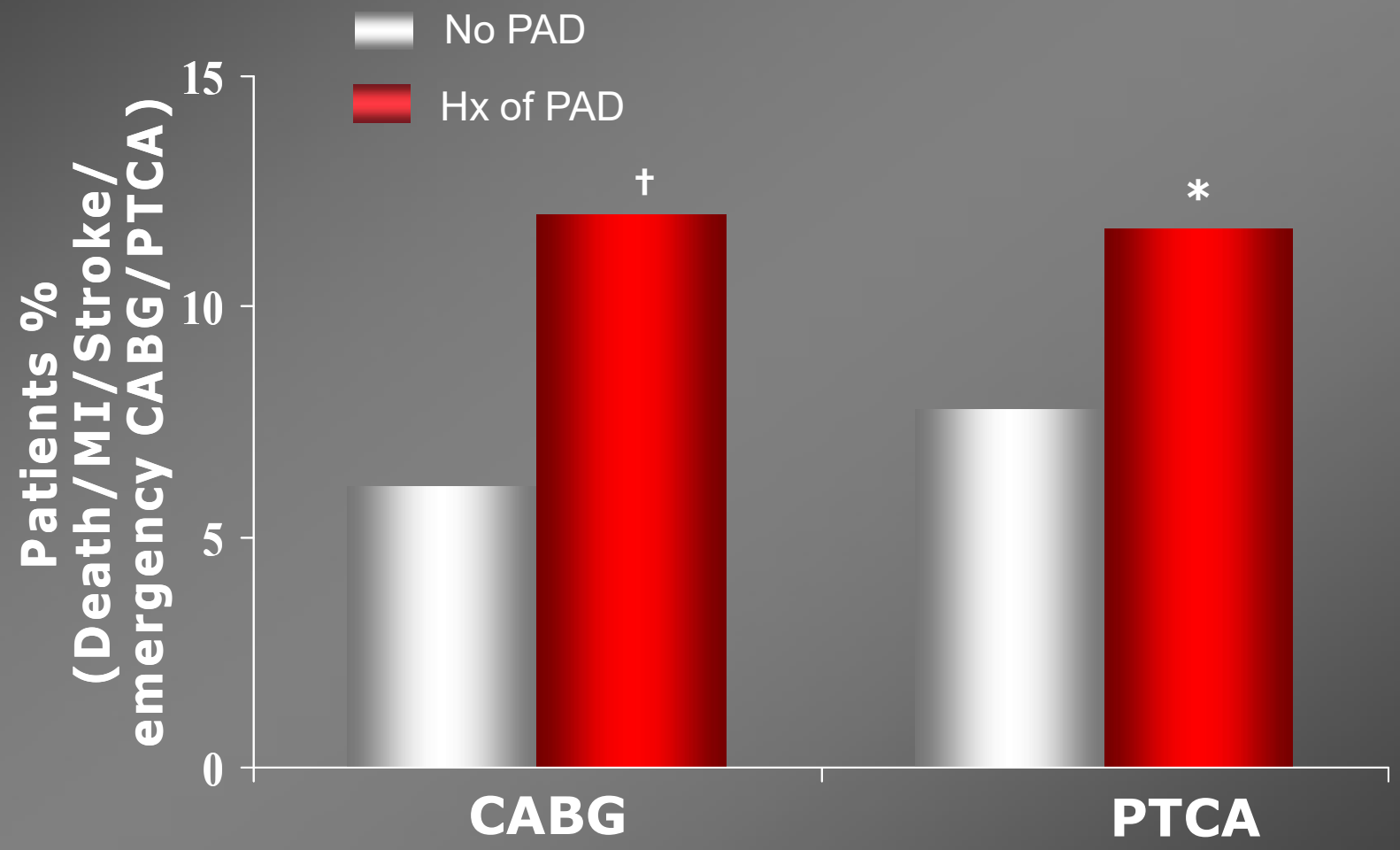
Adapted from Criqui MH et al. *N Engl J Med.* 1992;326:381-386.

Cardiovascular Events with PAD



1. Kannel WB. *J Cardiovasc Risk*. 1994;1:333-339.
2. Criqui MH et al. *N Engl J Med*. 1992;326:381-386.

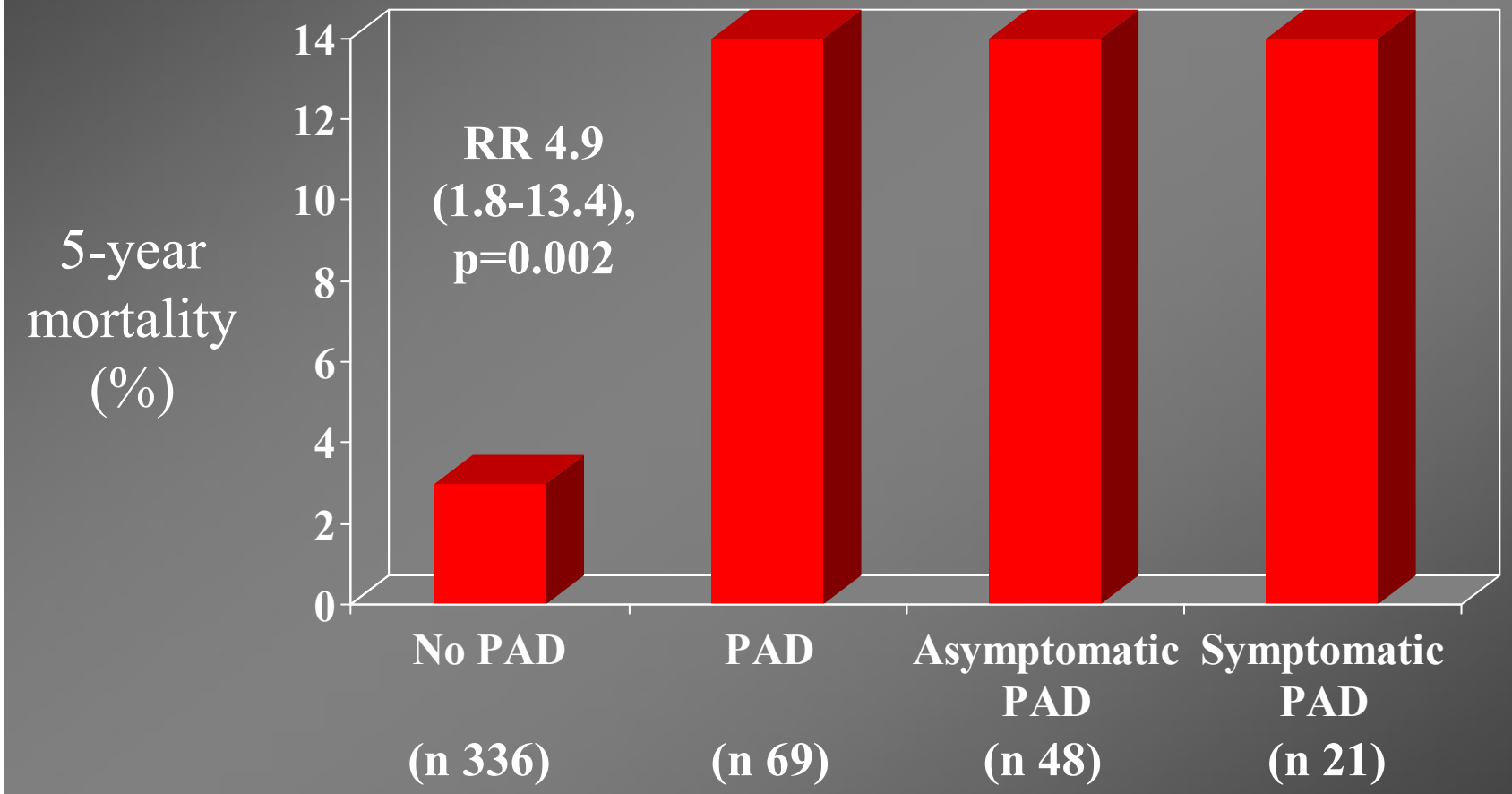
Increased Incidence of Periprocedural Complications in PAD



* P<0.05, †P<0.01. Note all comparisons are PAD vs. no PAD within treatment groups.

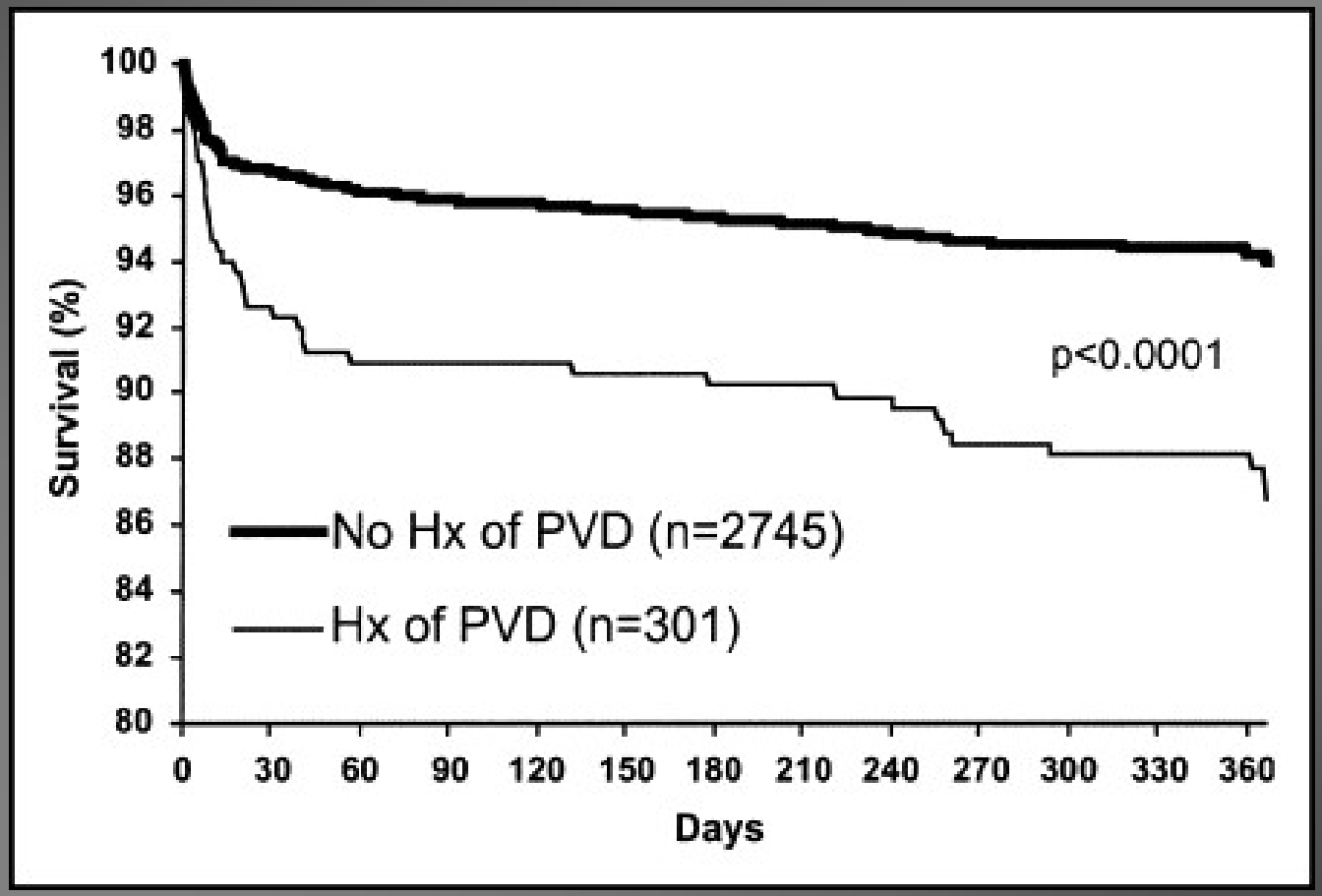
Rihal C et al. *Circulation* 1999; 100:171-177.

Prognostic importance of PAD in patients undergoing coronary revascularization



Burek. JACC 1999;34:716-21.

Effect of PVD on Mortality after AMI treated with PCI



Guerrero et al. Am J Cardiol 2005;96:649-654.

Treatment of PAD

Prevent Ischemic Events

Risk factor modification

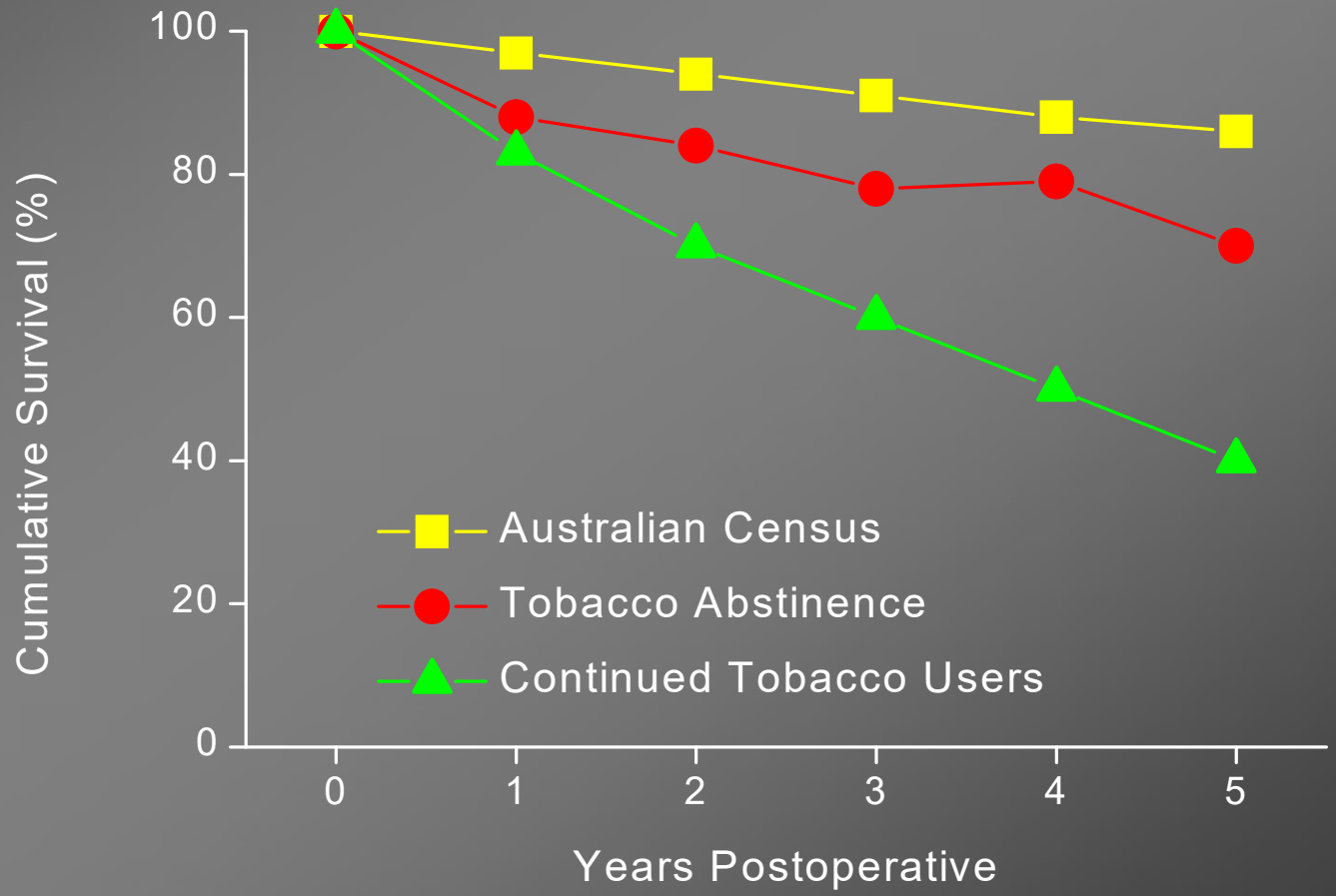
- **Smoking cessation**
  - Goal: complete cessation
- **Lipid management**
  - Target LDL < 100 mg/dL
- **Blood pressure control**
  - Goal <130/85 mm Hg
- **Blood sugar control**
  - Goal: HbA_{1c} <7%

Antiplatelet therapies

- **Aspirin or Clopidogrel**
  - Goal: reduction in risk of MI, stroke, and vascular death
  - Only clopidogrel is FDA approved
  - Many professional societies include ASA among first line agents in guidelines

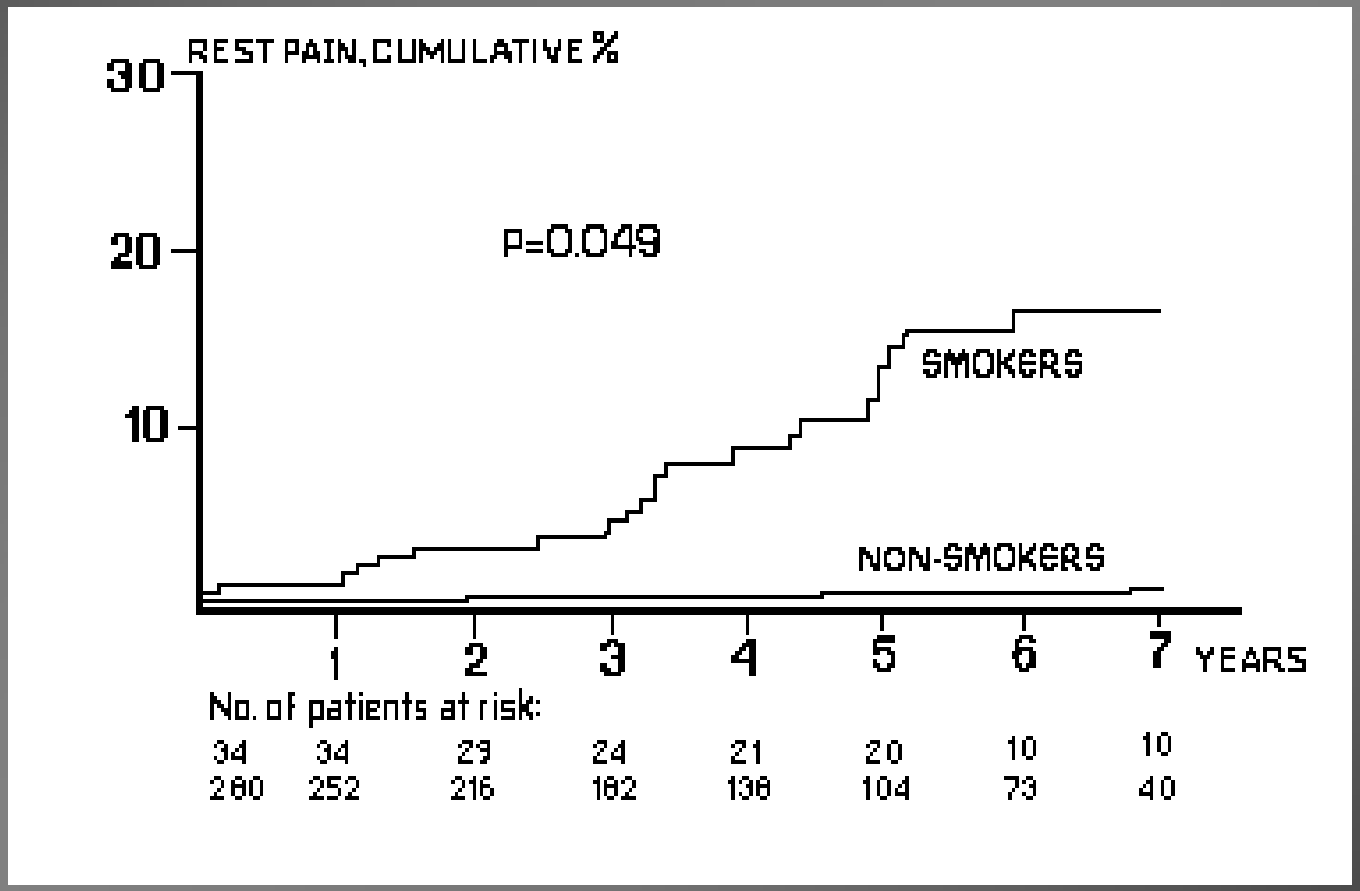
Effect of Smoking Cessation on Survival in PAD

131 Patients Followed After Bypass Graft or Lumbar Sympathectomy Surgery



Faulkner et al. *Med J Aust* 1983;1:217.

