Chronic arterial occlusions

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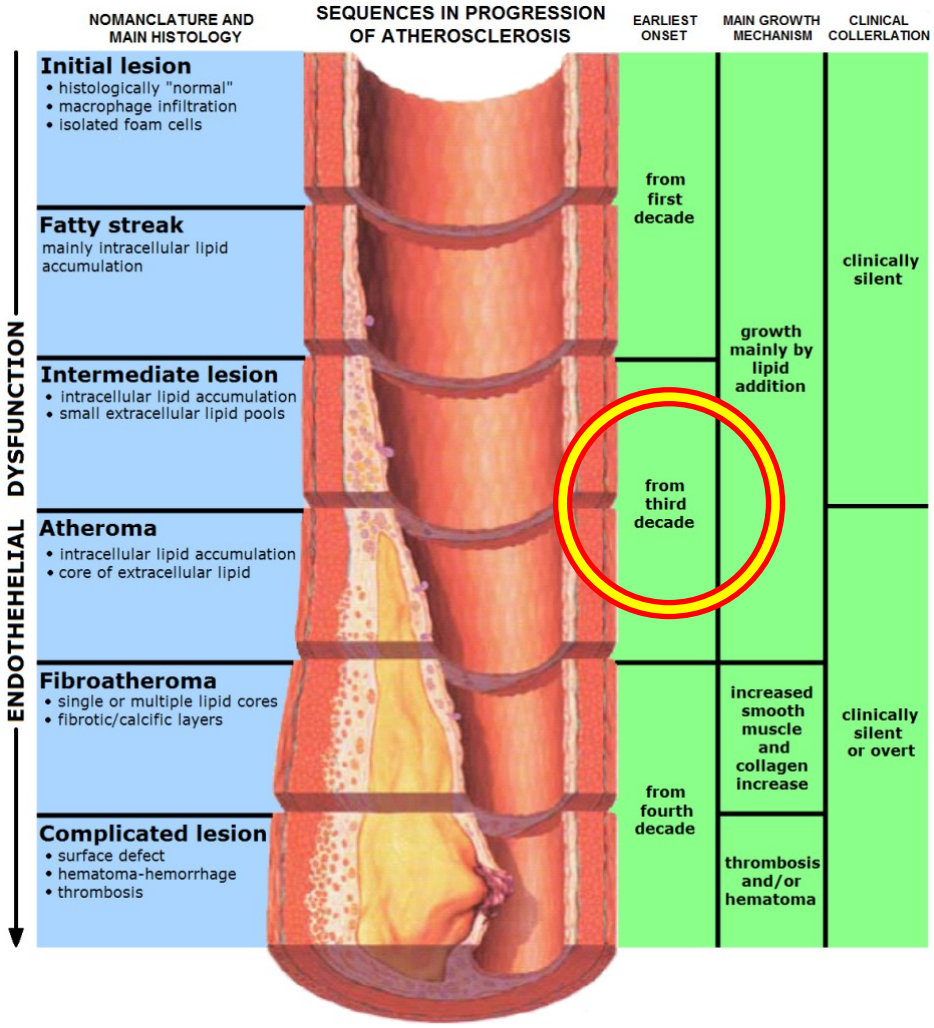
Arterial disease: atherosclerosis

- a **chronic systemic disease** leading to development of **characteristic atherosclerotic plaques**
- asymptomatic until
  - **significant narrowing** of an artery (>70%)
  - **rupture** generating thrombus and/or thrombemboli

Arterial disease: atherosclerosis



Source: wikimedia.org (cc)