Impact of Smoking Cessation on PAD

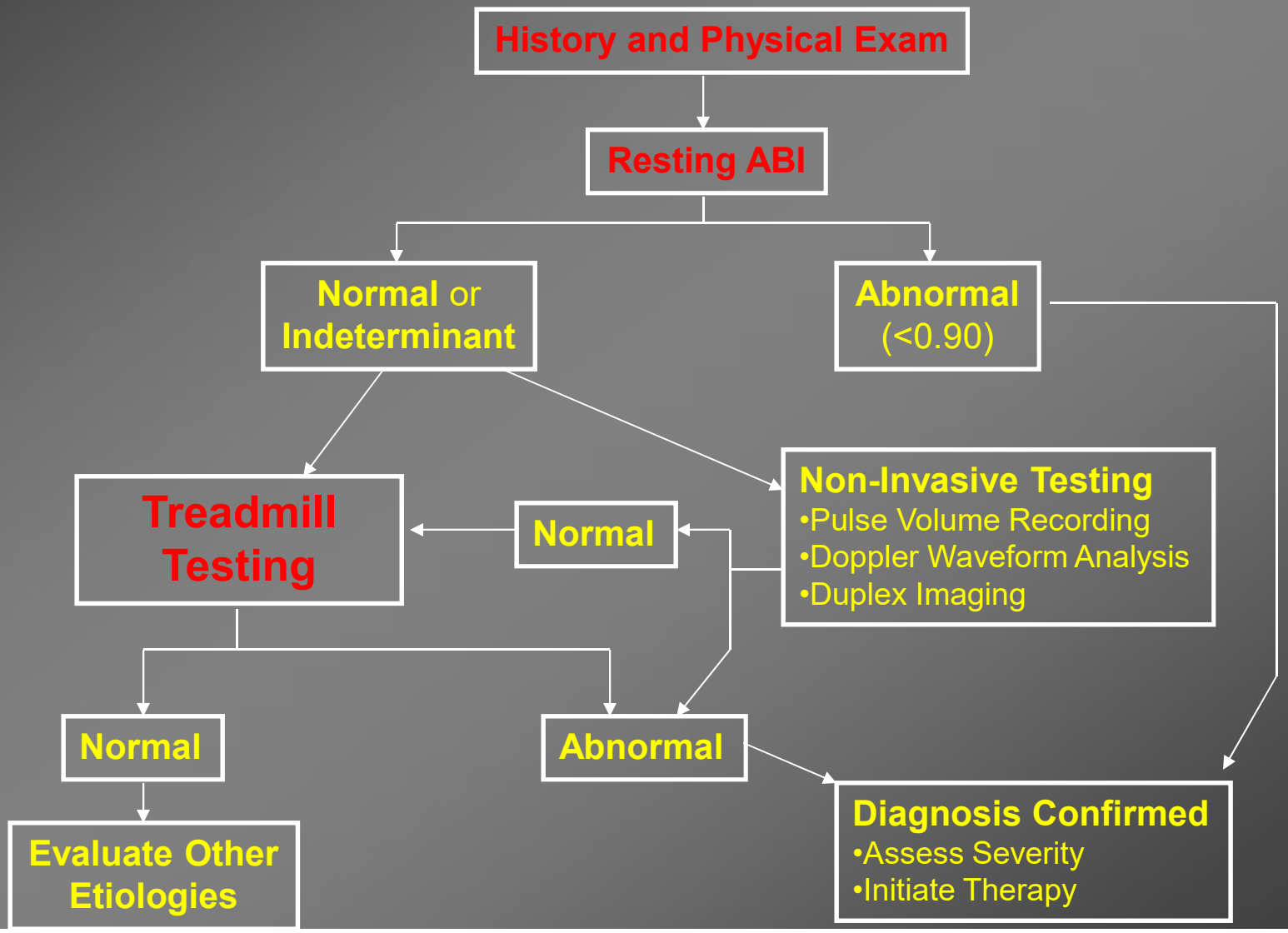


Jonason & Bergström. *Acta Med Scand* 1987;221:253-60

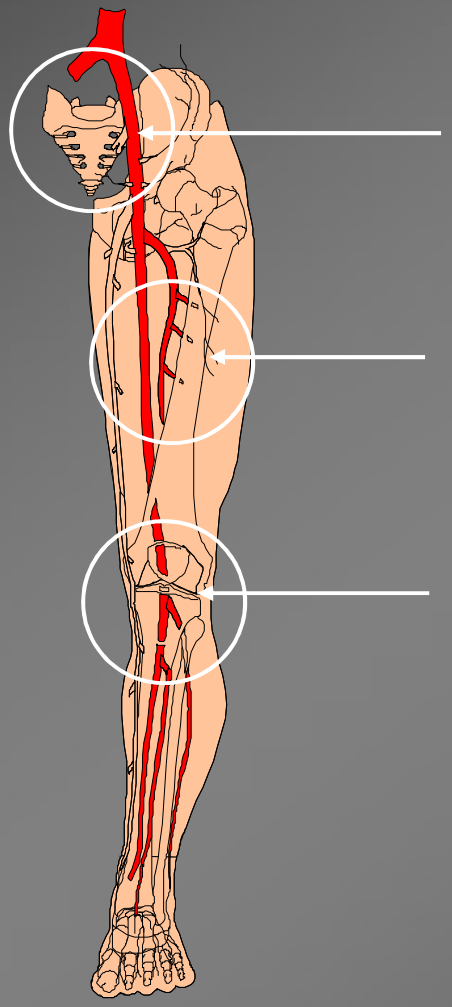
Diagnostic Testing

- Ankle-brachial index
- Segmental limb pressures
- Pulse volume recordings
- Doppler velocity waveform analysis
- Functional testing
  - Treadmill exercise testing
- Duplex scanning
- Advanced imaging techniques

Establishing the Diagnosis of Intermittent Claudication



Common Sites of Claudication

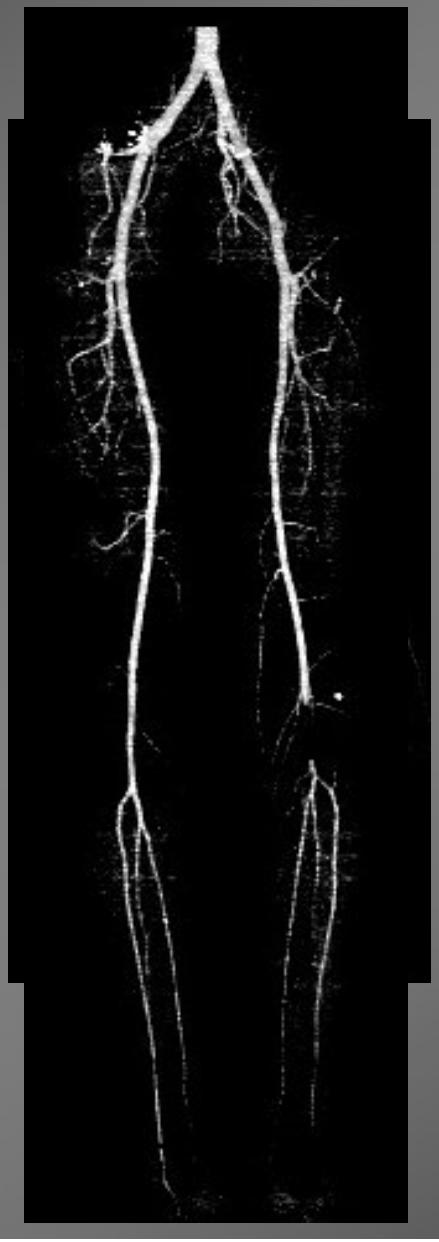


Obstruction in	Ischemia in
Aorta or iliac artery	Buttock, hip, thigh
Femoral artery or branches	Thigh, calf
Popliteal artery or distal	Calf, ankle, foot

Advanced Vascular Imaging

CT Angiography

- Maximum-intensity projection (MIPs)
  - Angiographic like representation
- Volume rendering
  - Preserves depth information
- Multi-planar reformat
- Curved planar reformat (CPR)
  - Perpendicular to median arterial centerline



MR Angiography

- Traditional: Time of flights
- Contrast-enhanced MRA
  - Improves speed of exam, anatomic coverage, and small- vessel resolution
- Time-resolved gadolinium enhanced sequences
  - Time-resolved imaging of contrast kinetics (TRICKS)
  - Provides angiographic like dynamic contrast passage
- Moving-table technique or multi-array, parallel-imaging
  - Optimize large field-of-view imaging

Treatment of PAD

Therapies Based Upon Symptoms

Intermittent Claudication

- Exercise Therapy
- Risk Factor Modification
- Revascularization
  - *Severe disability*

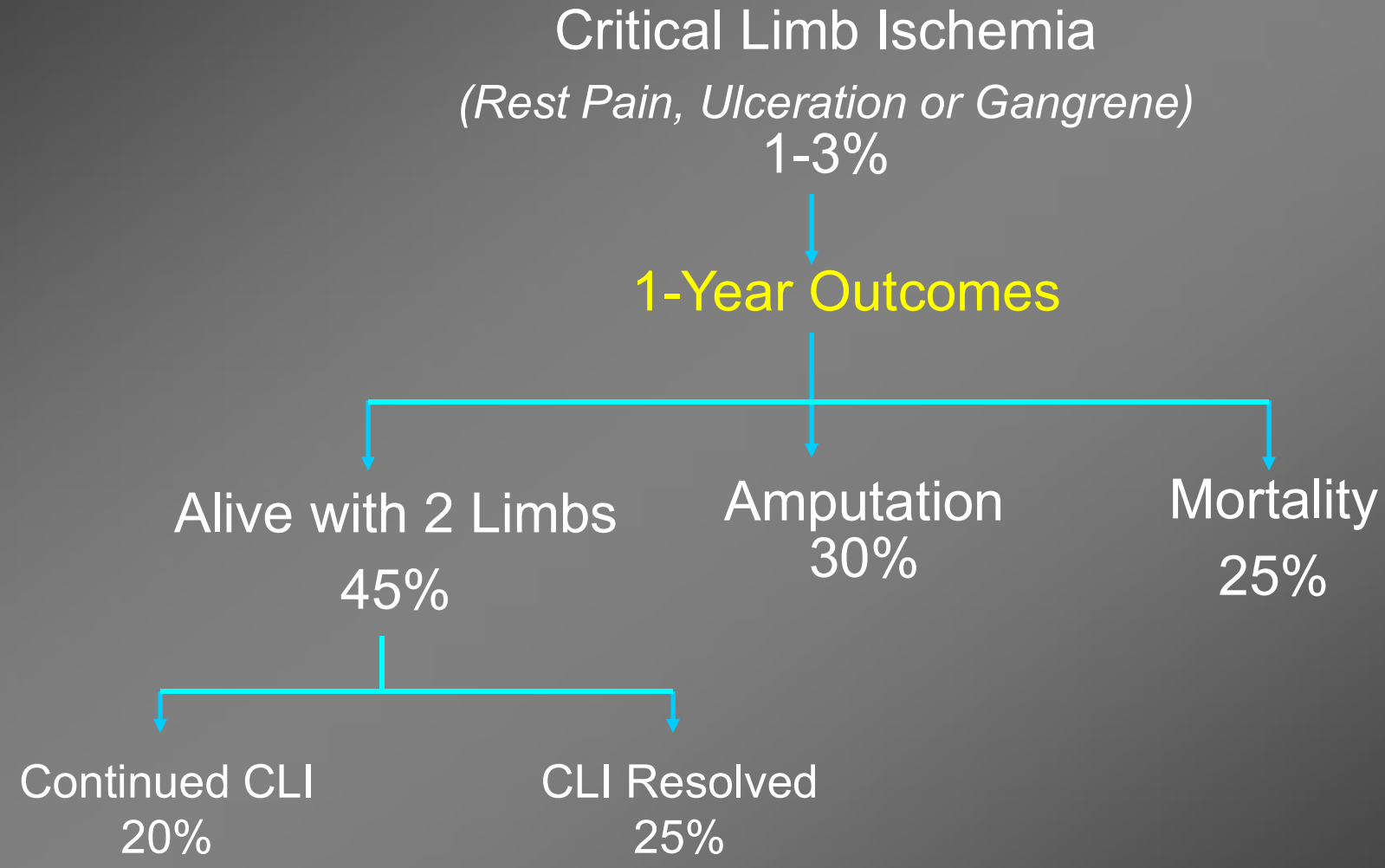
Goal to provide relief of symptoms

Critical limb ischemia

- Wound care
- Antibiotics
- Revascularization
  - Endovascular
  - Surgery

Goal to promote limb survival

Natural History of Critical Limb Ischemia



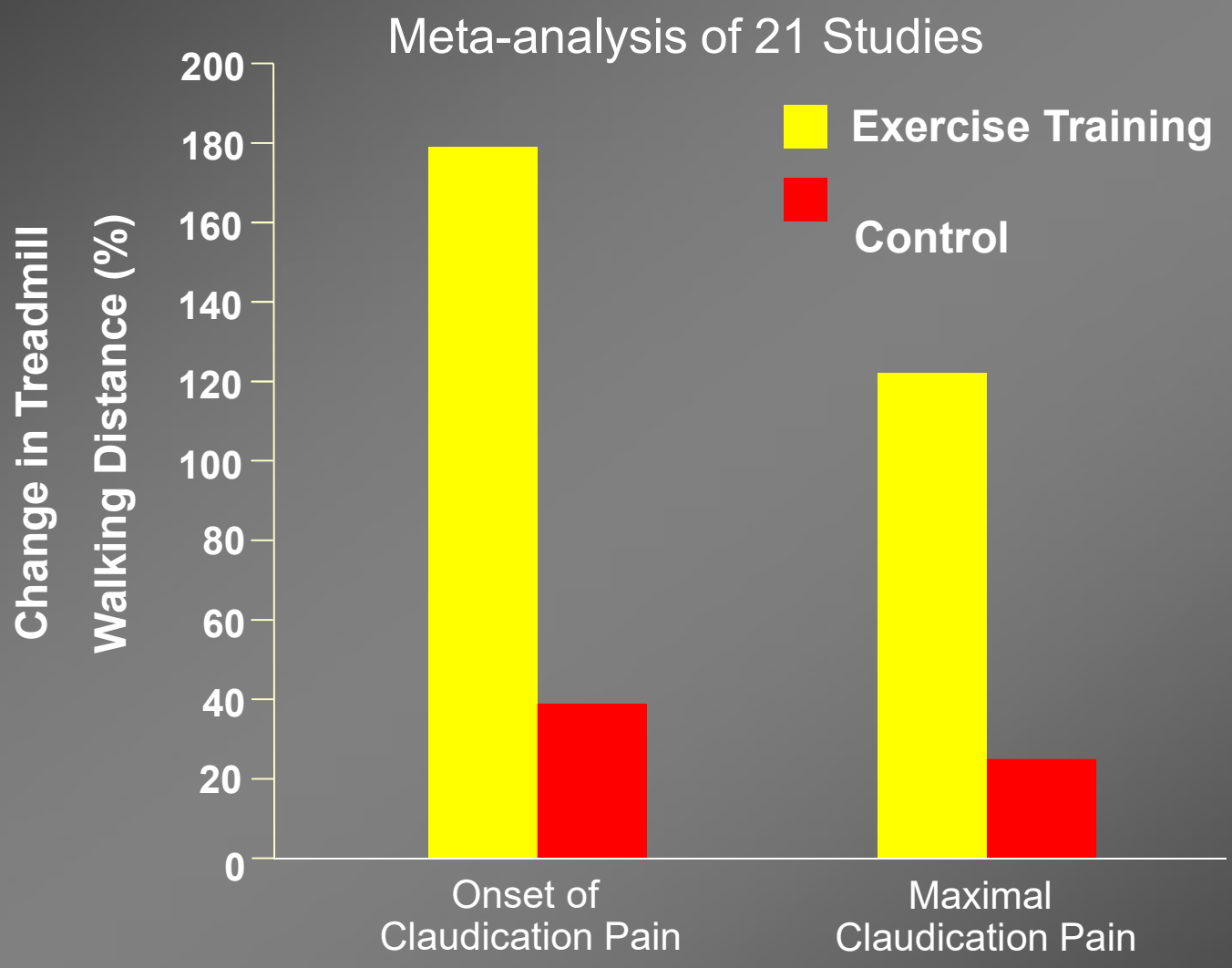
Hirsh et al. *JACC*. 2006;47:1239-1312.

Exercise for PAD?

Your legs hurt when you walk so
go out and walk?

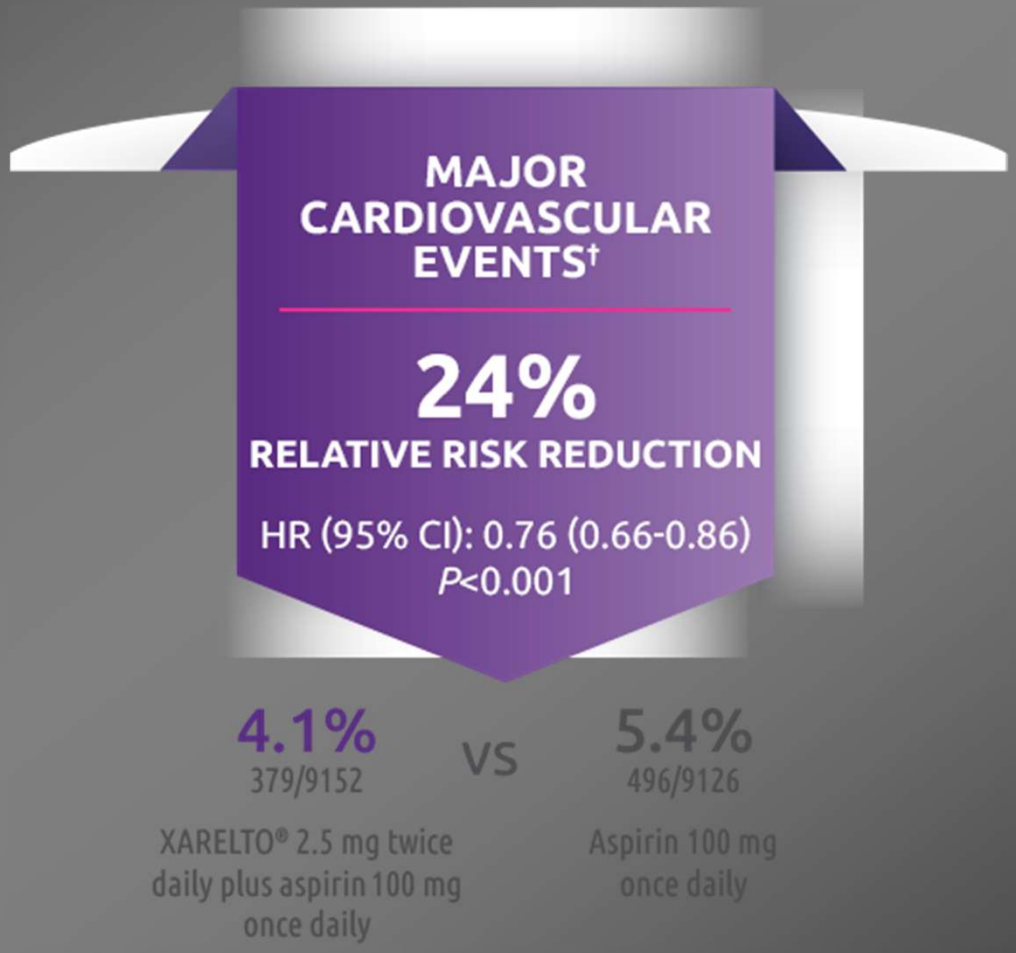
Treatment of PAD

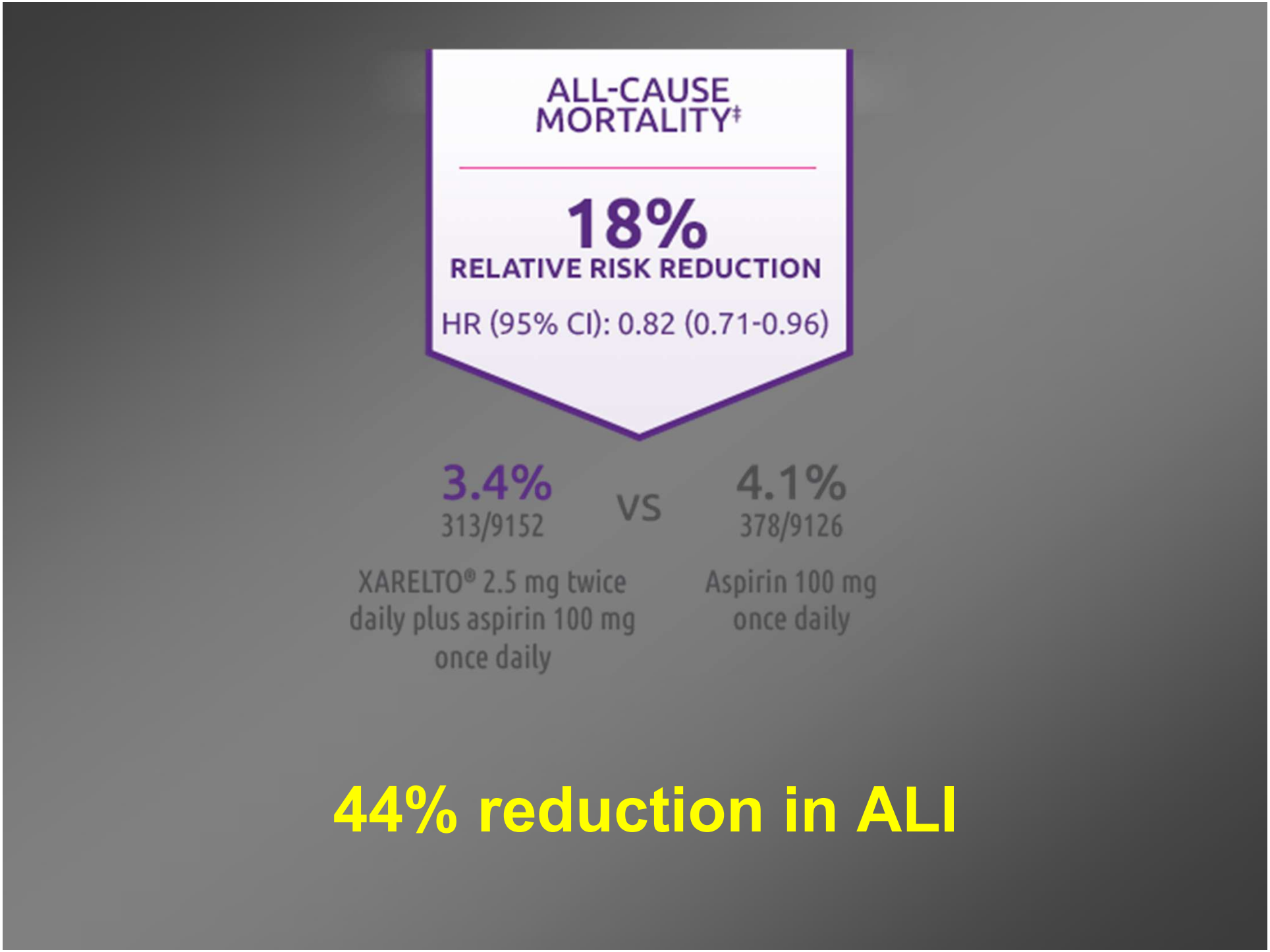
Effect of Exercise Training



Gardner AW. *JAMA*. 1995;274:975-980.