Atherosclerosis risk factors

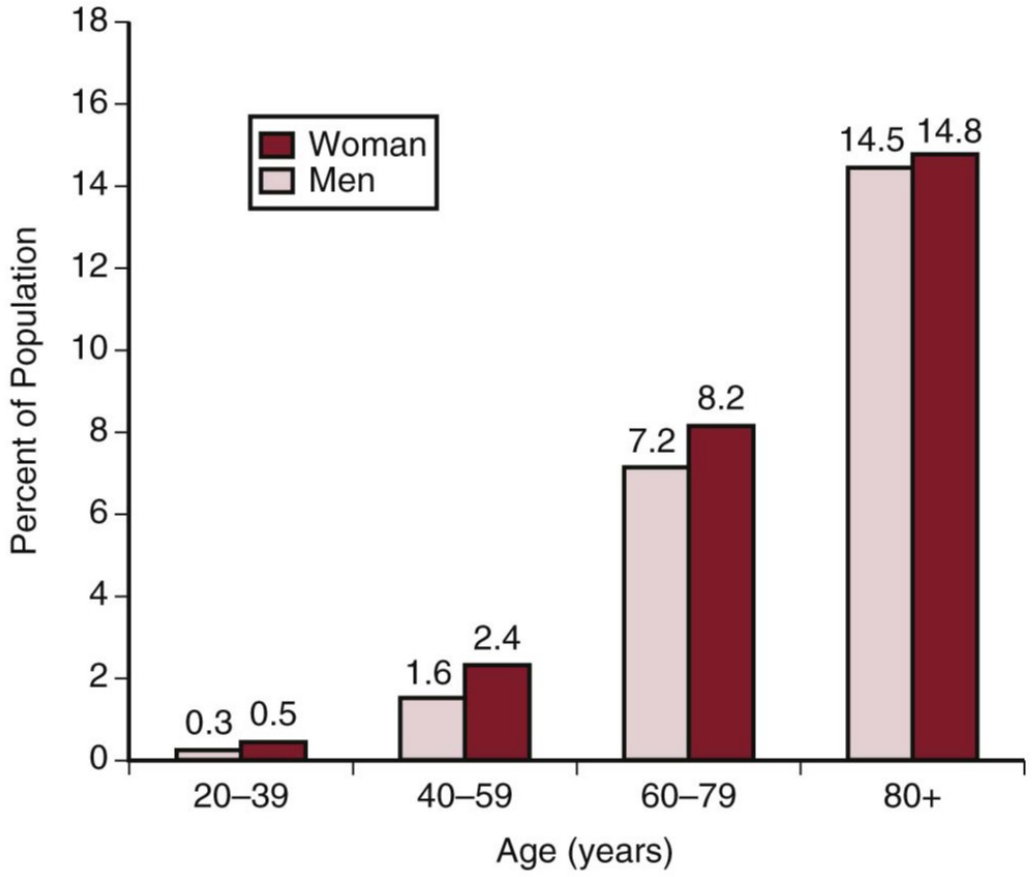
- **Conventional**
  - Smoking
  - Diabetes mellitus
  - Hyperlipidemia
  - Hypertension
- **Conditional**
  - e.g. homocysteine, CRP
- **Emerging**
- **Predisposing**
  - Advanced age
  - Overweight and obesity
  - Physical inactivity
  - Gender: male sex, postmenopausal women
  - Insulin resistance
  - Family history and genetics
  - Behavioral and socioeconomic factors

Arterial disease: atherosclerosis

- **Predilection arterial beds**
  - coronary arteries
  - **carotid arteries**
  - **lower limb arteries**
  - **mesenteric arteries**