COMPASS Trial
Xarelto 2.5 BID + ASA



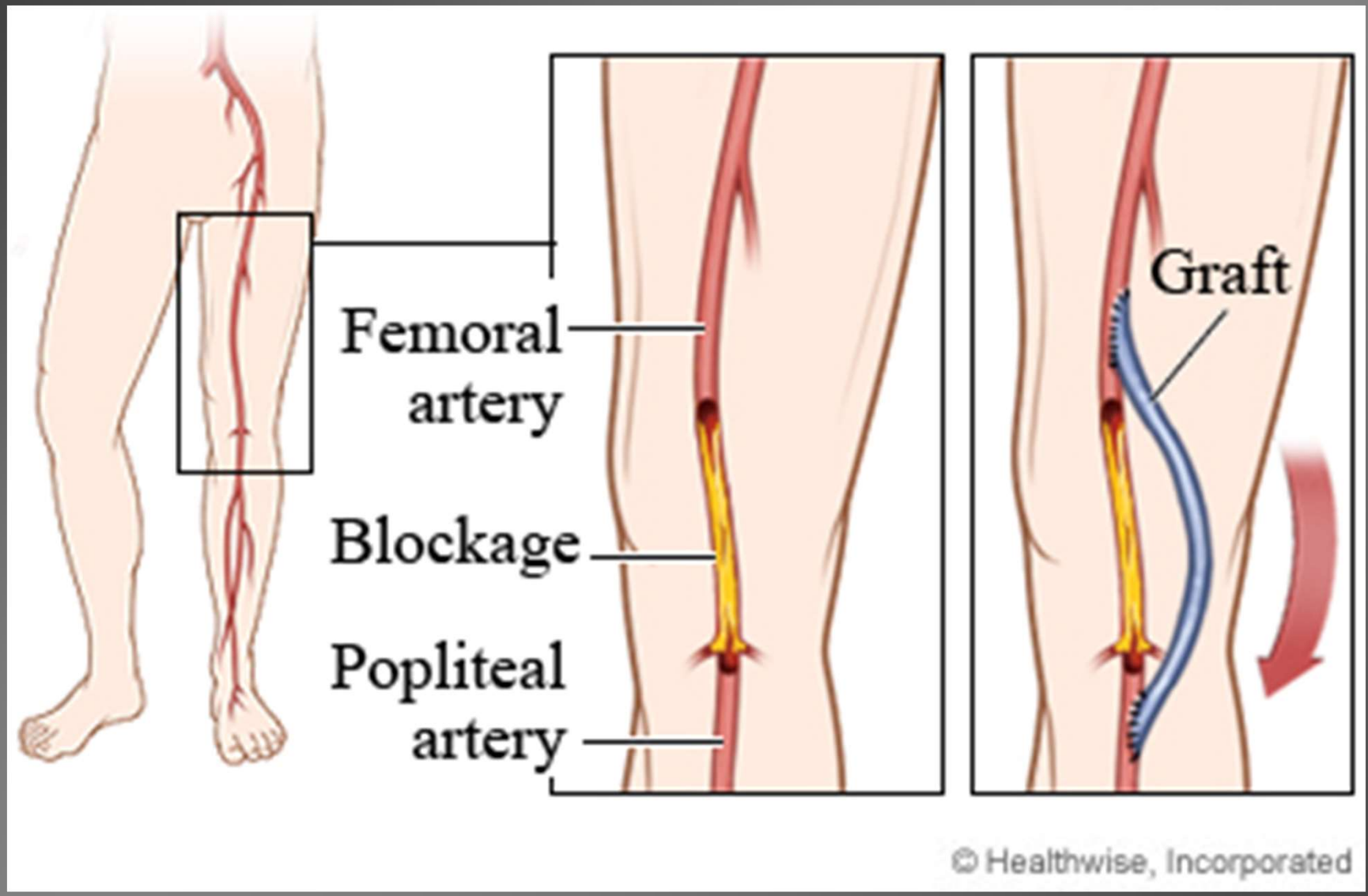

ALL-CAUSE MORTALITY‡
18%
RELATIVE RISK REDUCTION
HR (95% CI): 0.82 (0.71-0.96)
3.4%
313/9152
XARELTO® 2.5 mg twice daily plus aspirin 100 mg once daily
VS
4.1%
378/9126
Aspirin 100 mg once daily
44% reduction in ALI

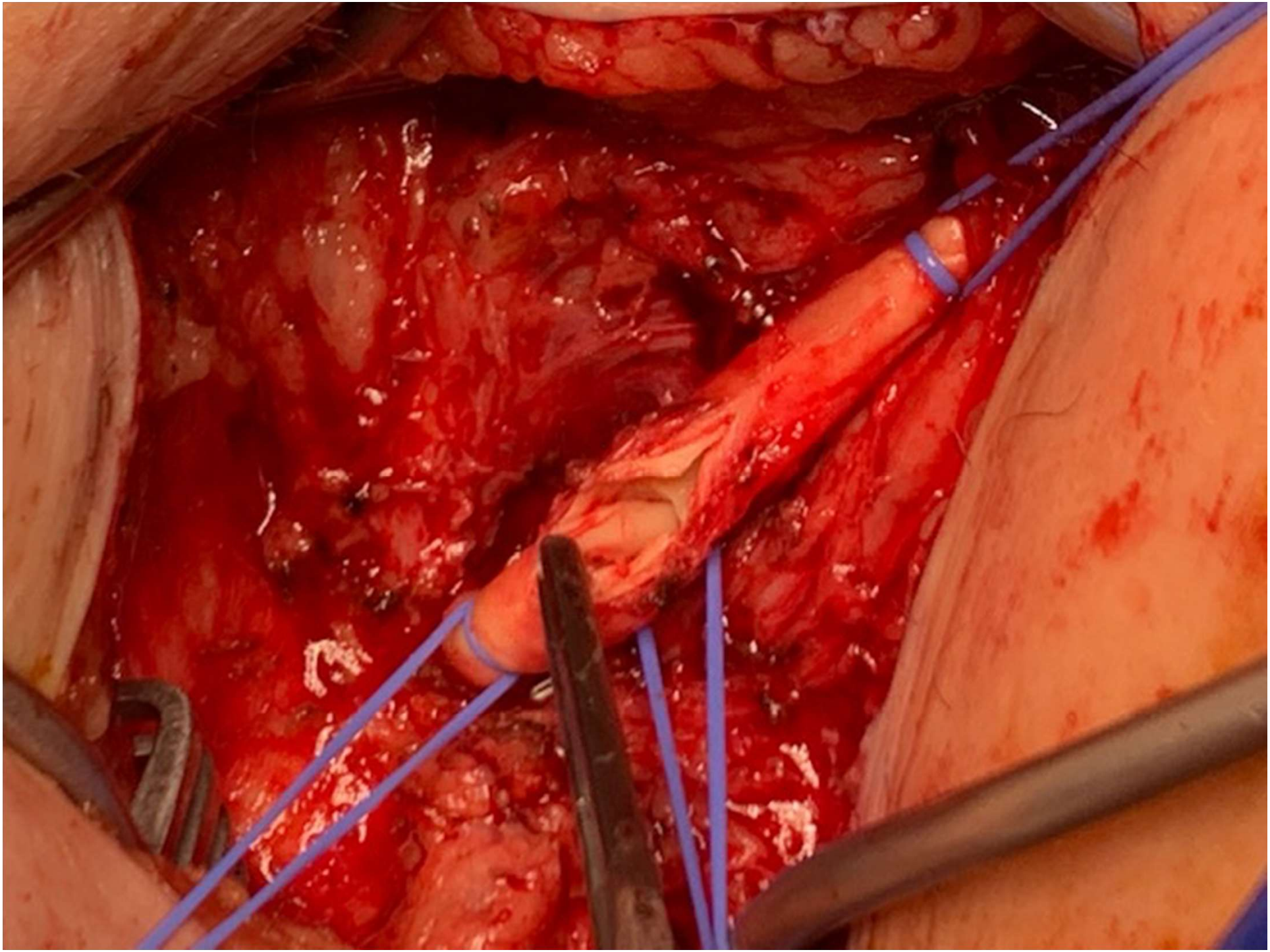
Failed Conservative MGMT

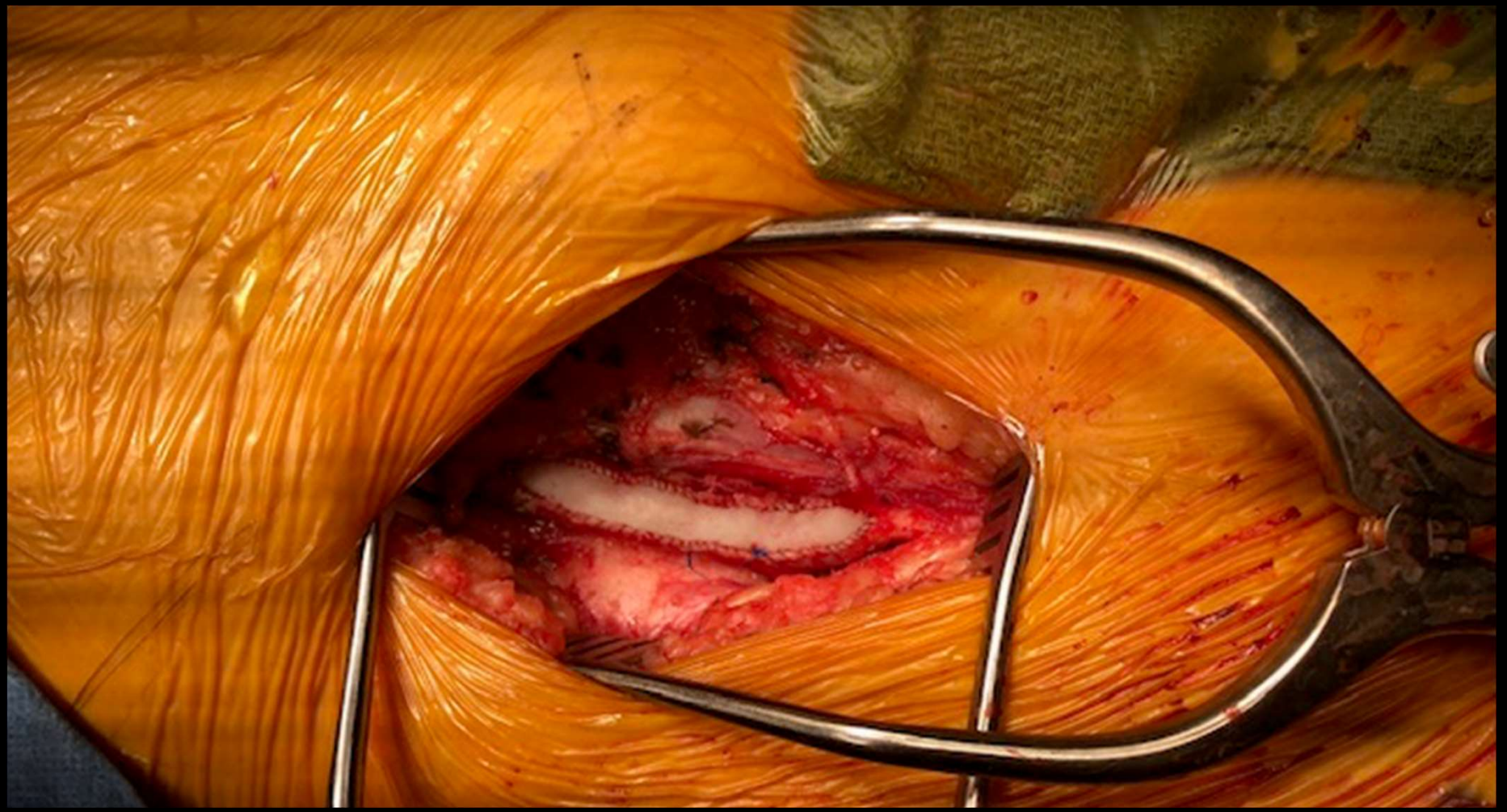
- Invasive Therapy
  - Endovascular
  - Open Surgical
  - Hybrid

Open Surgical

- Bypass
- Endarterectomy
- Amputation


Femoral artery
Blockage
Popliteal artery
Graft
© Healthwise, Incorporated





Endovascular Revascularization

- Aortoiliac Reconstructions
- SFA Stenting
- Atherectomy
- DCB angioplasty
- Thrombolysis
- Endovascular Bypass

Revascularization for Aorto-Iliac Arterial Disease

Aortofemoral Bypass

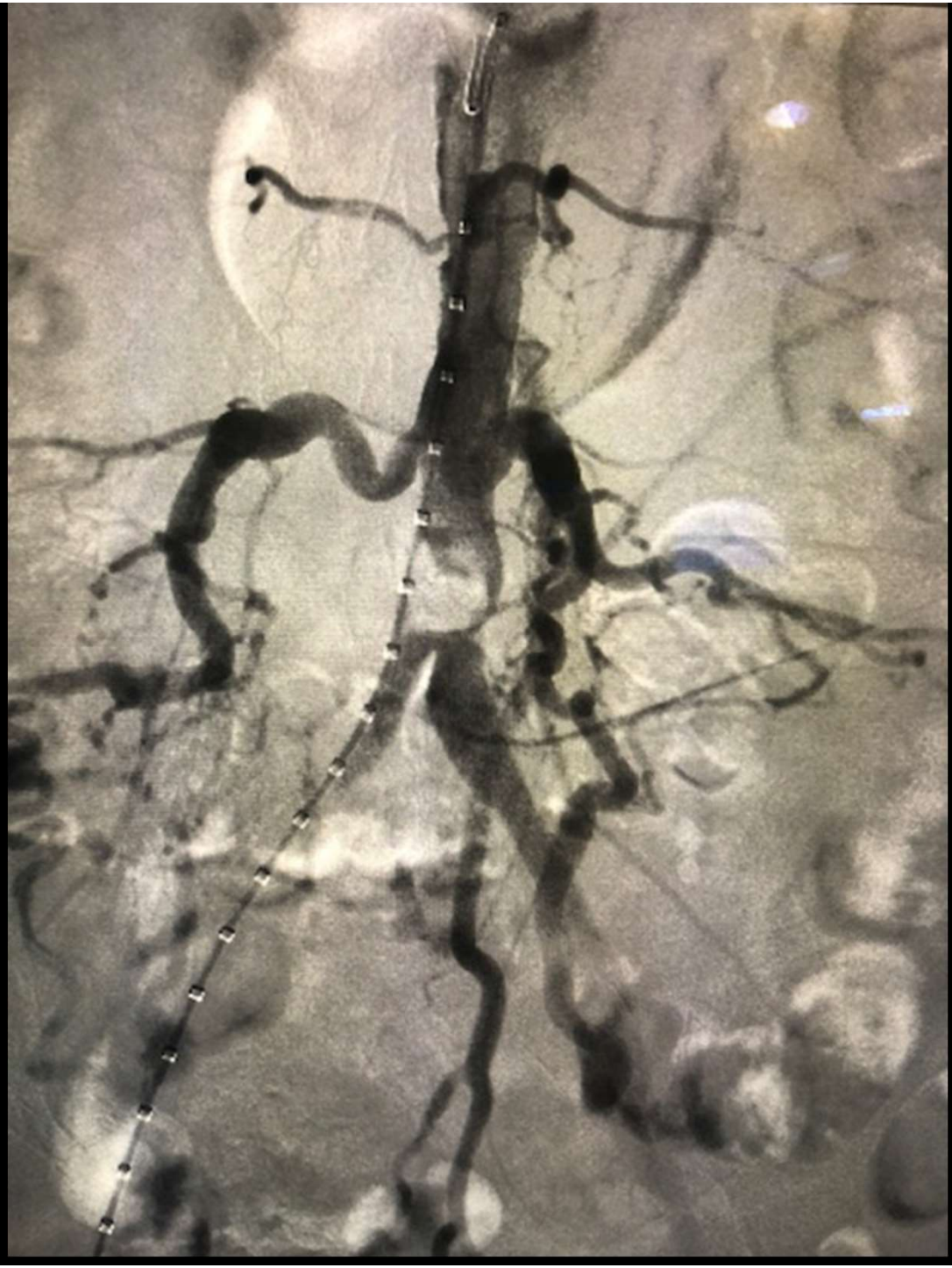
- Primary patency at 5 years of 81-85%[1]
- Perioperative mortality 5-8%[1]
- Reserved for severe diffuse disease cases[2]

1. Raptis S. et al. Eur. J. Vasc. Endovasc. Sur. 1995; 9: 97-102
2. Rosenfield K and Isner JM. Chap 97 in Textbook of Cardiovascular Medicine 1998

Percutaneous Intervention

- Patency at 5 years of 65-80%[1]
- Perioperative mortality 0.1%[1]
- Treatment of choice[3]

1. Becker GJ et al. Radiology 1989;170:921-940
2. Belli A-M et al. Clin Radiol 1990;41:380-3
3. Rosenfield K and Isner JM. Chap97 in Textbook of Cardiovascular Medicine 1998



Treatment of PAD

Revascularization for Femoro-Popliteal Disease

Femoro-Popliteal Bypass Surgery

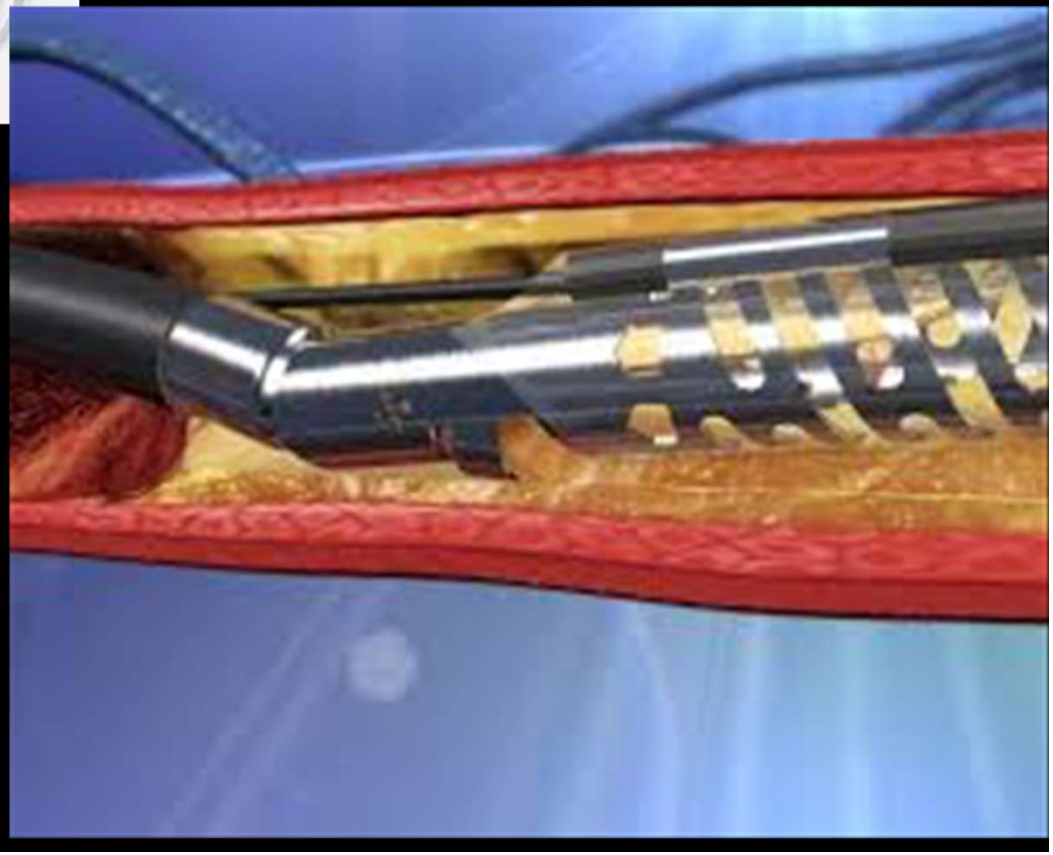
- Primary patency at 5 years of 60-80%
- Autologous veins preferred to synthetic grafts
- Perioperative mortality 0-3%
- Indicated for Rutherford class ≥ 3

Femoro-Popliteal Angioplasty

- Patency at 2-5 years ranges between 40-70%
- Technical problems due several anatomic issues:
  - Occlusions vs stenosis
  - Diffuse disease
  - Adductor canal
  - Disease in run off vessels
- Perioperative mortality is very low
- Indicated for Rutherford class ≥ 2