Cerebrovascular disease

Epidemiology – prevalence of stroke



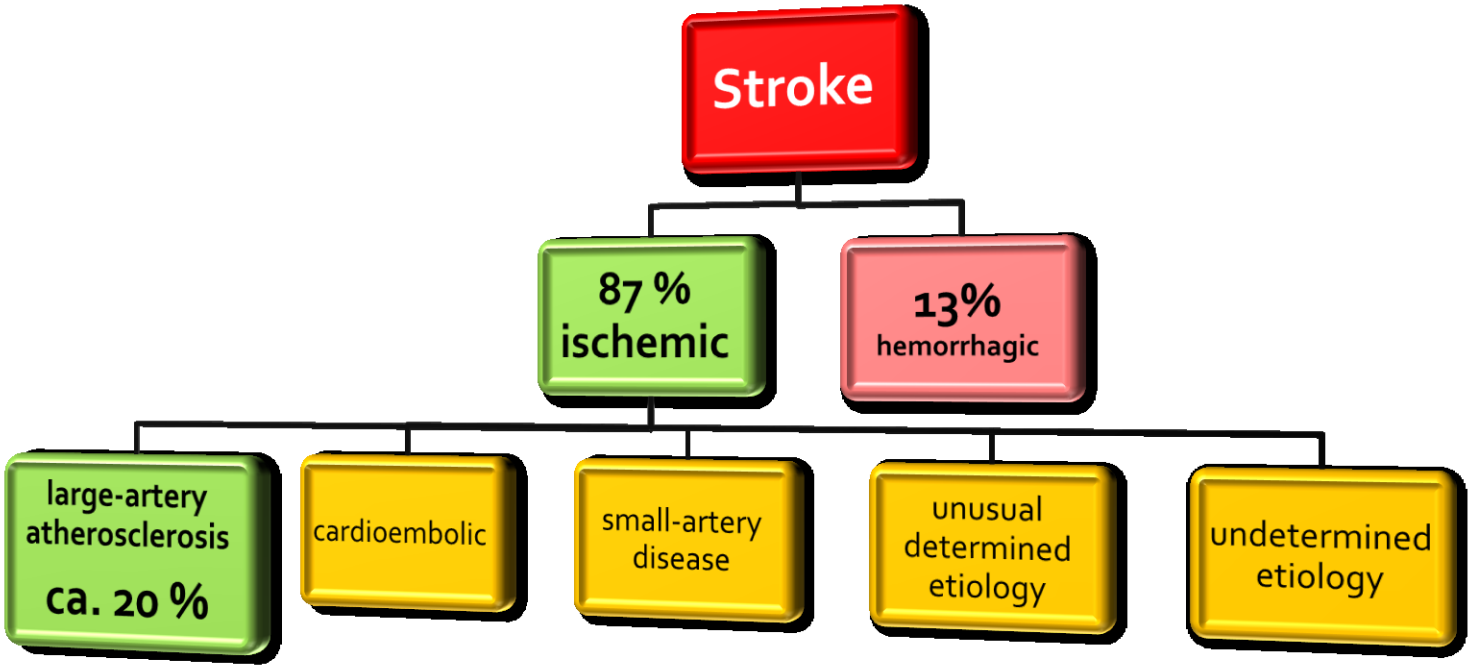
Source: Ruhterford's Vascular Surgery 8th Edition

Epidemiology – stroke

- **Risk**
  - of **recurrence** 29% at 5 years
  - of **death** 53 % at5 years

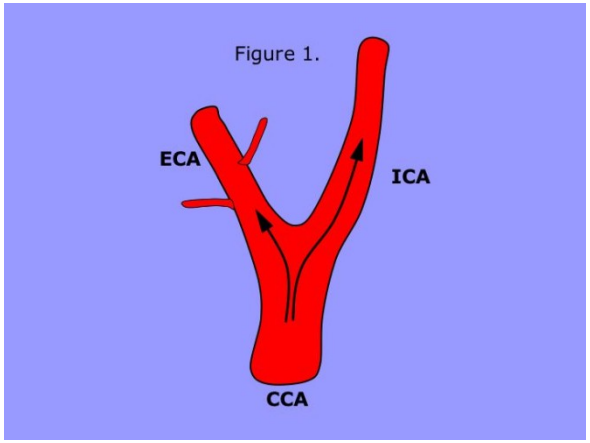
- **Stroke survivors 65+ after 6 months**
  - 50% - hemiparesis
  - 30% - unable to walk without assistance
  - 26% - dependent in daily activities
  - 19% - aphasia
  - 26% - institutionalized

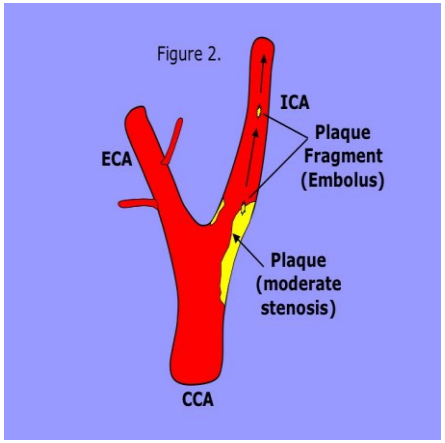
Types of stroke

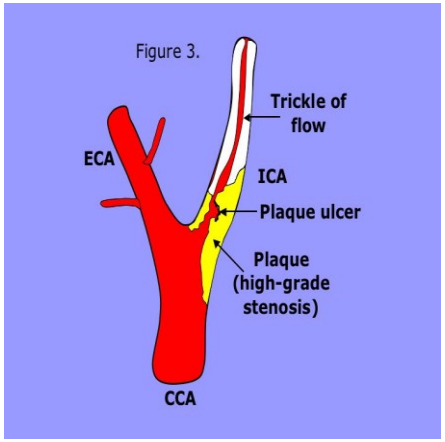


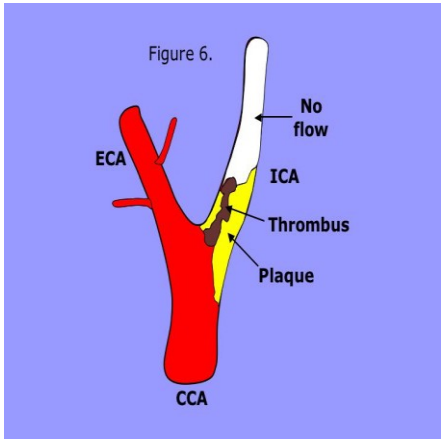
TOAST (Trial of ORG 10172 in Acute Stroke)