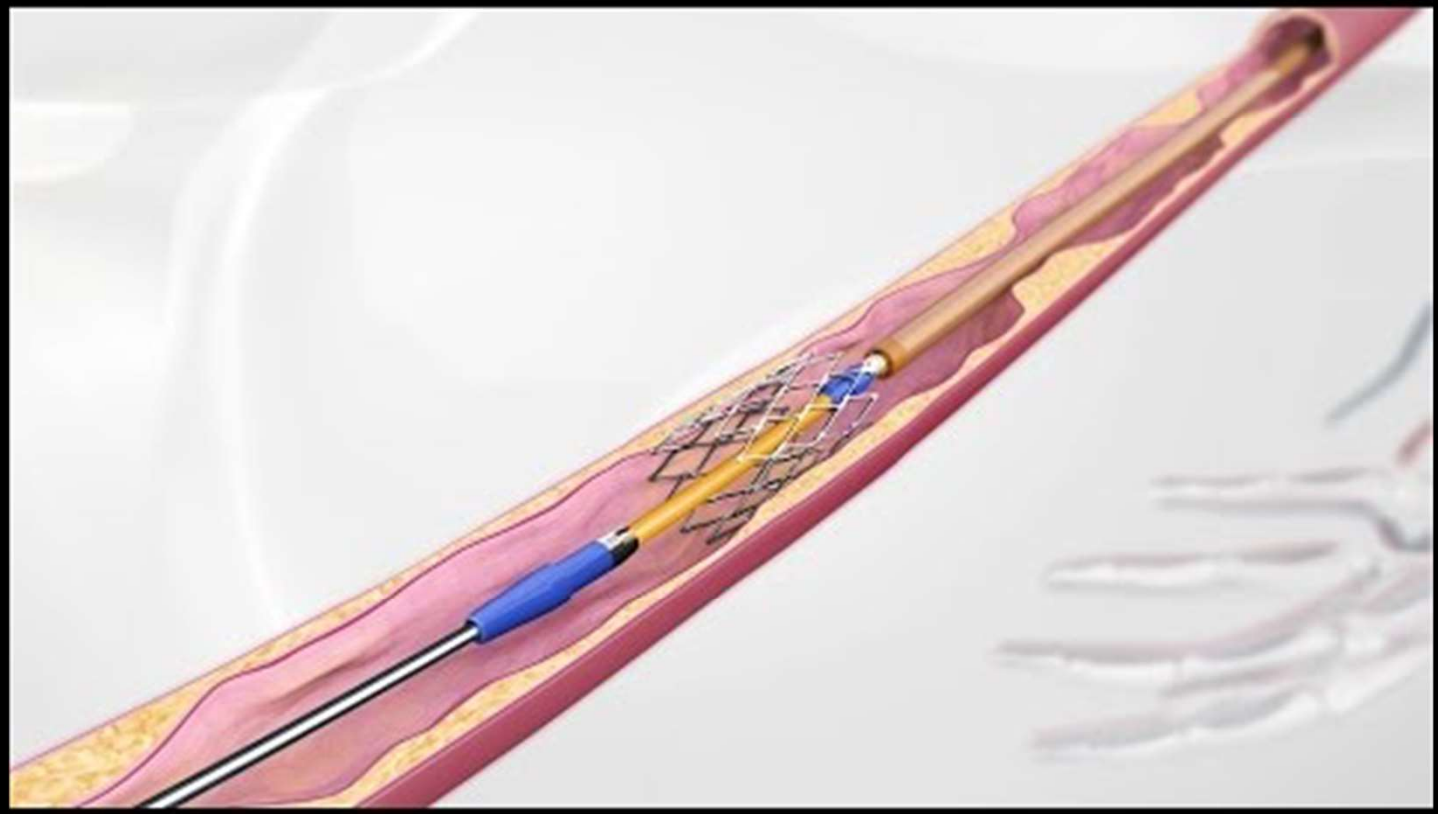
Atherectomy


CSI




Pre-Treatment
Post Jetstream™ Navitus™ Atherectomy
Final Angio

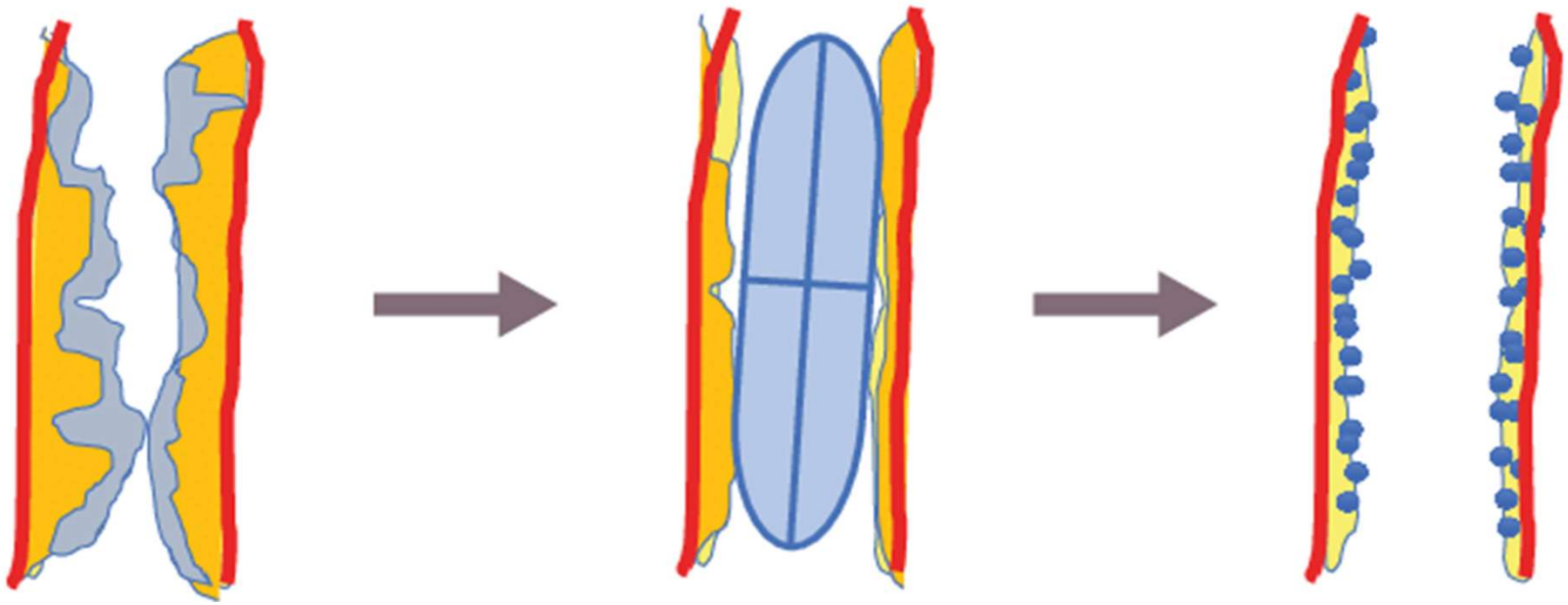
Stenting




A
B
C
D

Drug Coated Balloon Angioplasty

Lesion preparation (debulking) using atherectomy techniques



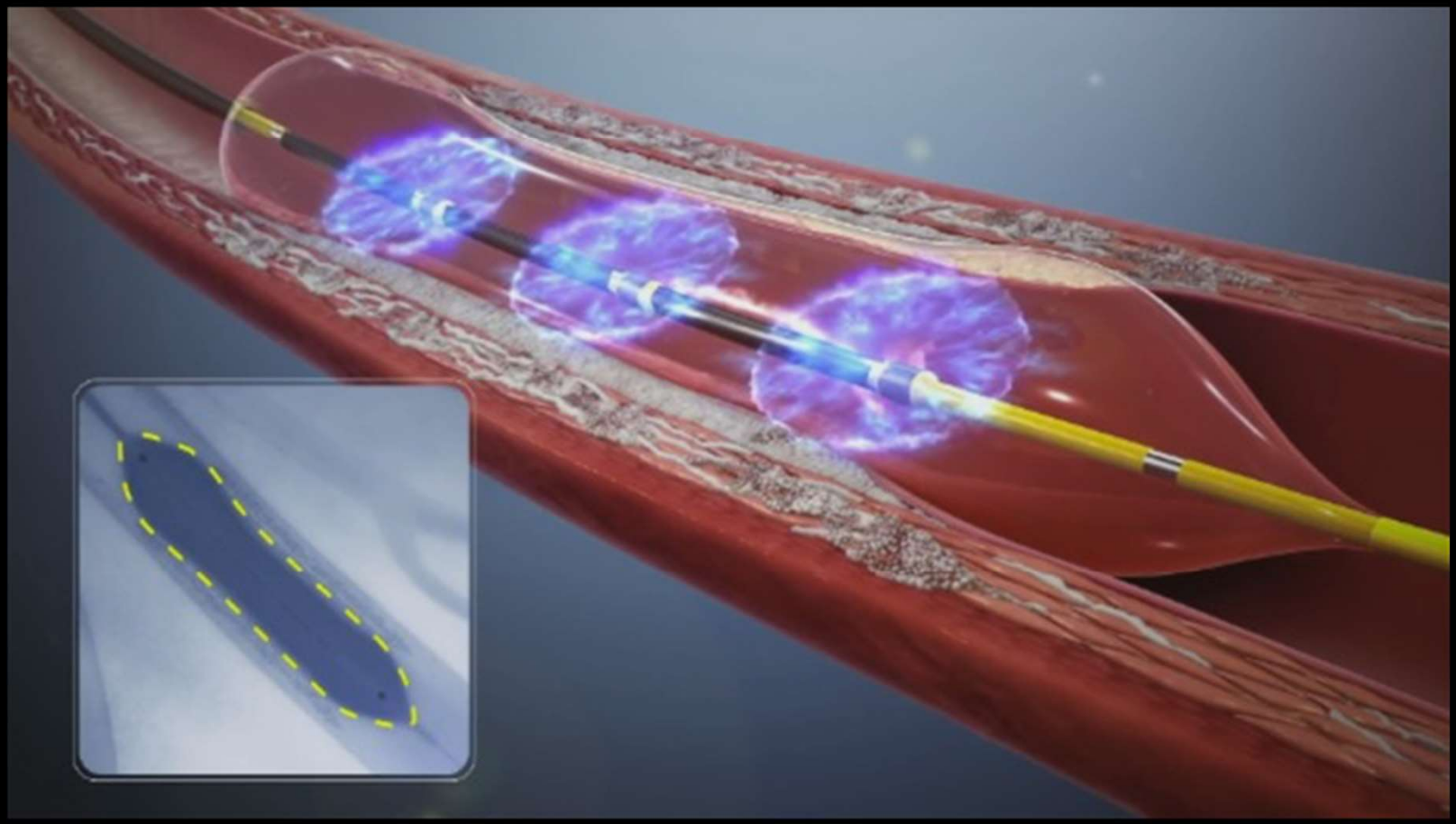
1. Atherectomy removes atherosclerotic/calcific tissue, similar to open surgical techniques, resulting in lumen gain without barotrauma

2. Lesion preparation is followed by low-pressure balloon angioplasty, decreasing the chance of dissection and obviating the need for stent placement

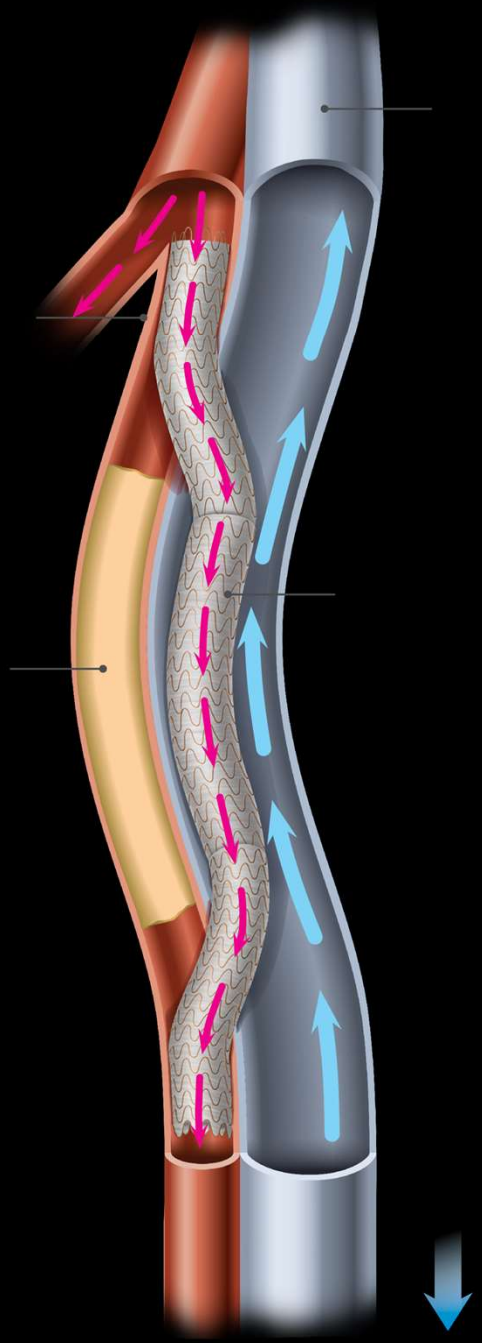
3. Simultaneously, drug delivery to the vessel wall is increased, lowering the chance of restenosis due to neointimal tissue hyperplasia in the long term

Thrombolysis

Lithotripsy



PQ Bypass



Summary of PAD and Its Management

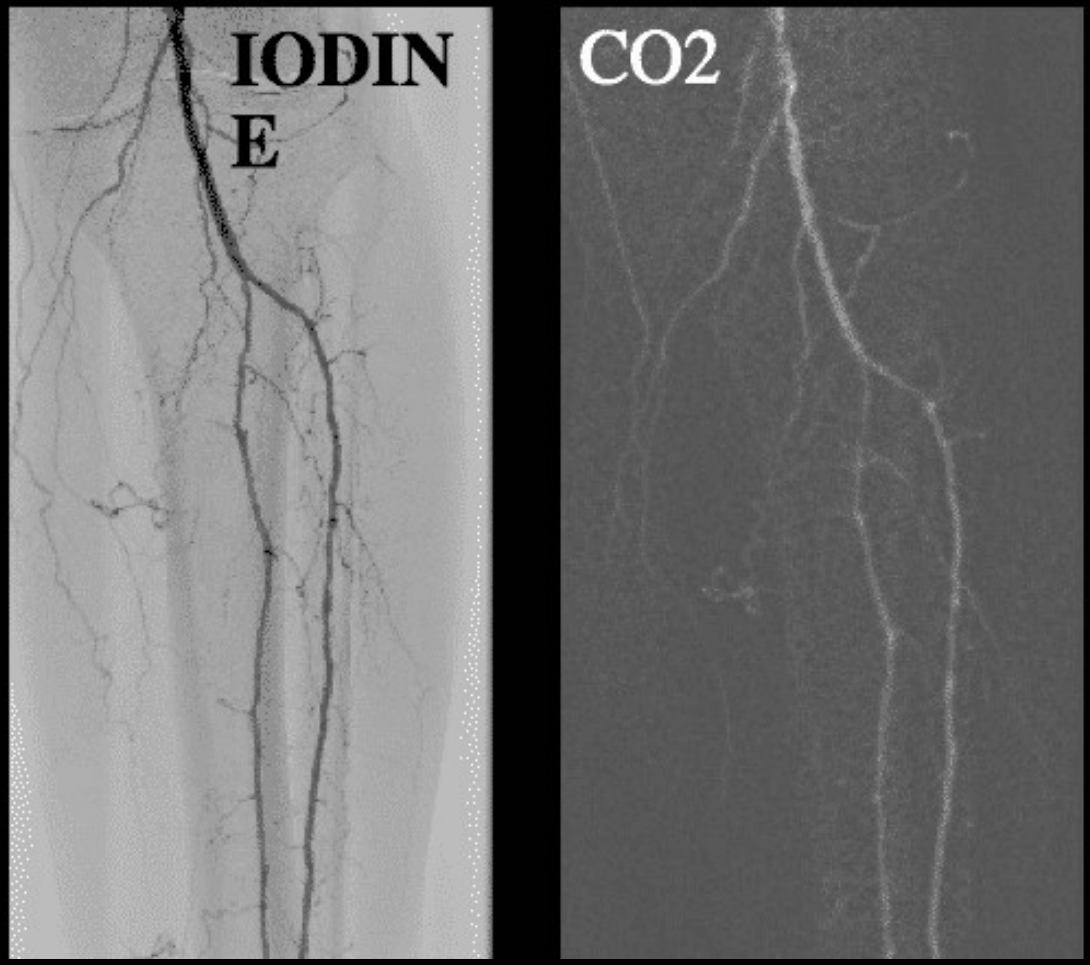
- PAD is common and has a significant impact upon cardiovascular outcomes
- Treatment of PAD, even asymptomatic, should focus on risk factor modification/risk reduction
- Treatment of intermittent claudication should include exercise therapy, drug therapy and selective use of revascularization
- Treatment for critical limb ischemia warrants aggressive efforts at revascularization, including surgery, to reduce the risk of amputation

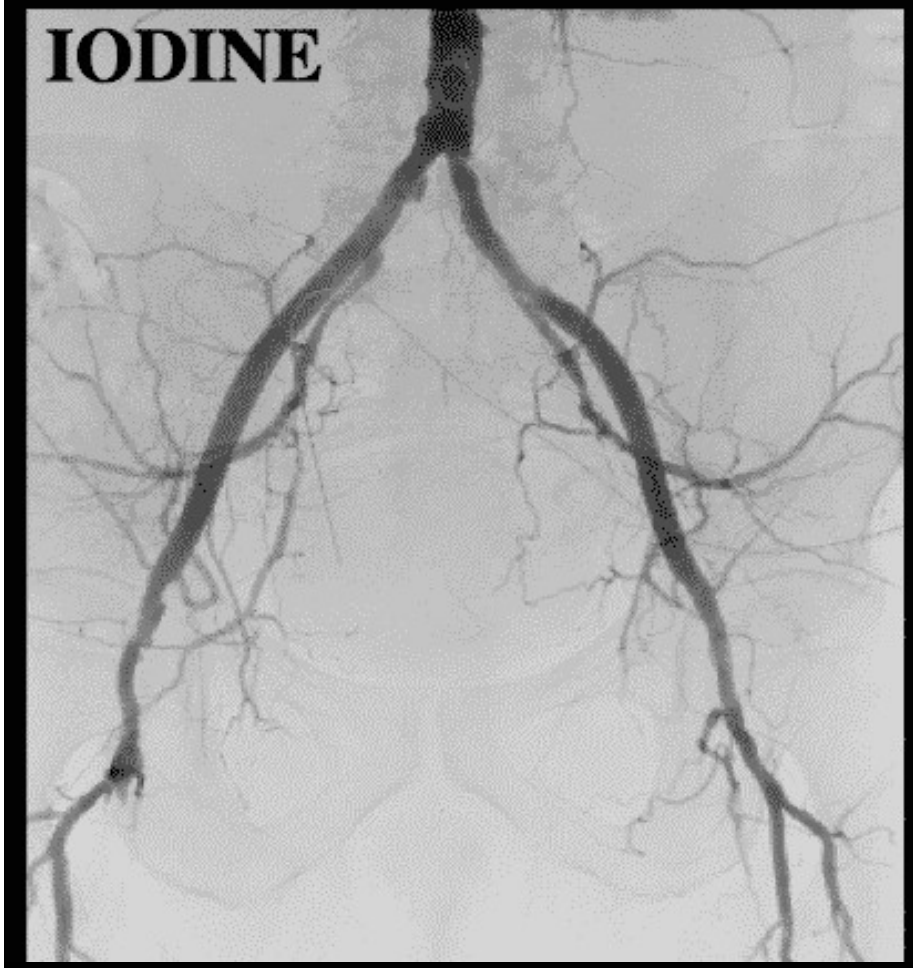
ESRD

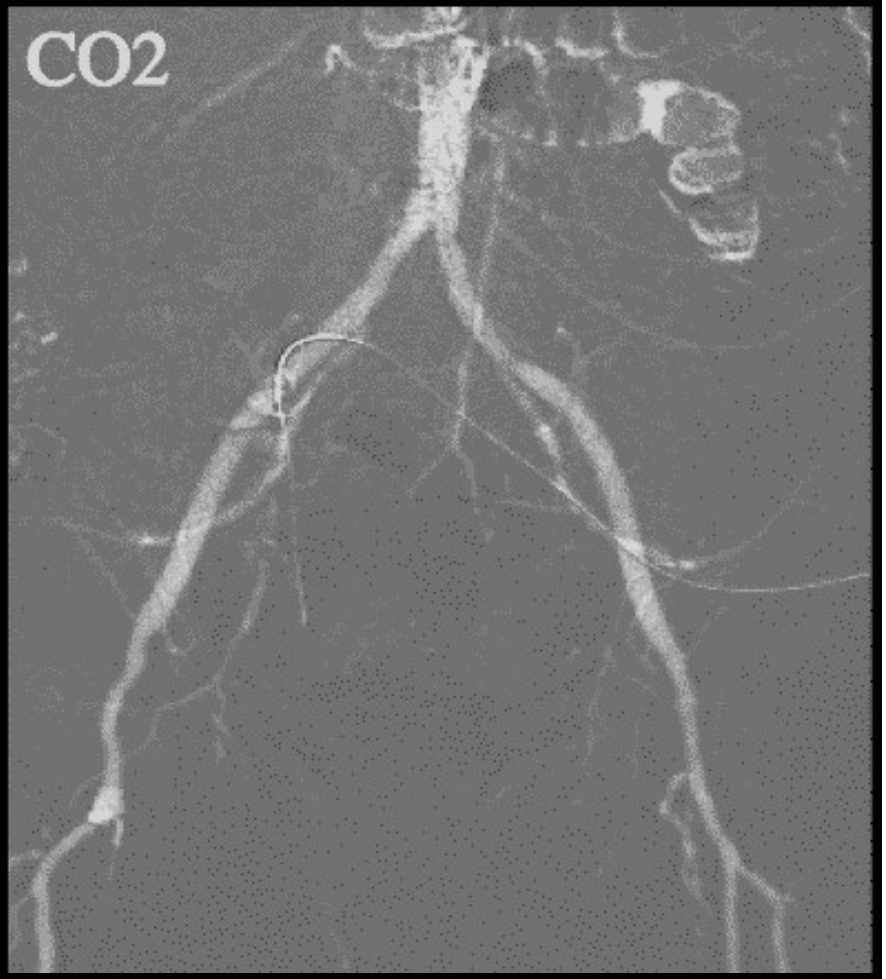
CKD Angiography

New Access Options

CO2



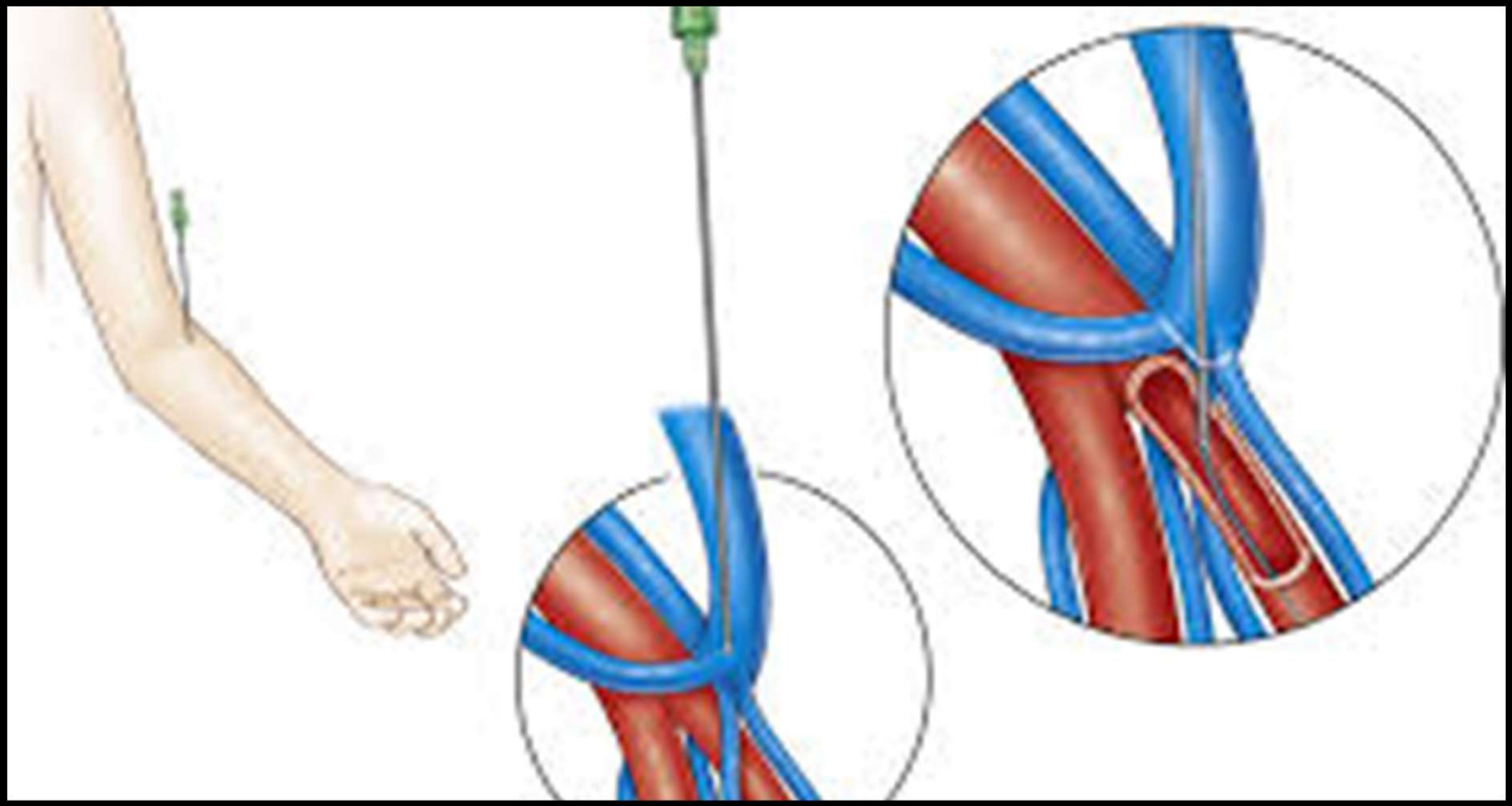

IODINE

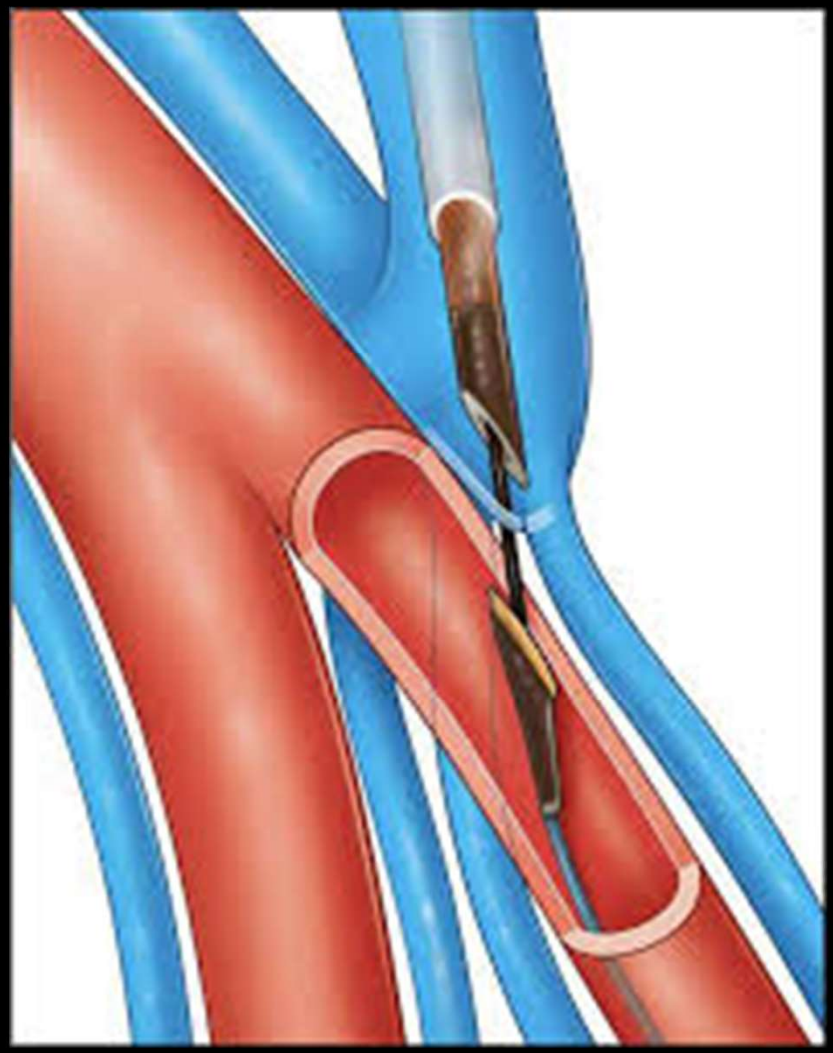

CO2

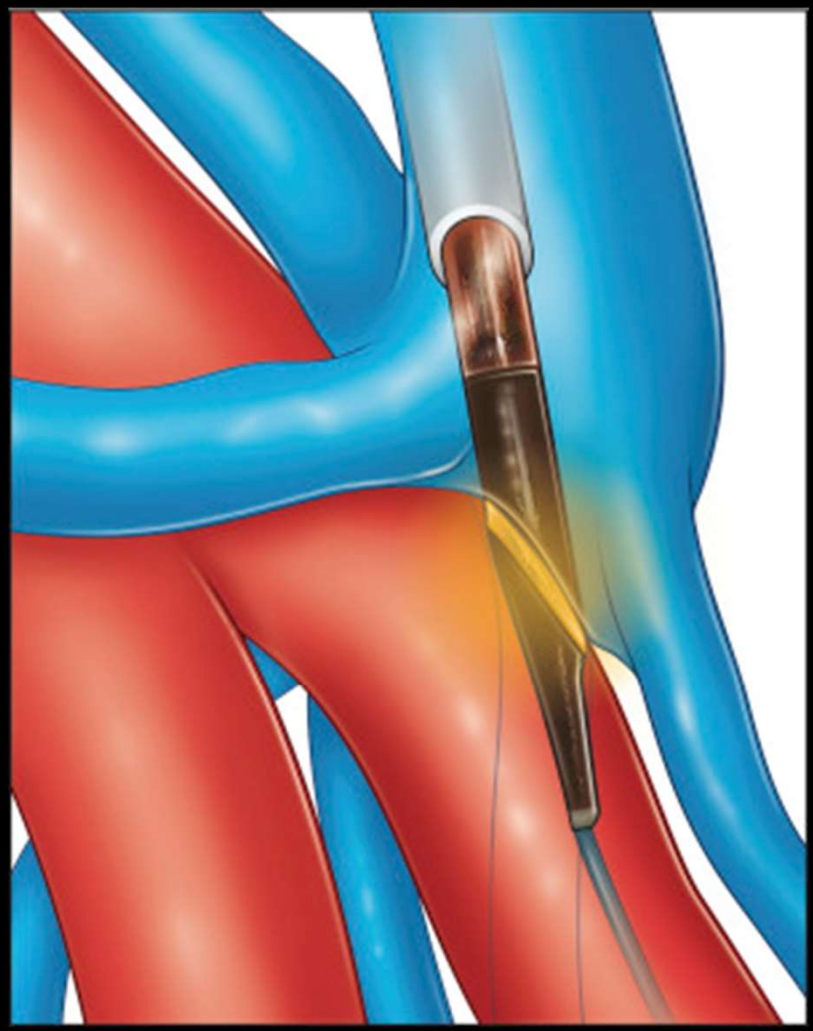
Percutaneous AVF

- Ellipsys
- Wavelinq

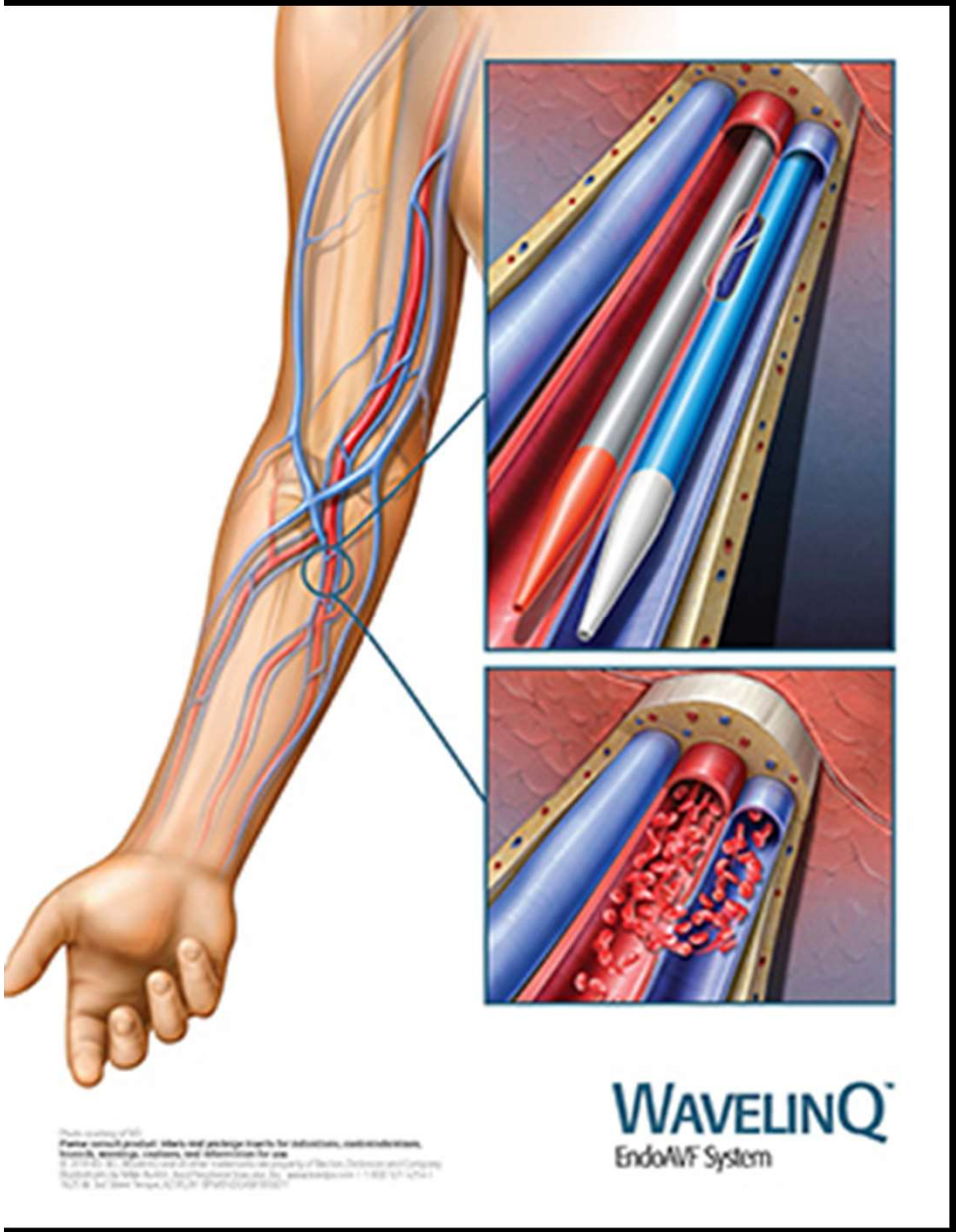
Ellipsys

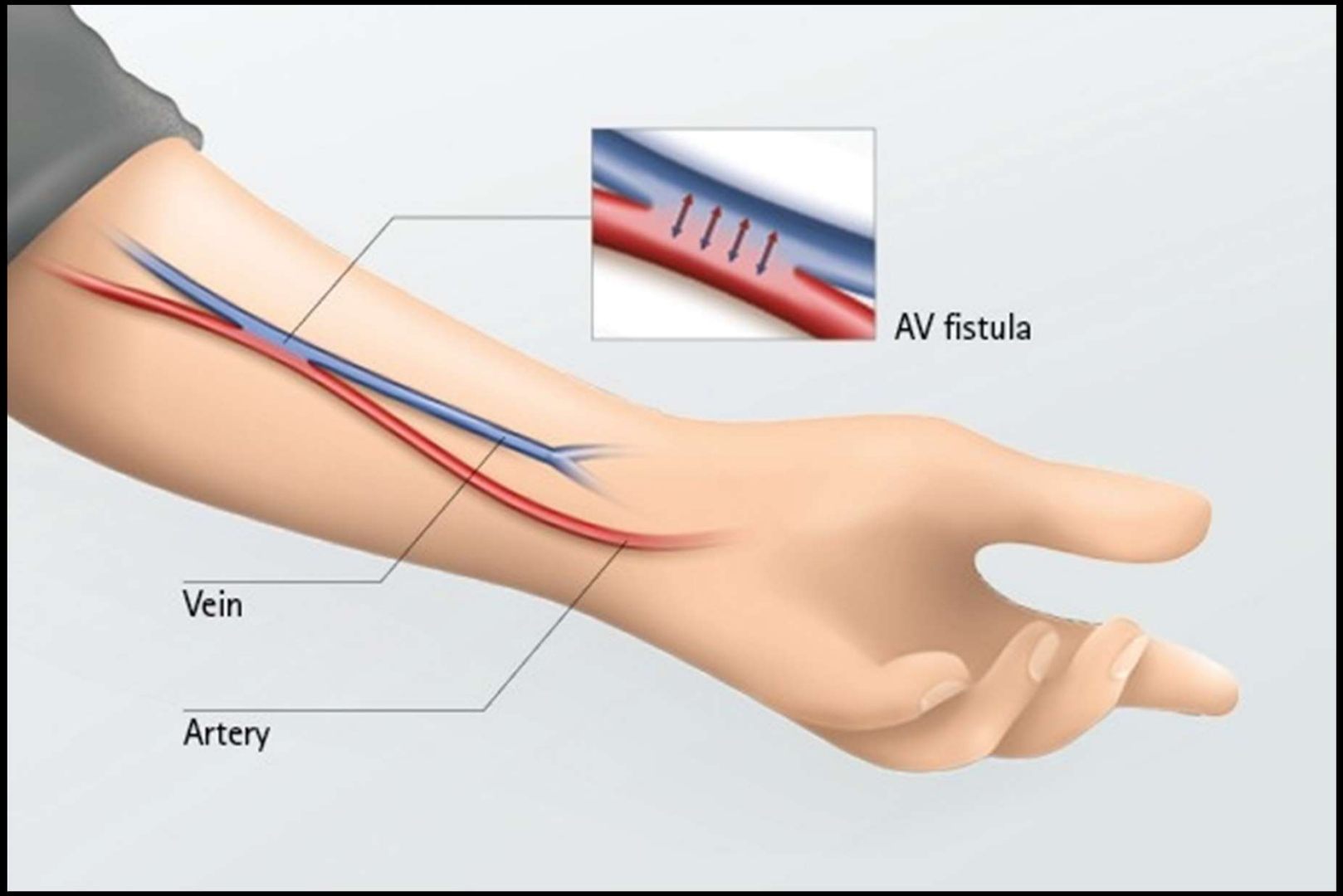






Wavelinq




AV fistula
Vein
Artery

Cerebrovascular Disease

Screening

- No good guidelines
- Recommended against screening in the asymptomatic general population
- Recommend screening in patients with bruits who are candidates for intervention and in pre-op planning of CABG surgery

Screening

- Potential “High Risk” Group
  - >60
    - HTN
    - CAD
    - Smoking
    - 1st Deg relative with a CVA

    - 1 = 6%
    - 2 = 14%
    - 3 = 16%
    - 4 = 76%

Recommended Imaging

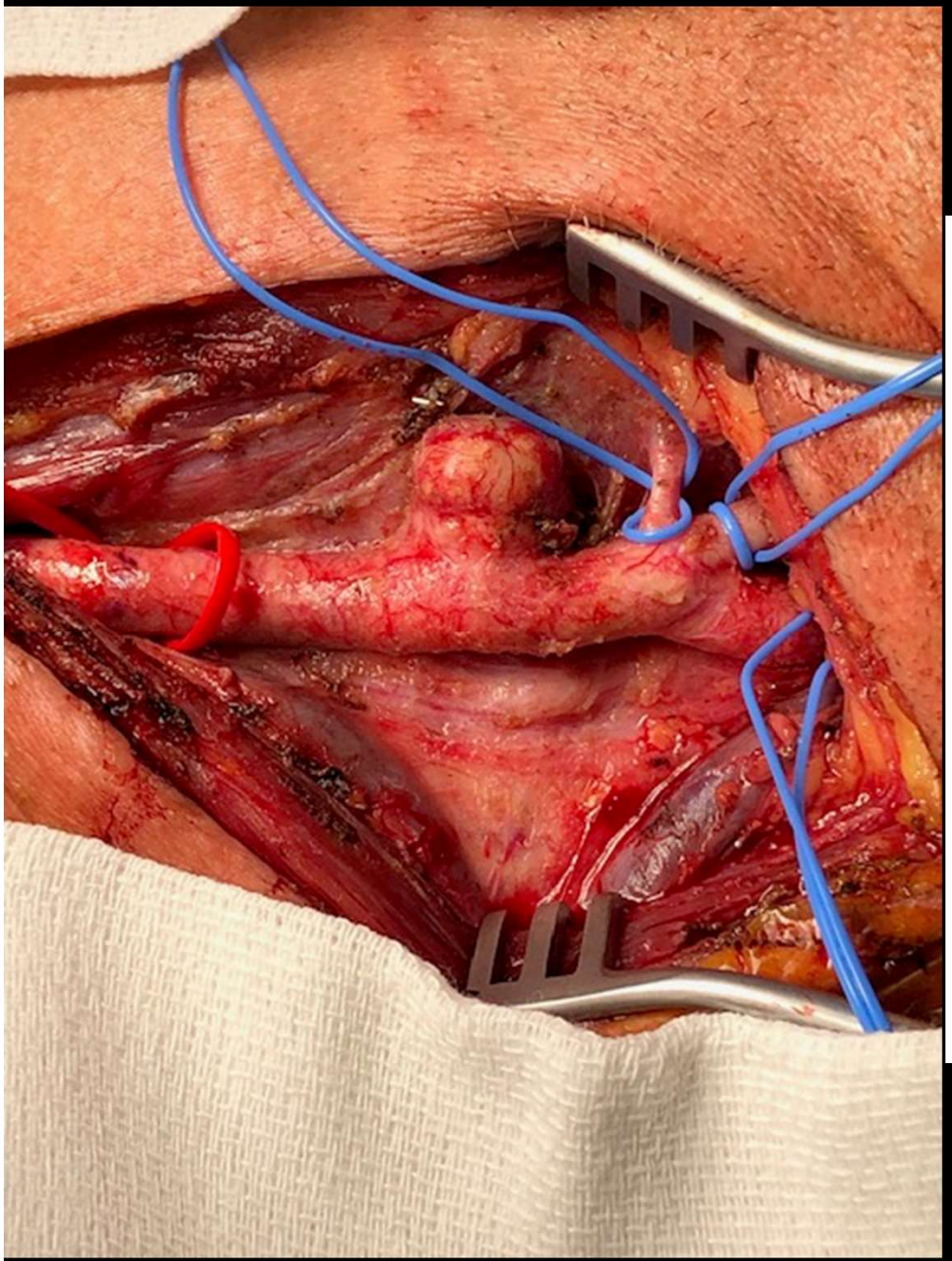
- TIA/CVA w/in 6 mo
- Amaurosis Fugax
- Retinal Artery Occlusion
- Asymptomatic Cerebral Infarction

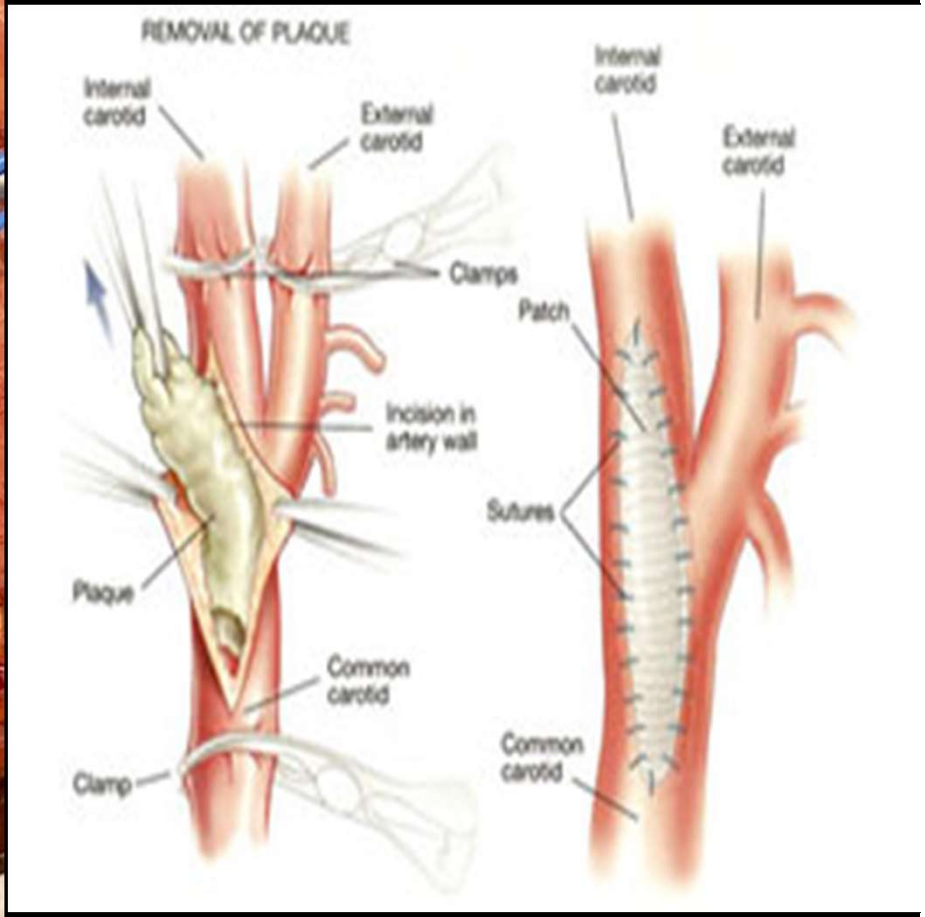
Indications

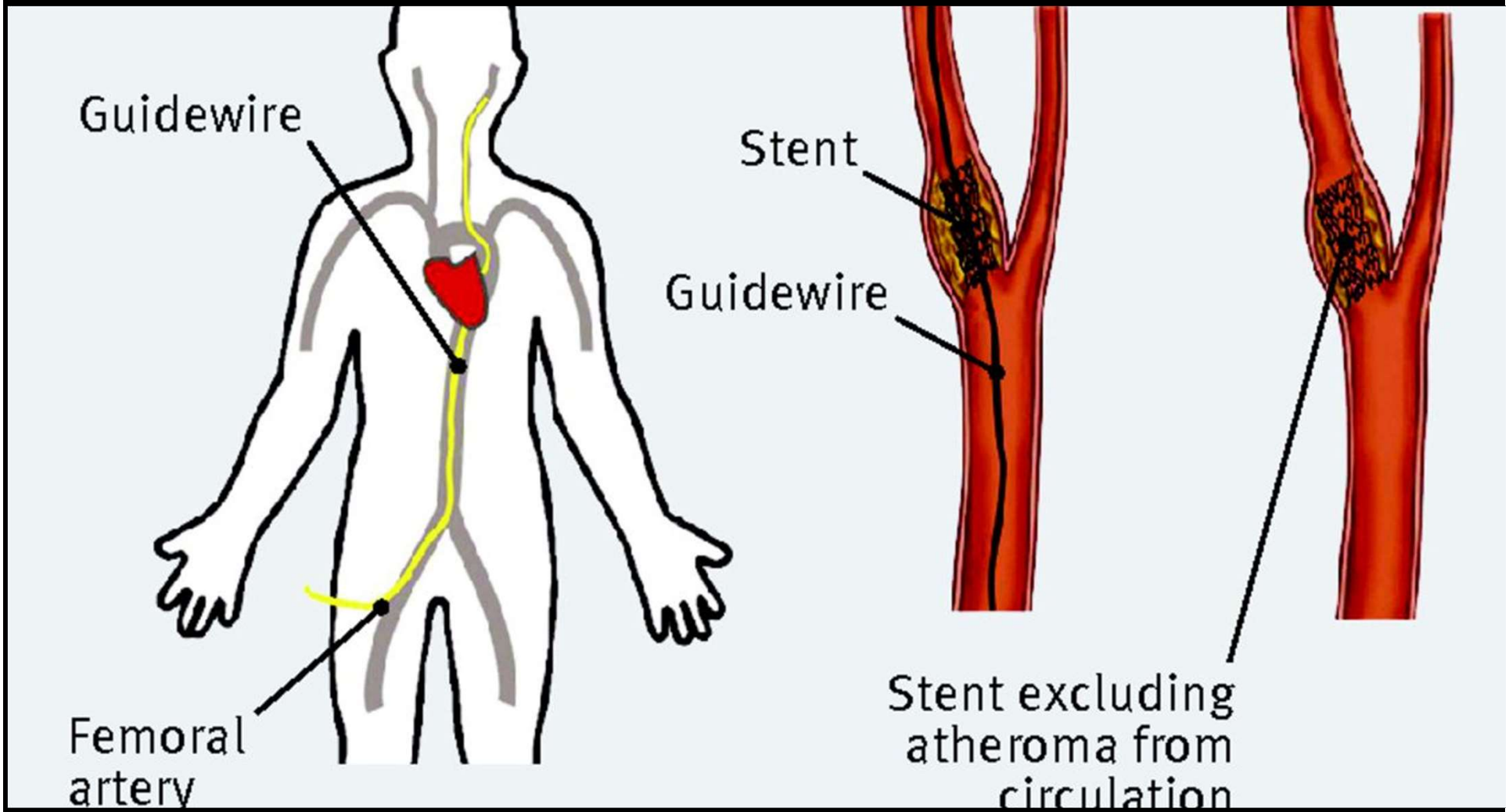
- Greater then 80% stenosis
  - US, CTA, Angiography
- Symptomatic Disease
  - TIA/CVA w/in 6 mo
  - Amaurosis Fugax
  - Retinal Artery Occlusion
  - Asymptomatic Cerebral Infarction

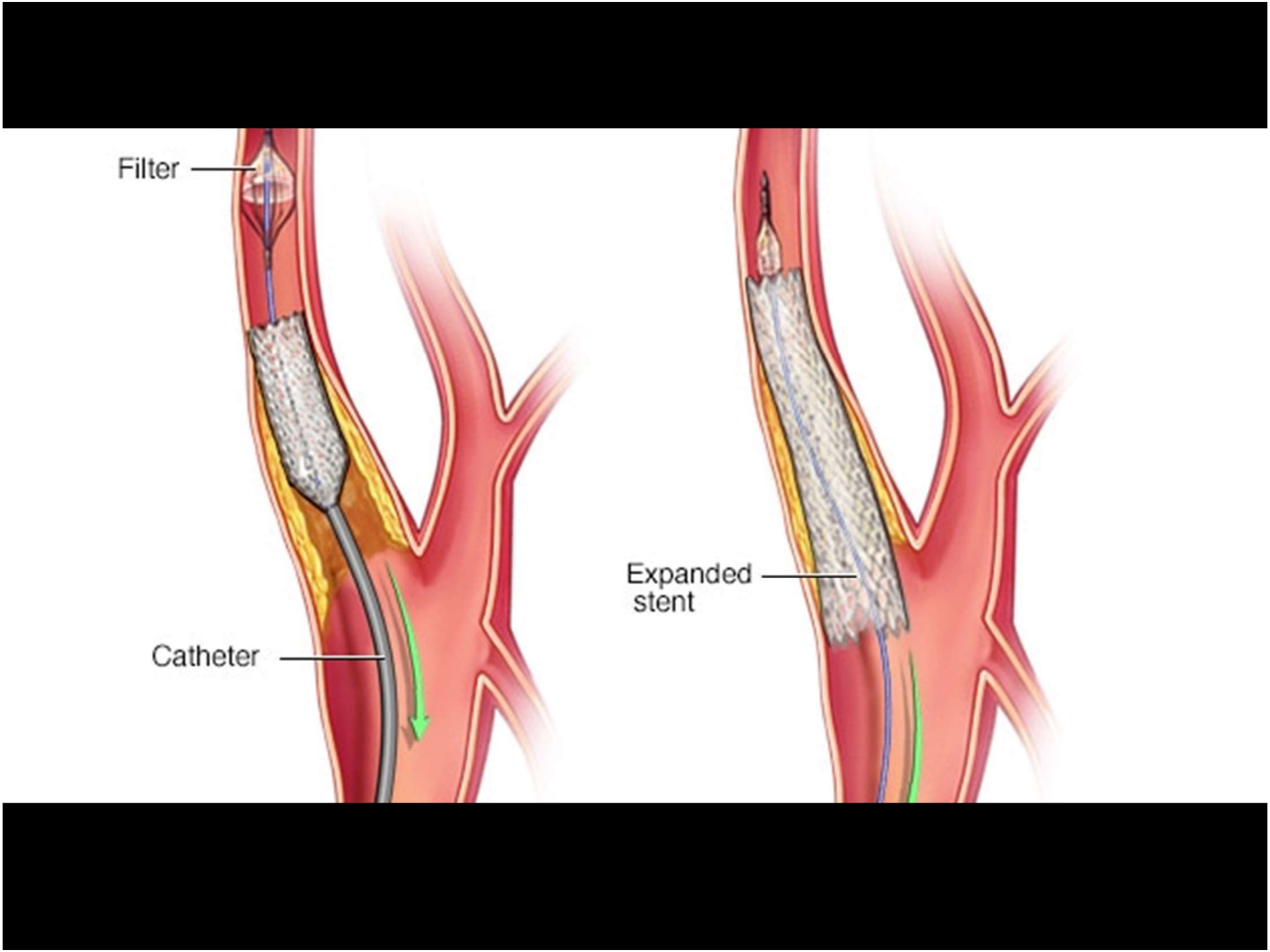
Treatment Options

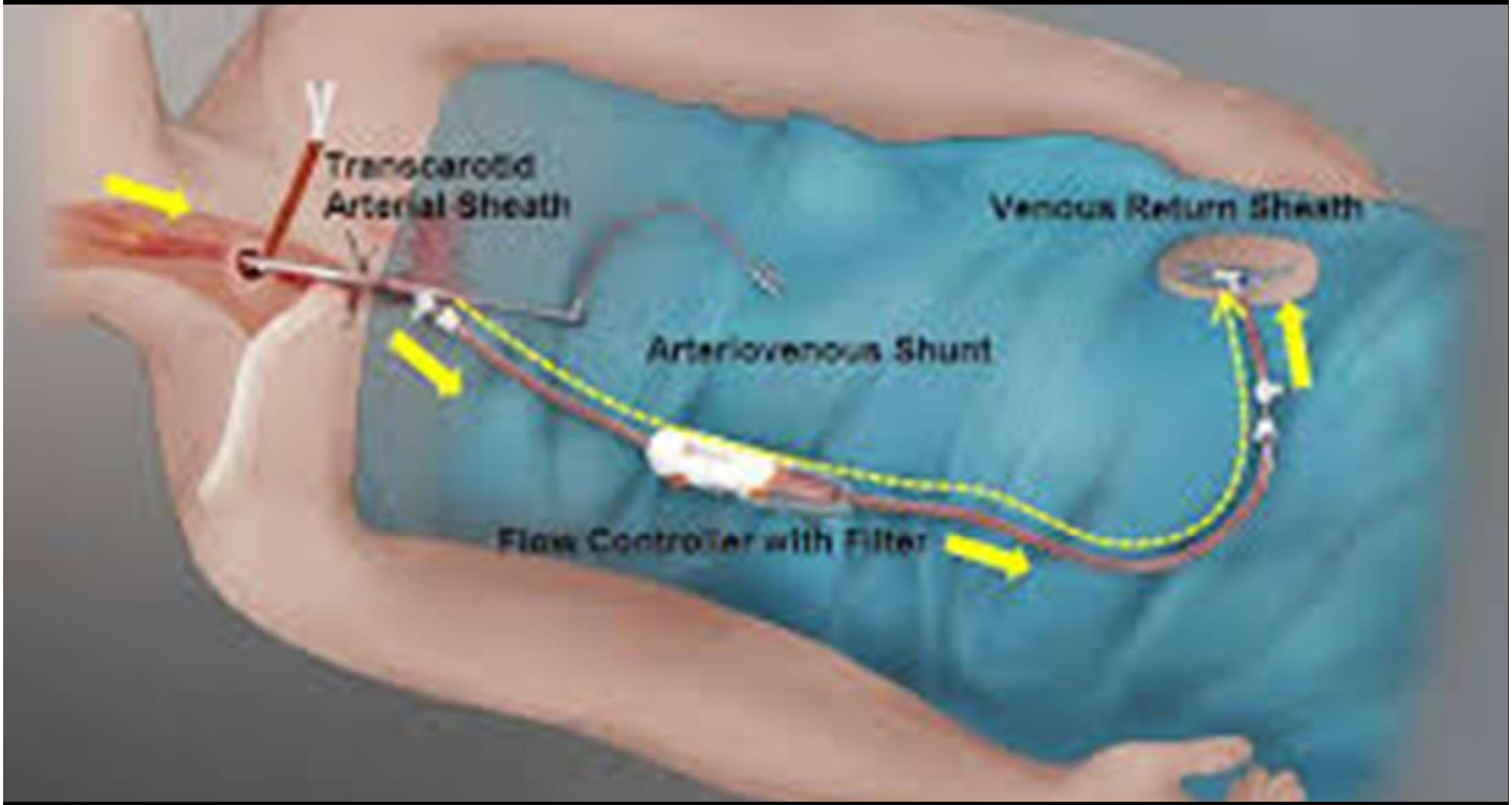
- Carotid Endarterectomy
- Trans-Femoral Stenting
- Trans-Carotid Stenting (TCAR)



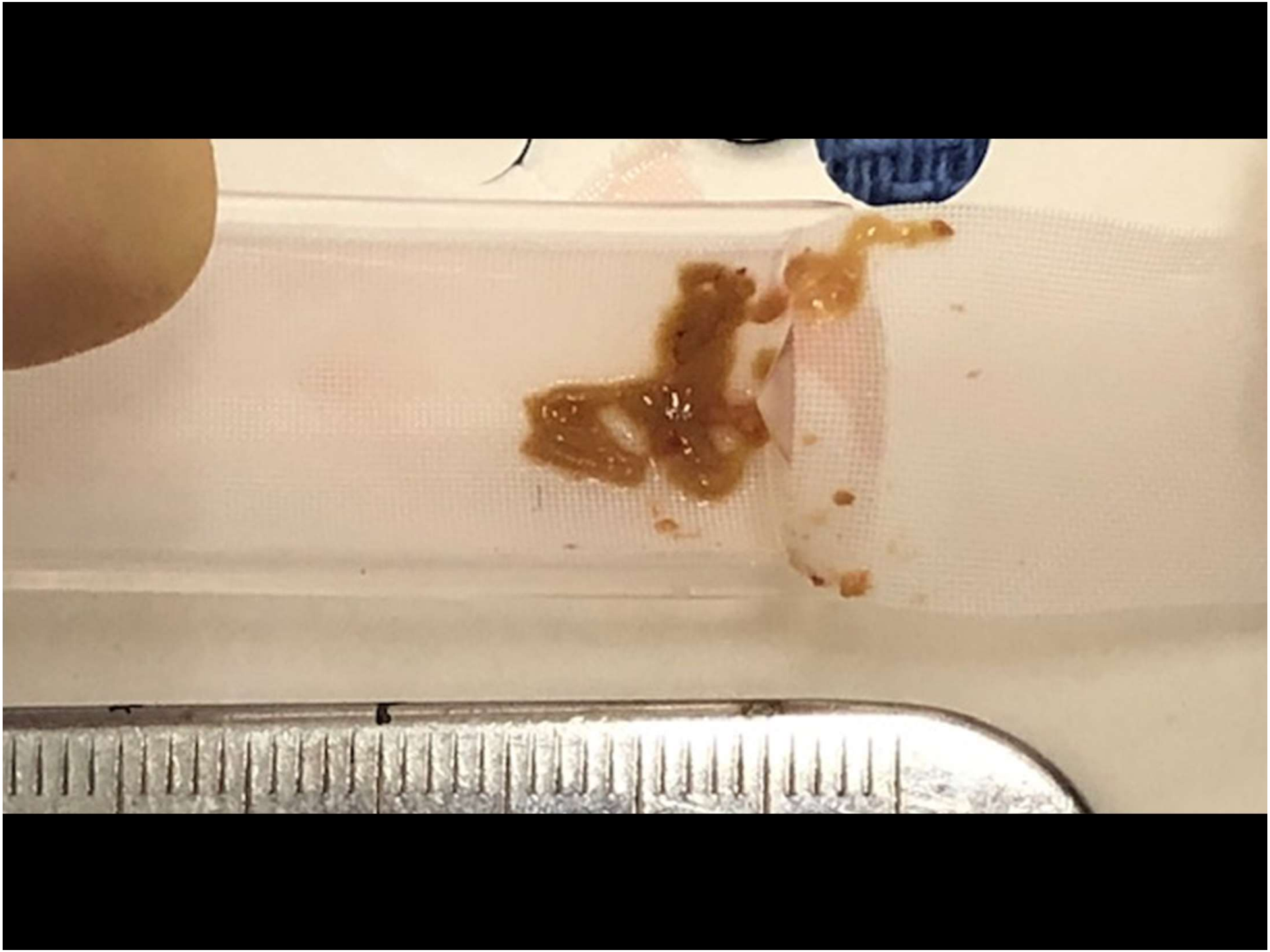

REMOVAL OF PLAQUE
Internal carotid
External carotid
Clamps
Incision in artery wall
Plaque
Common carotid
Clamp
Internal carotid
External carotid
Patch
Sutures
Common carotid

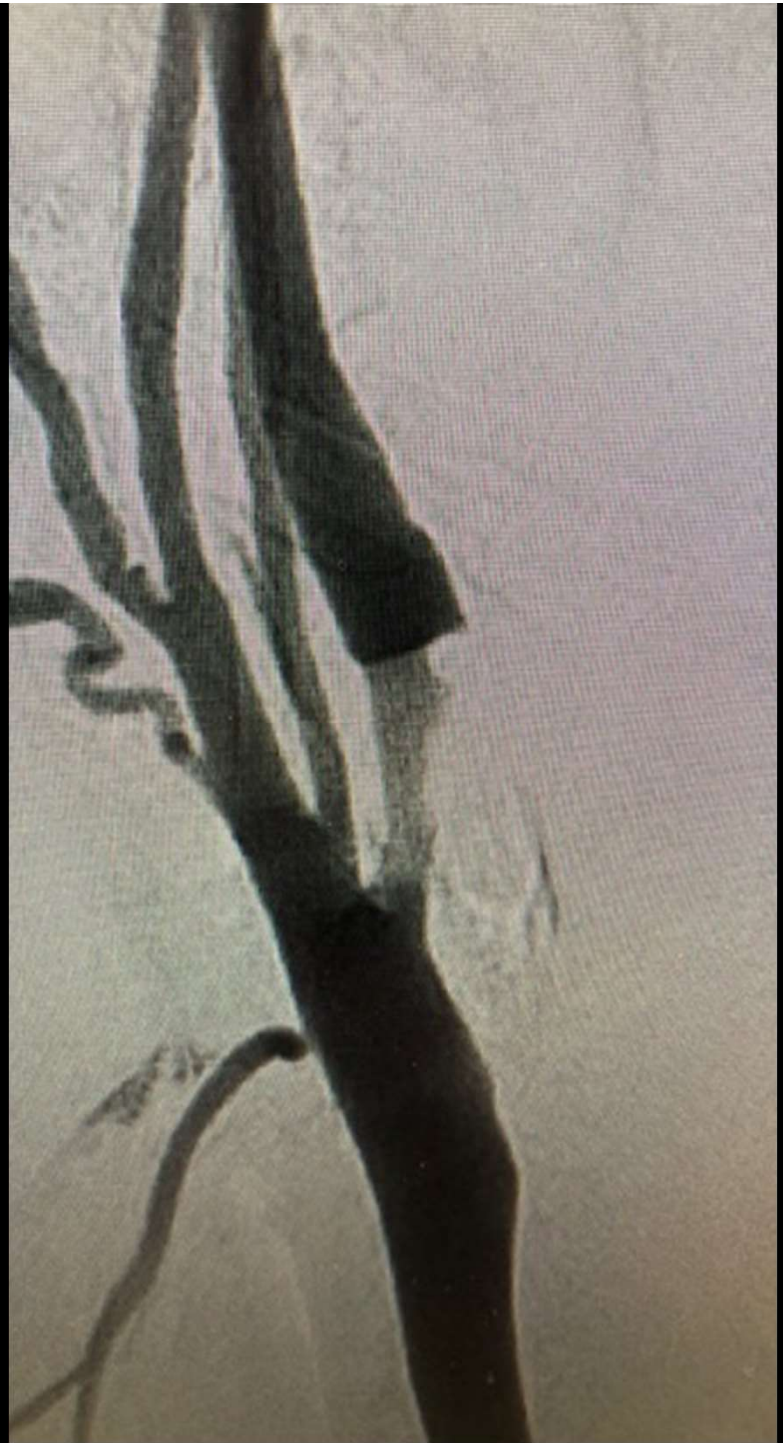

Guidewire
Femoral artery
Stent
Guidewire
Stent excluding atheroma from circulation

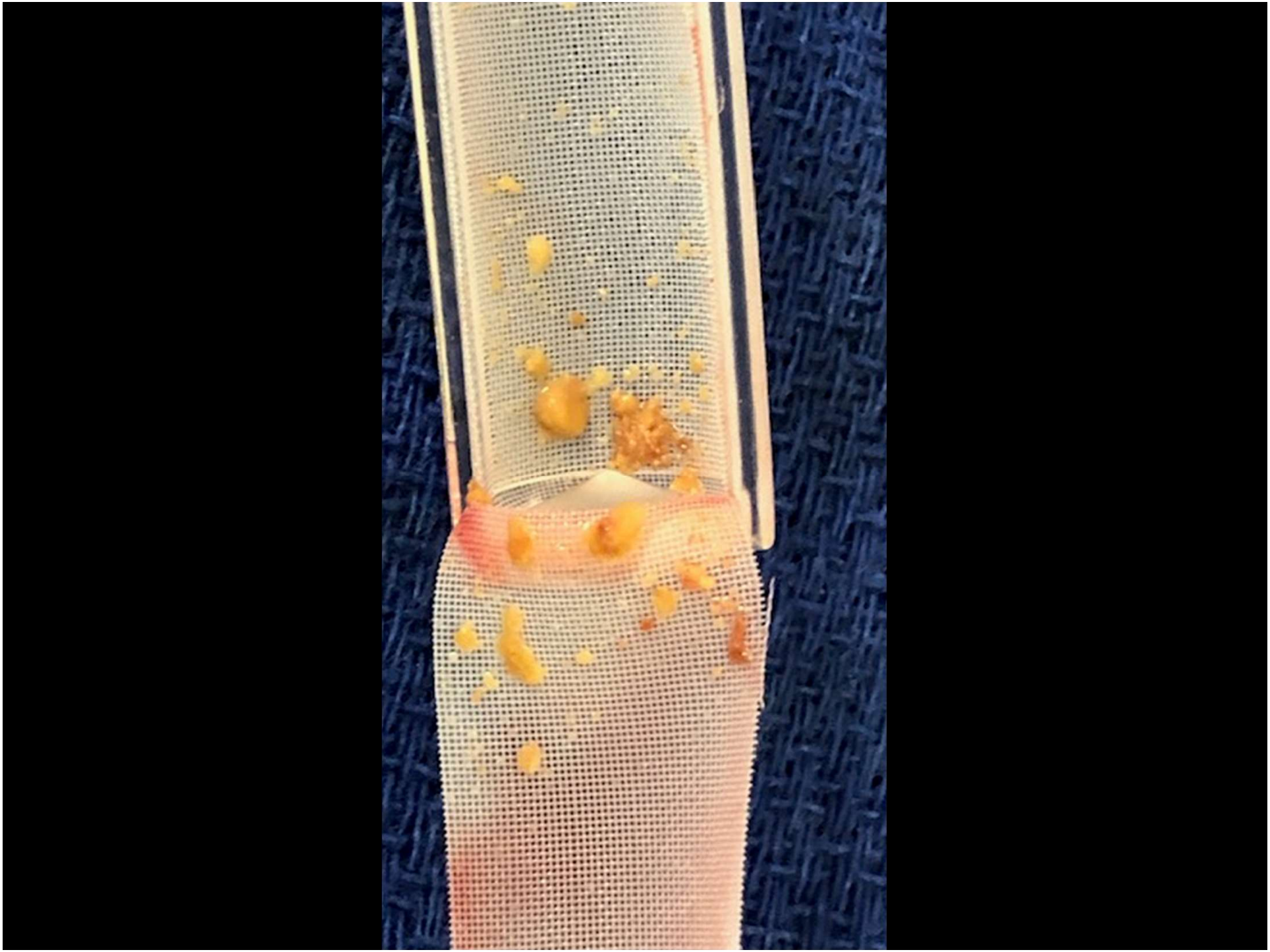

Filter
Catheter
Expanded
stent


Transcarotid
Arterial Sheath
Venous Return Sheath
Arteriovenous Shunt
Flow Controller with Filter


TCAR Procedure
TransCarotid Artery Revascularization







AAA

Screening

- Male > 65
  - 100 cigs/lifetime
- Family History

Aortic Aneurysm Population

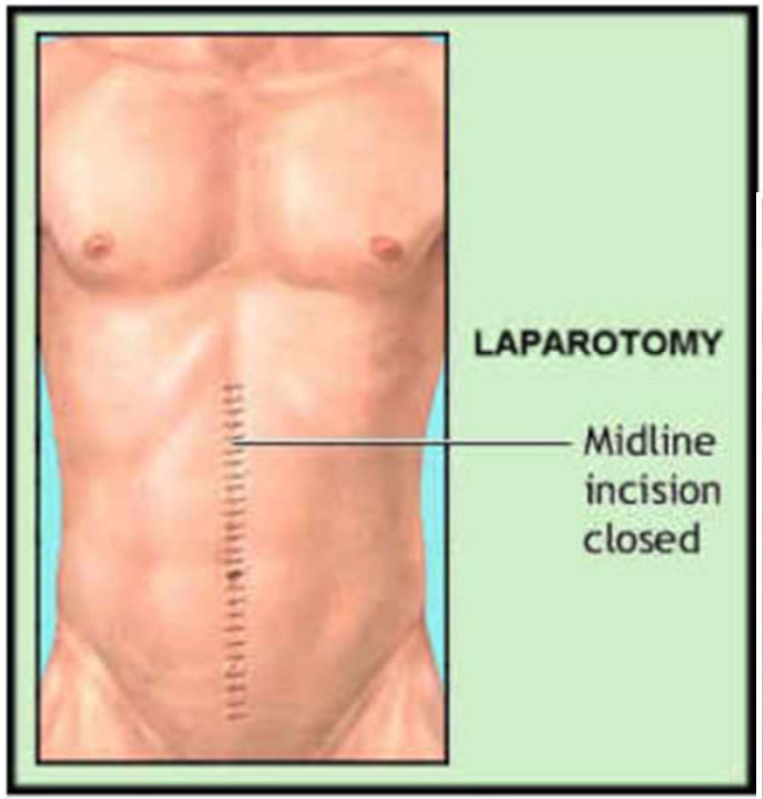
- Average age 69
- Age at rupture 74
- 25% DM
- 60% COPD
- 70% CAD
- 65% present emergently
- 85% are ASA III or greater

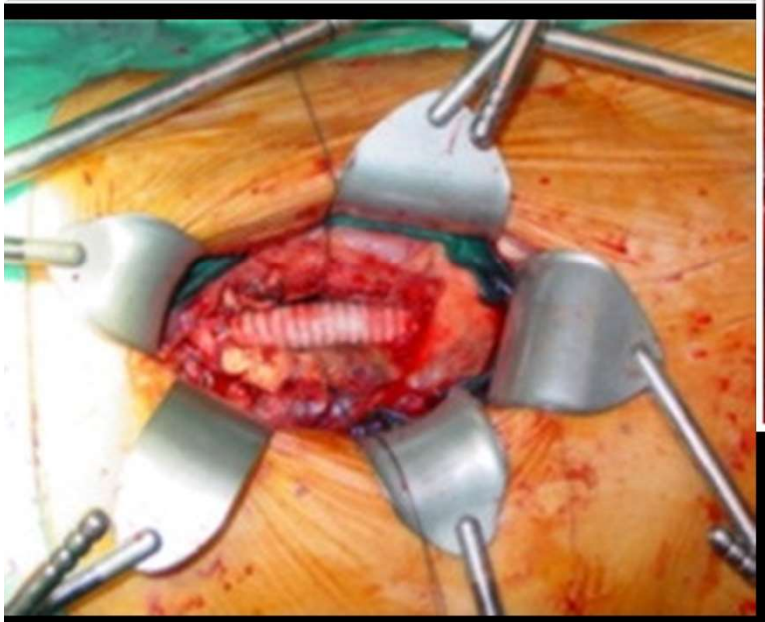
Indications

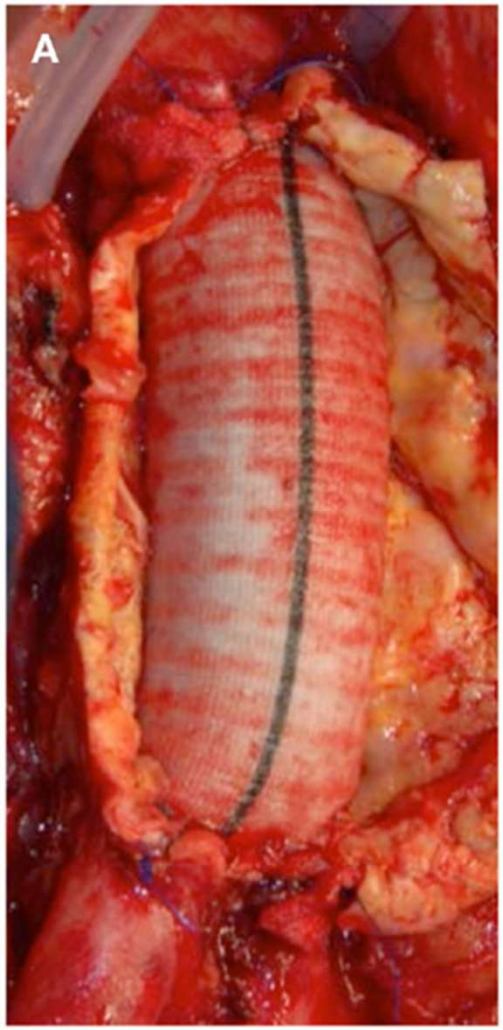
- 5.0 cm Infrarenal AAA fusiform
- 4.5 cm Infrarenal AAA Saccular
- 2.5-3.0 cm Iliac Aneurysm

Treatment

- Open
- Endovascular
  - Infrarenal
  - Fenestrated
  - Snorkle
  - Physician Modified


LAPAROTOMY
Midline incision closed




A

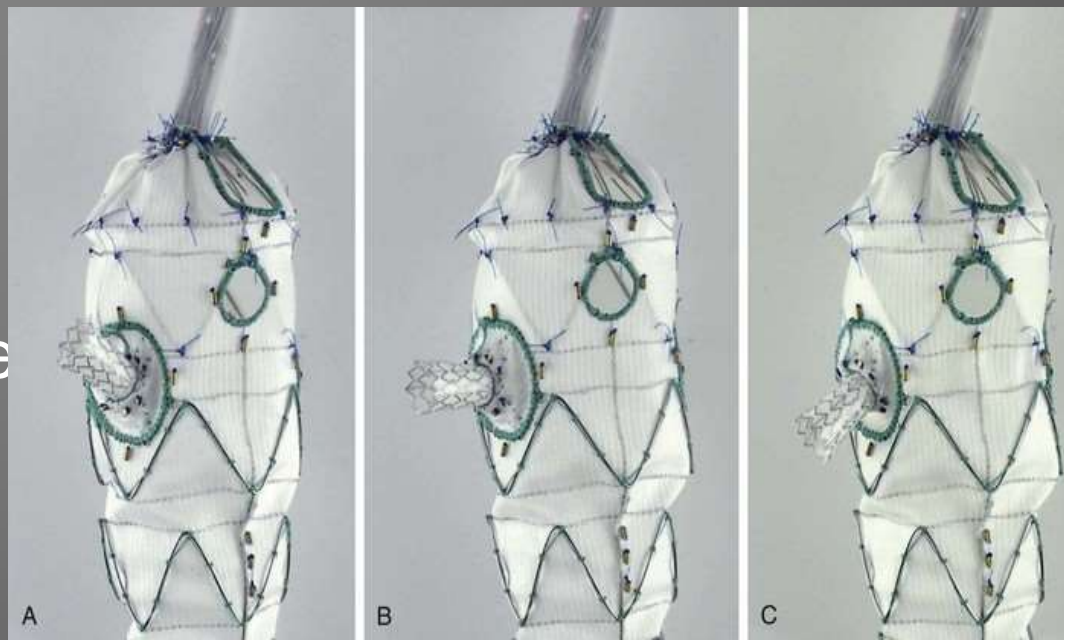

B

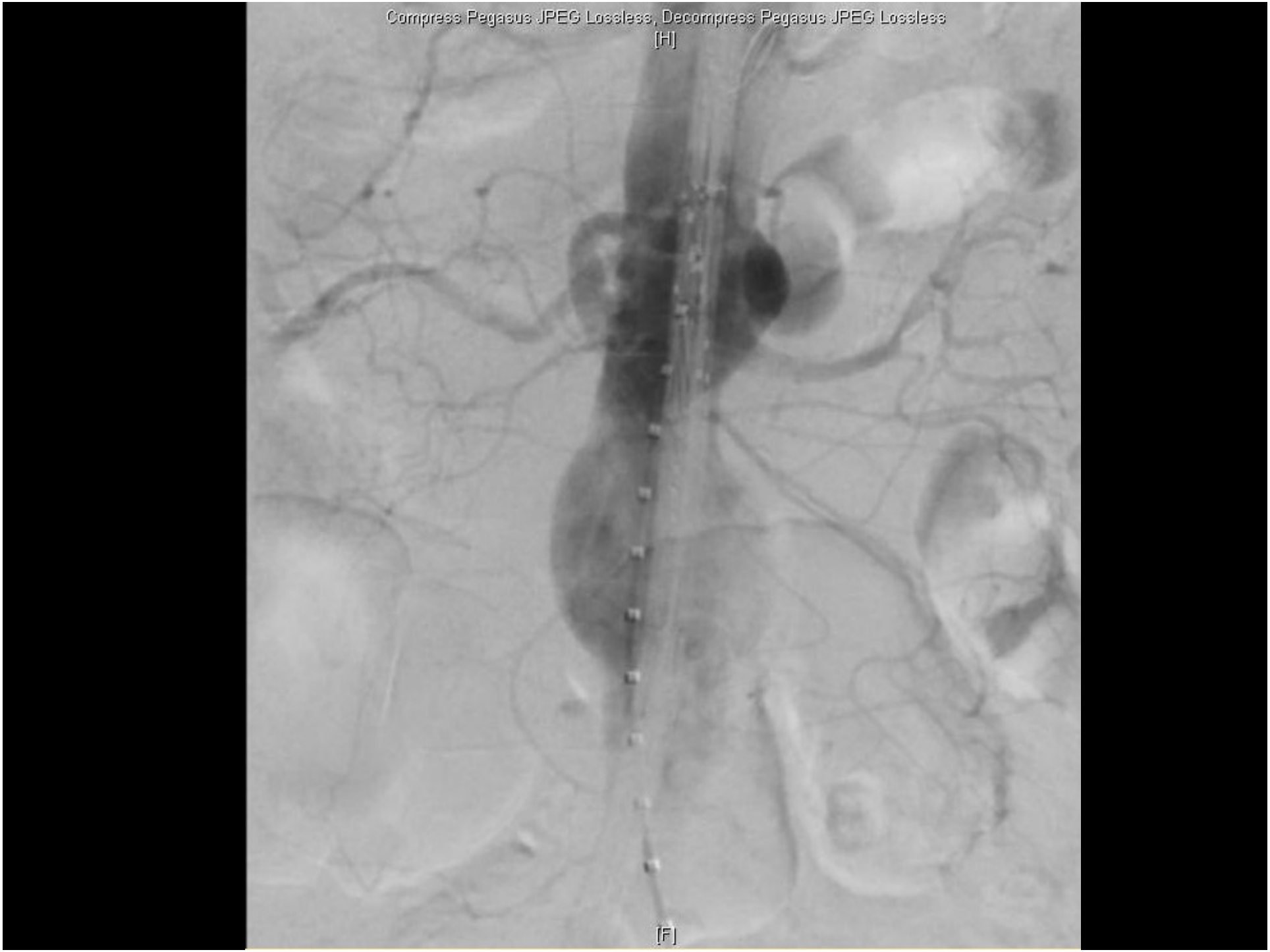
Complex Endo Aortic Techniques

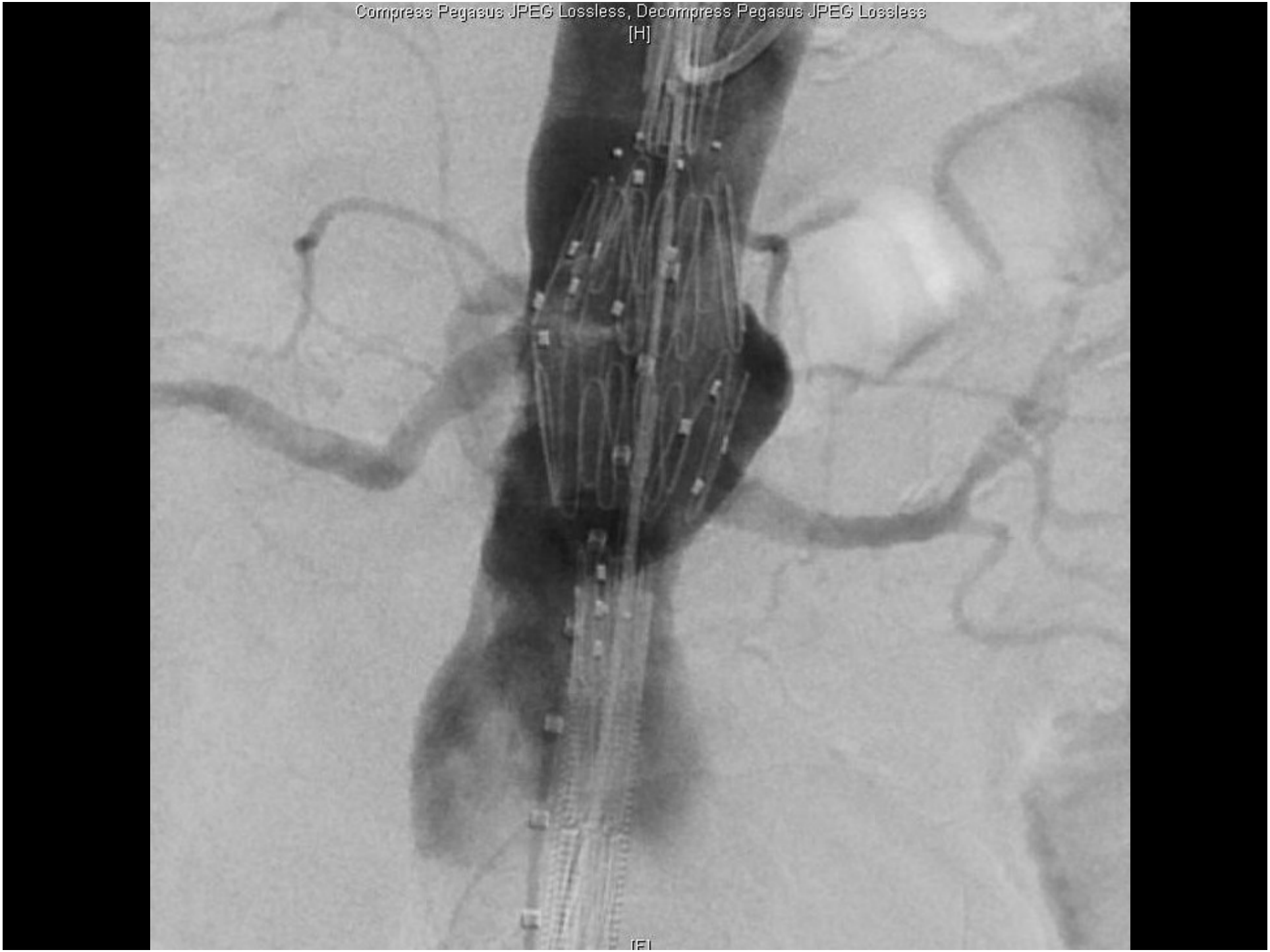
- FEVAR
  - Fenestrated EndoVascular Aortic Repair
- ChEVAR
  - Chimeney EndoVascular Aortic Repair
- BEVAR
  - Branched EndoVascular Aortic Repair
- Hybrid Repair

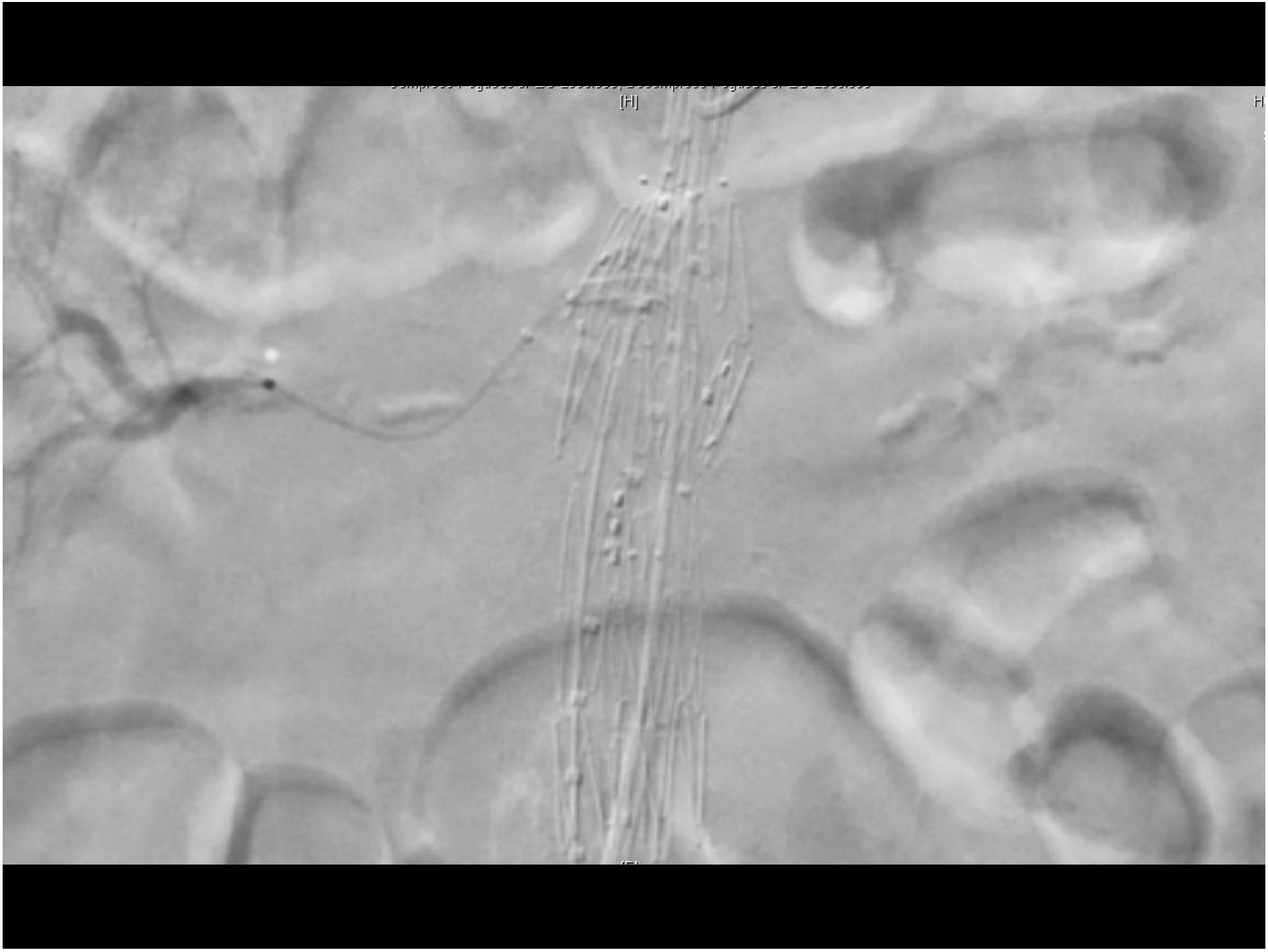
FEVAR

- Grafts are custom made to a specific anatomy
- Only FDA approved device in the US is the Cook Zenith Fenestrated (ZFEN).
- Indications
  - AAA with hostile necks
    - 4-15 mm
    - Thrombus
  - Juxtarenal
  - Suprarenal
  - 3 weeks to fabricate




Compress Pegasus JPEG Lossless, Decompress Pegasus JPEG Lossless
[H]
[F]


Compress Pegasus JPEG Lossless, Decompress Pegasus JPEG Lossless
[H]
[F]

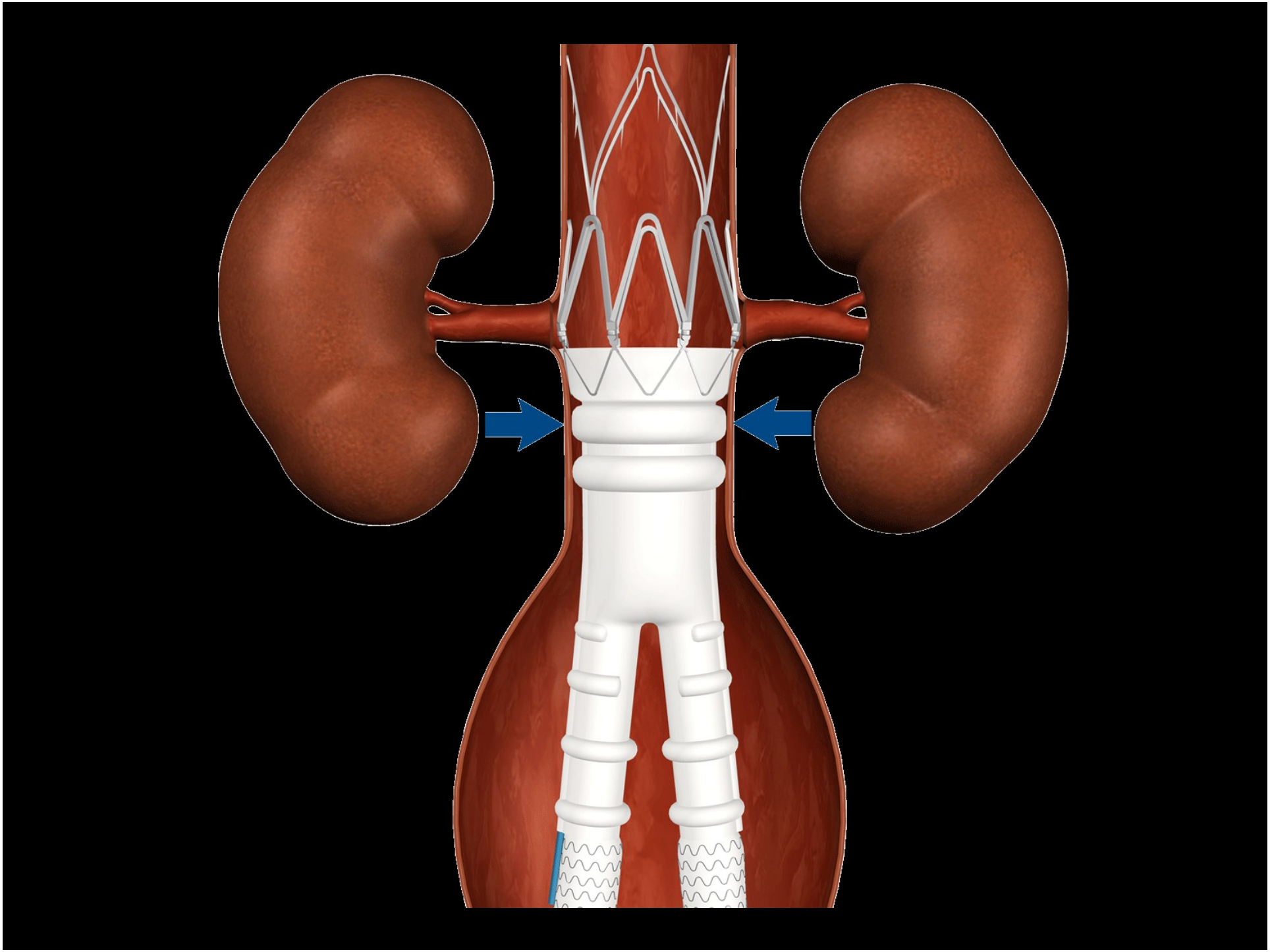


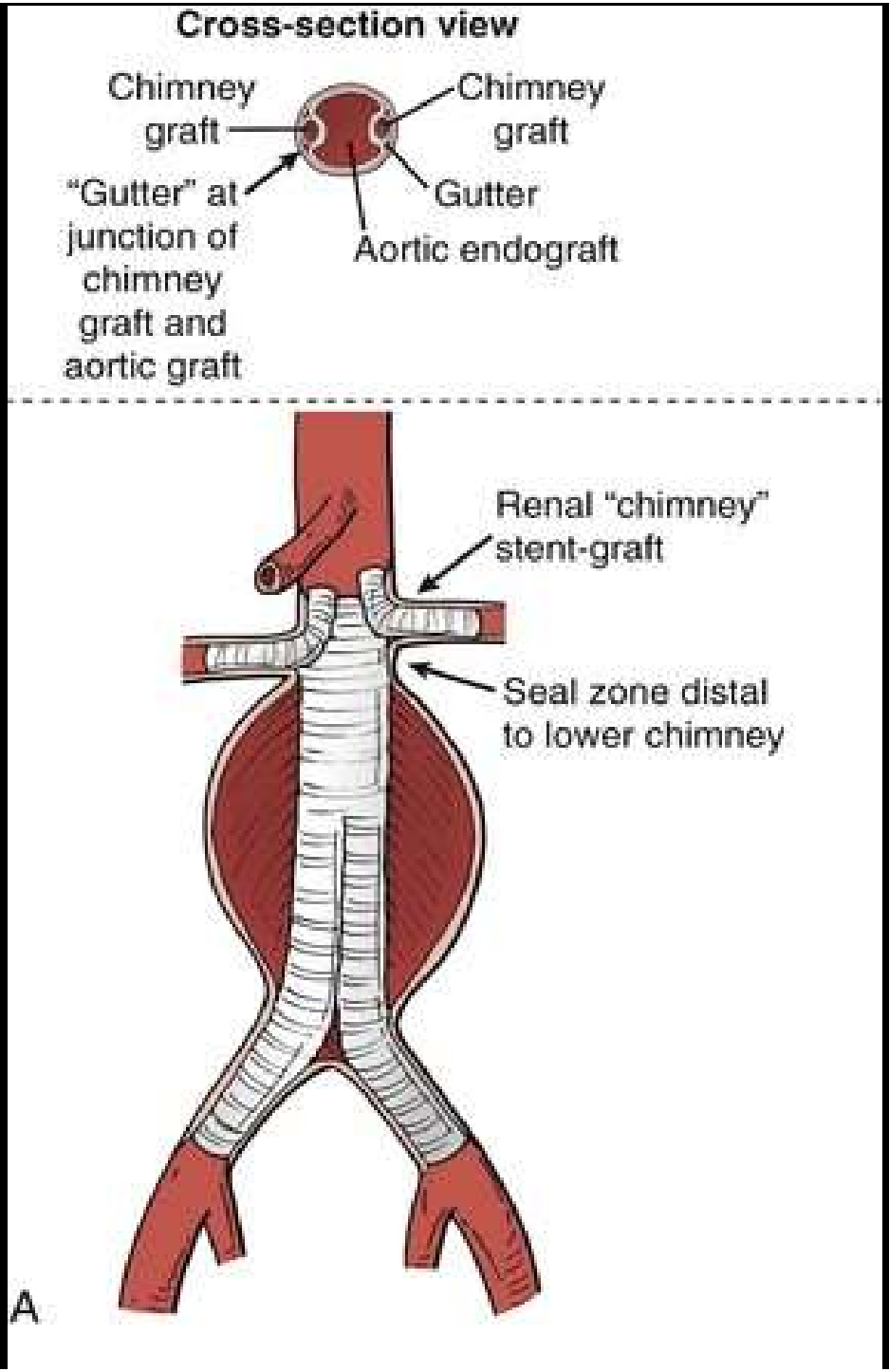

Compress Pegasus JPEG Lossless, Decompress Pegasus JPEG Lossless
[H]
[F]

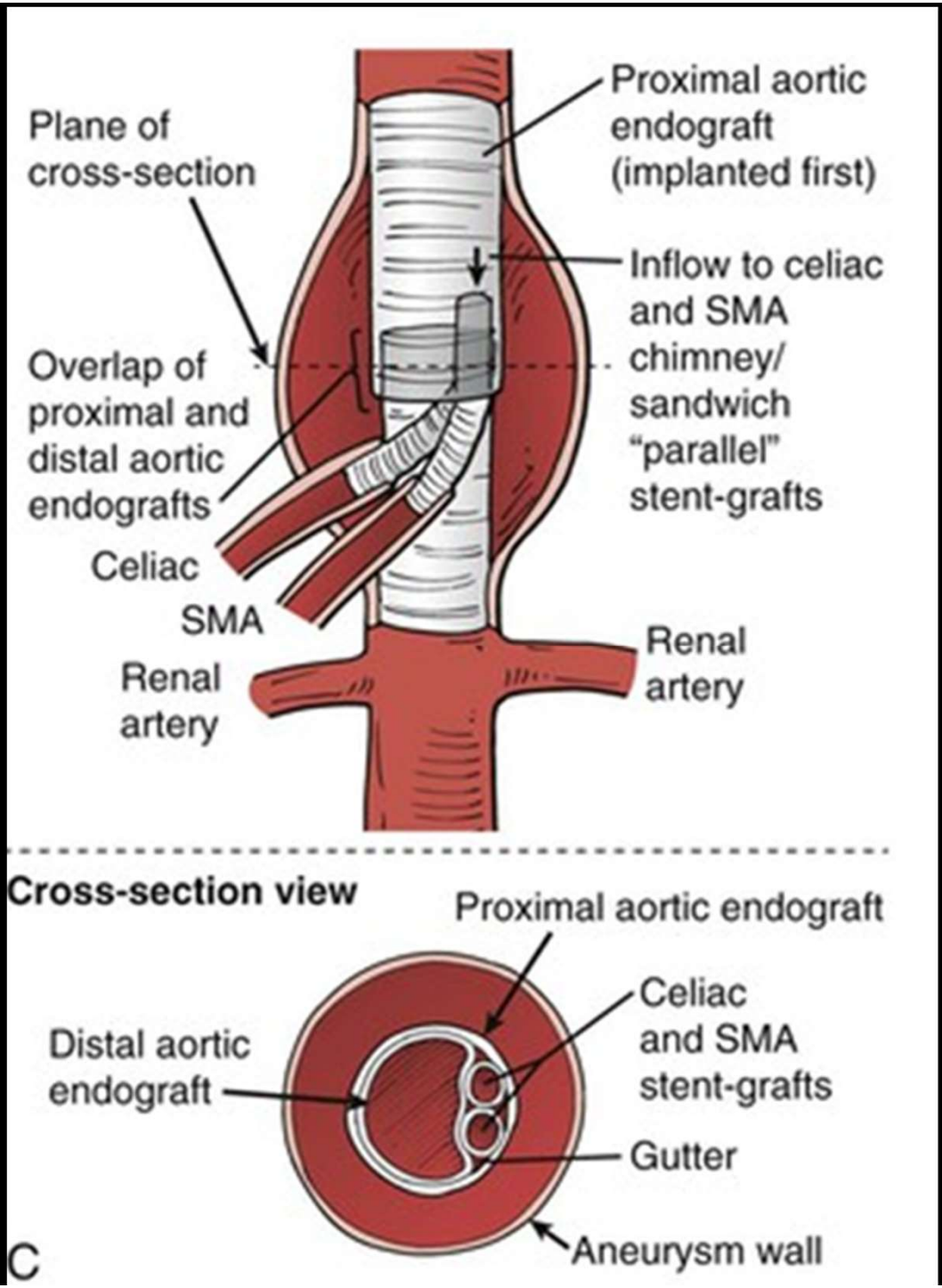

Compress Pegasus JPEG Lossless, Decompress Pegasus JPEG Lossless
[H]
[F]

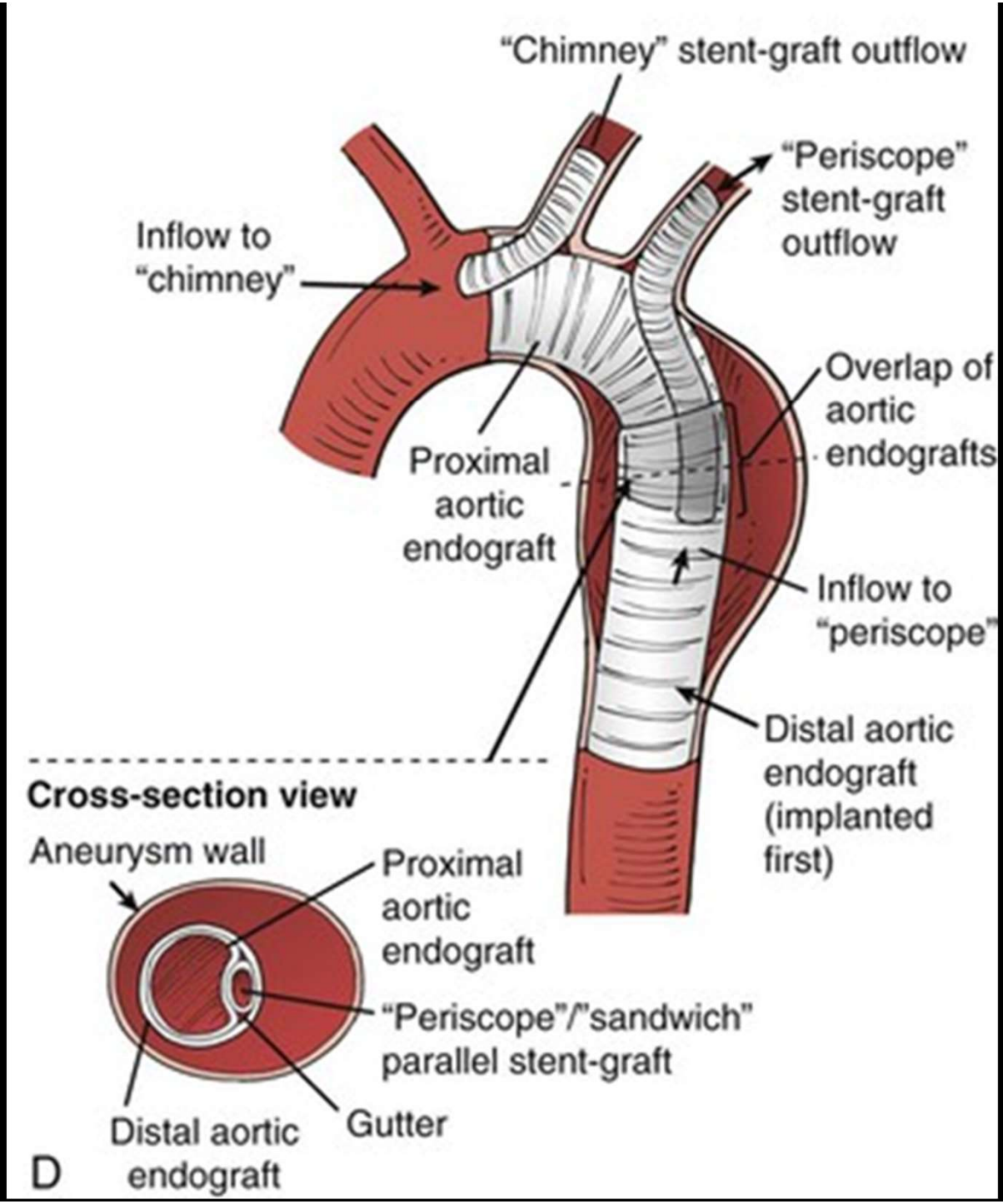
ChEVAR

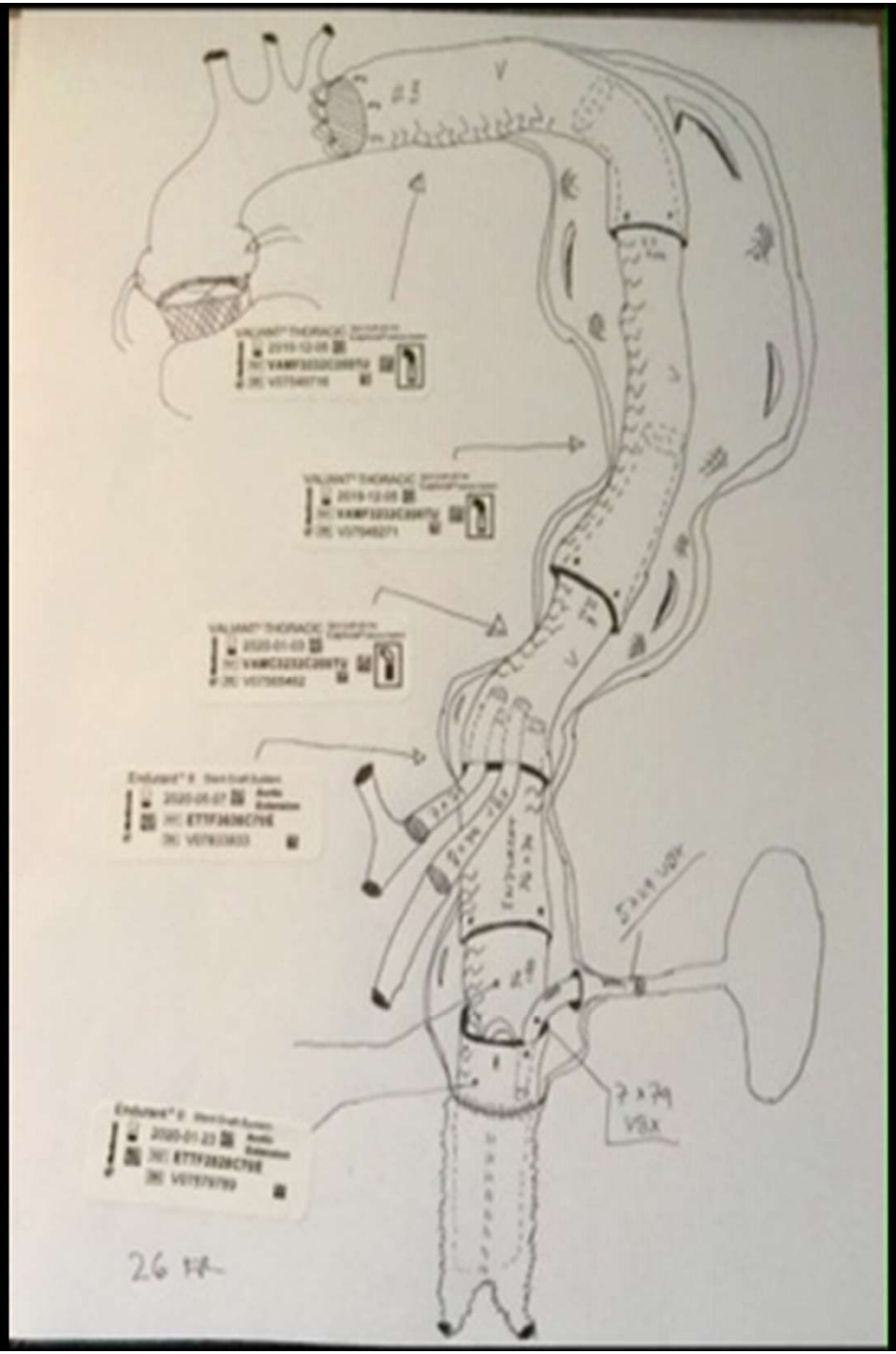
- “Poor mans FEVAR”
  - Aka
    - Parallel grafting
    - Snorkeling
    - Parascoping
- Utilize a combination of off the shelf EVAR graft and stents to build up to a more favorable seal zone.




Cross-section view
Chimney graft
Chimney graft
"Gutter" at junction of chimney graft and aortic graft
Gutter
Aortic endograft
Renal "chimney" stent-graft
Seal zone distal to lower chimney
A


Plane of cross-section
Proximal aortic endograft (implanted first)
Inflow to celiac and SMA chimney/ sandwich "parallel" stent-grafts
Overlap of proximal and distal aortic endografts
Celiac
SMA
Renal artery
Renal artery
Cross-section view
Proximal aortic endograft
Celiac and SMA stent-grafts
Distal aortic endograft
Gutter
Aneurysm wall
C

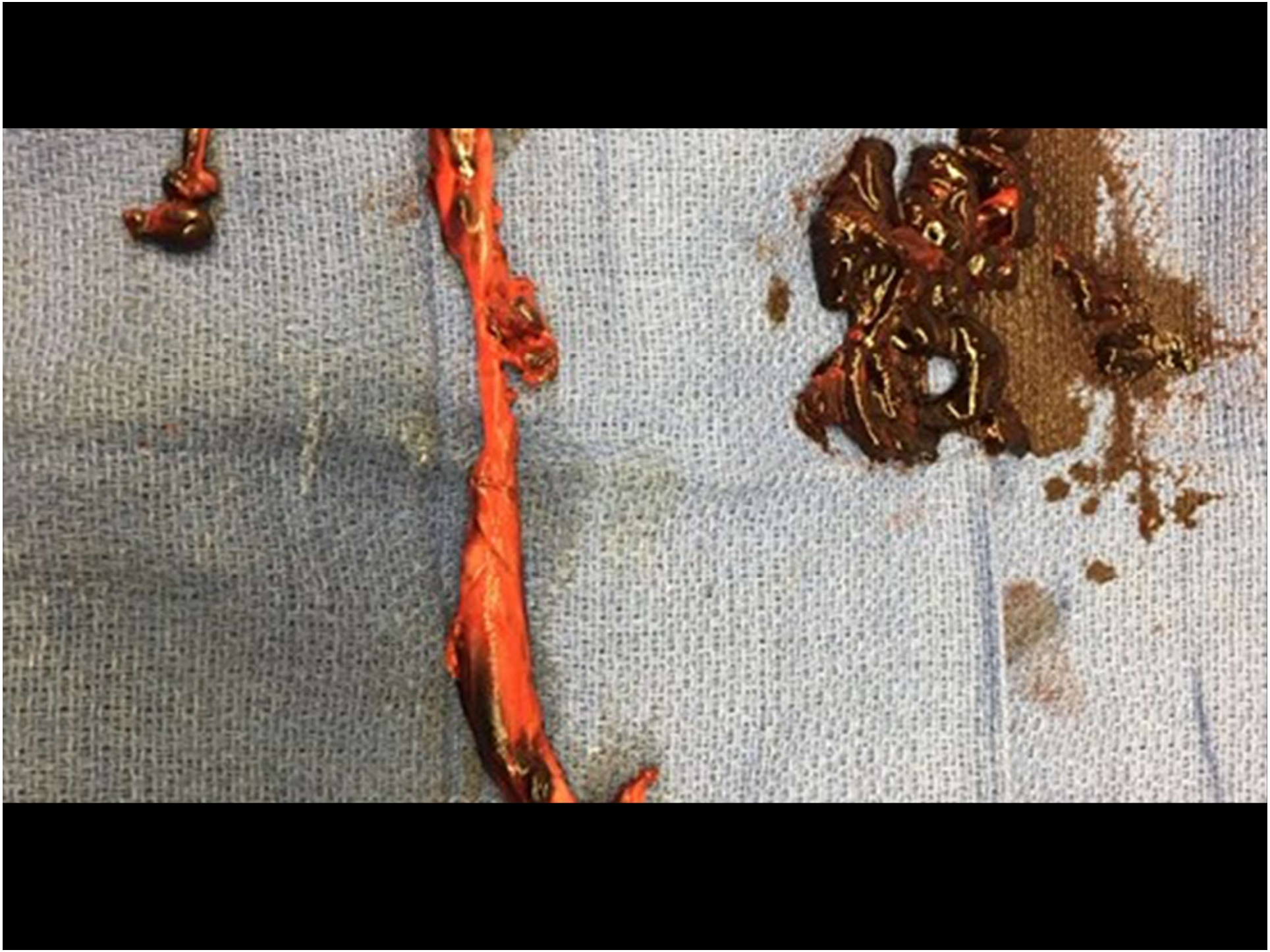

"Chimney" stent-graft outflow
"Periscope" stent-graft outflow
Inflow to "chimney"
Overlap of aortic endografts
Proximal aortic endograft
Inflow to "periscope"
Distal aortic endograft (implanted first)
Cross-section view
Aneurysm wall
Proximal aortic endograft
"Periscope"/"sandwich" parallel stent-graft
Gutter
Distal aortic endograft
D


VALIANT THORACIC
VALIANT THORACIC
VALIANT THORACIC
Endurant II
Endurant II
26 mm

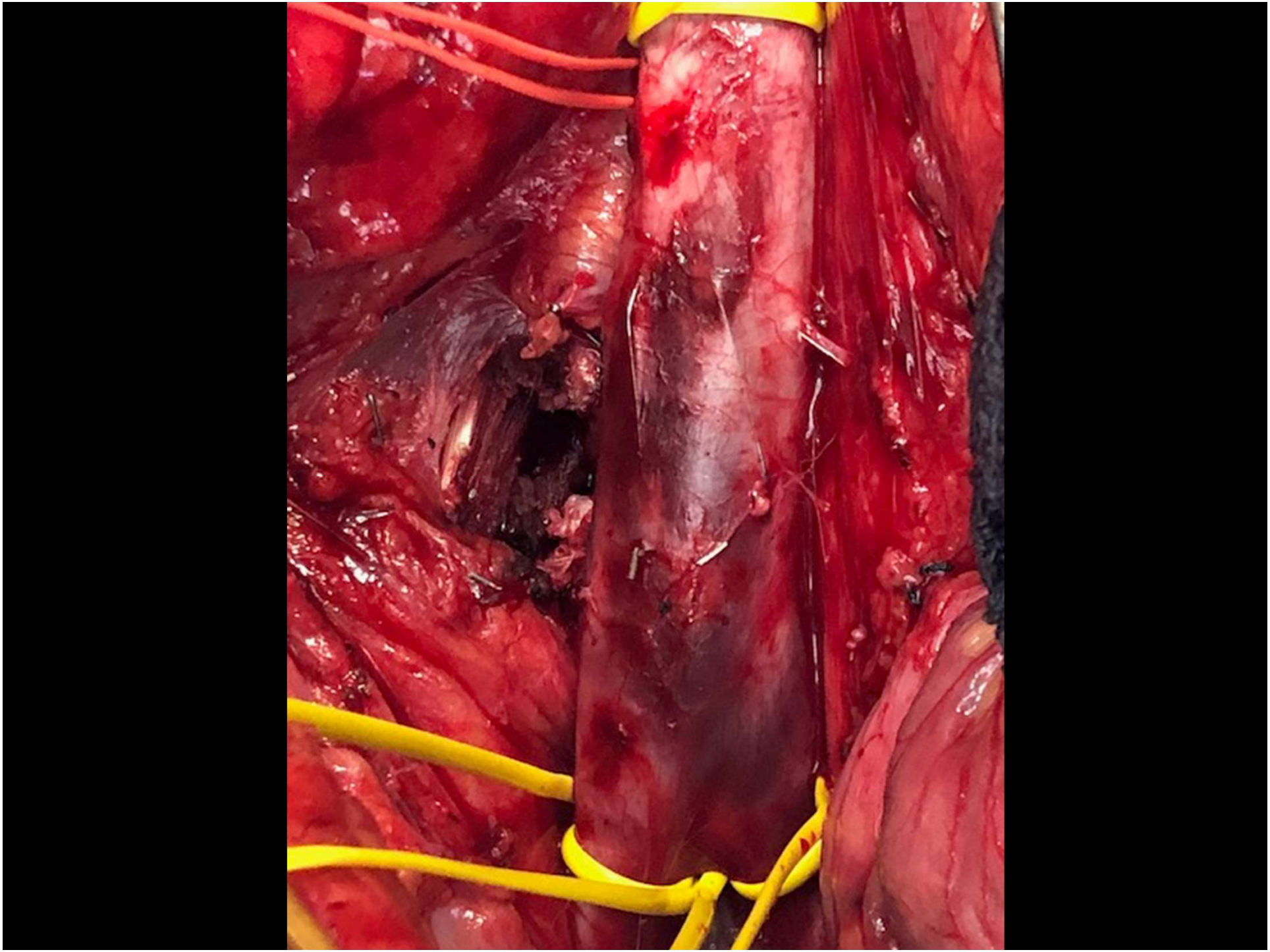
Physician Modified Grafts

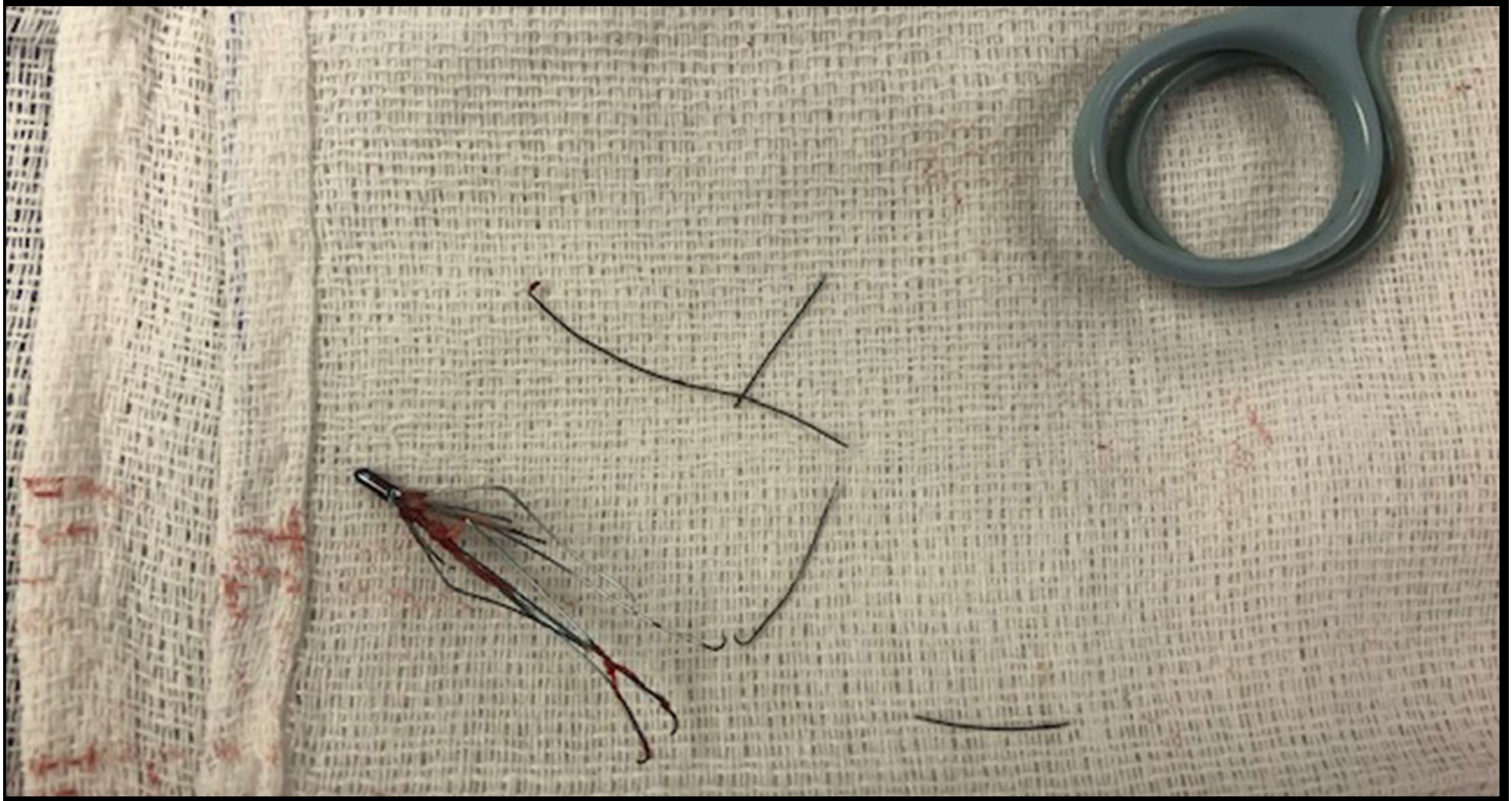
Venous Disease

- DVT
  - Iliofemoral DVTs in young patients
- PE
  - Submassive and Massive PEs
- IVC Filters
- Pelvic Congestion Syndrome




P





Questions


LSU
GEAUX TIGERS