Pathogenesis



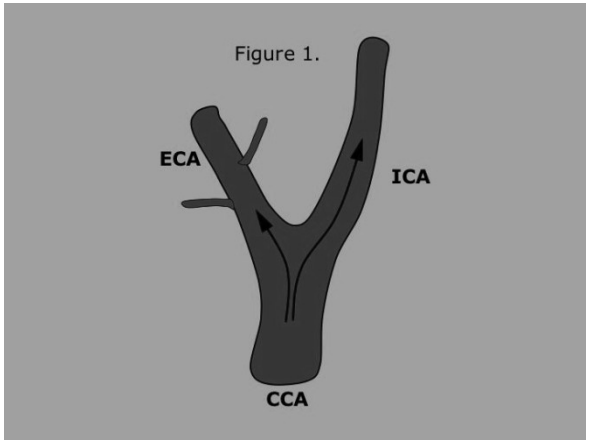


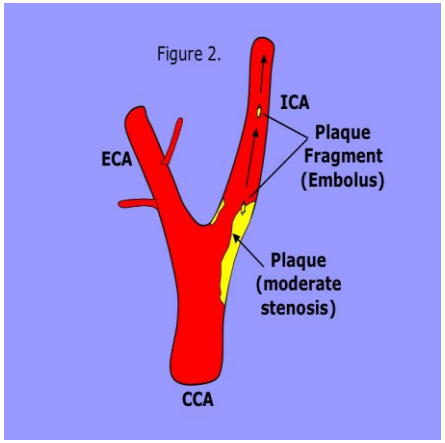


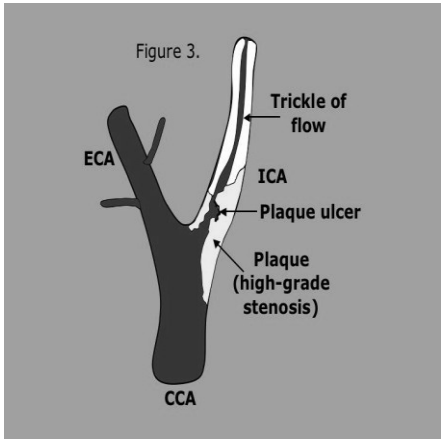


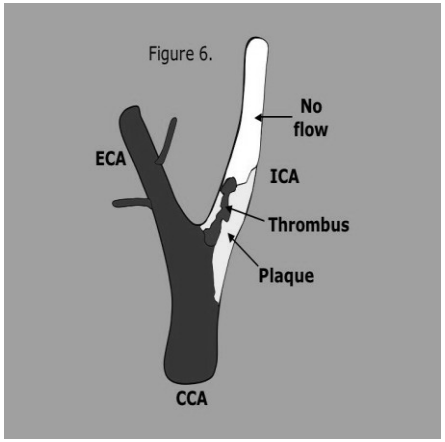
source: http://www.brain-aneurysm.com

Pathogenesis









source: http://www.brain-aneurysm.com

Clinical presentation

- **Transient ischemic attack (TIA)**
  - stroke-like symptoms lasting **less than 24 hours**
  - the vast **majority** last for **only a few minutes**
  - **30%** of patients **will suffer a stroke within 5 years**
  - is a **clinical diagnosis**
    - brain infarction on computed tomography (CT) in circa 25% of patients

Clinical presentation

- **Stroke**
  - an **acute neurologic dysfunction** of vascular etiology
  - **signs and symptoms lasting more than 24 hours**
  - resulting from infarction of focal areas of the brain
- **Typical signs**
  - sudden contralateral **motor-sensory loss**
  - **speech deficit** (dysarthria, dysphasia, aphasia)
  - ipsilateral **monocular blindness / field cuts**

Clinical presentation

Clinical assessment

- **History**
- clinical presentation of present illness
- atherosclerosis
  - risk factors

- **Physical findings**
- vital signs
  - blood pressure, heart rate, rhythm
- alertness, orientation
- speech, basic motor and sensory deficits
- carotid pulse palpation and auscultation

Diagnostic evaluation

- carotid **duplex ultrasonography** with transcranial Doppler
- carotid **CT angiography**
- magnetic resonance angiography
  - price, imaging limitations
- digital subtraction angiography
  - specific indications (CT/MRI artifacts, planned endovascular intervention)

CT angiography

Treatment

- „best“ medical therapy (BMT)
- carotid endarterectomy (CEA)
- carotid stenting (CAS)

How do we choose the proper treatment?

- **symptom status** (within last 6 months)
- **degree of stenosis**
  - at present, the most reliable imaging predictor of stroke risk
- plaque progression; plaque character („vulnerable plaque"); evidence of clinically silent emboli
- 2017 Clinical Practice **Guidelines of the European Society for Vascular Surgery**

Symptomatic patient

- **Carotid endarterectomy**
  - **is recommended - 70%-99% stenosis** [I,A]
  - **should be considered - 50-69% stenosis** [IIa,A]

  - The perioperative stroke/death rate should be <6%

  - should be performed **within 2 weeks of** the last **symptoms** [I,A]

Management of Atherosclerotic Carotid and Vertebral Artery Disease: 2017 Clinical Practice Guidelines of the European Society for Vascular Surge

Symptomatic patient

- **Carotid stenting**
  - **might be considered** in symptomatic patients aged <70 years with **50-99% stenosis** as an alternative to CEA [IIb,A]
  - **is recommended** that in **patients 70+ CEA should be preferred over CAS** [I,A]
  - The periprocedural stroke/death rate should be <6%
  - should be performed **within 2 weeks of** the last **symptoms** [I,A]
  - **CEA should be preferred** over CAS **within 2 weeks of symptoms** [I,A]

Management of Atherosclerotic Carotid and Vertebral Artery Disease: 2017 Clinical Practice Guidelines of the European Society for Vascular Surge

Asymptomatic patient

- **Carotid endarterectomy**
  - **should be considered** in asymptomatic patient with **60-99% stenosis** and life expectancy exceeding 5 years [IIa,B].
  - The perioperative stroke/death rate should be <3%

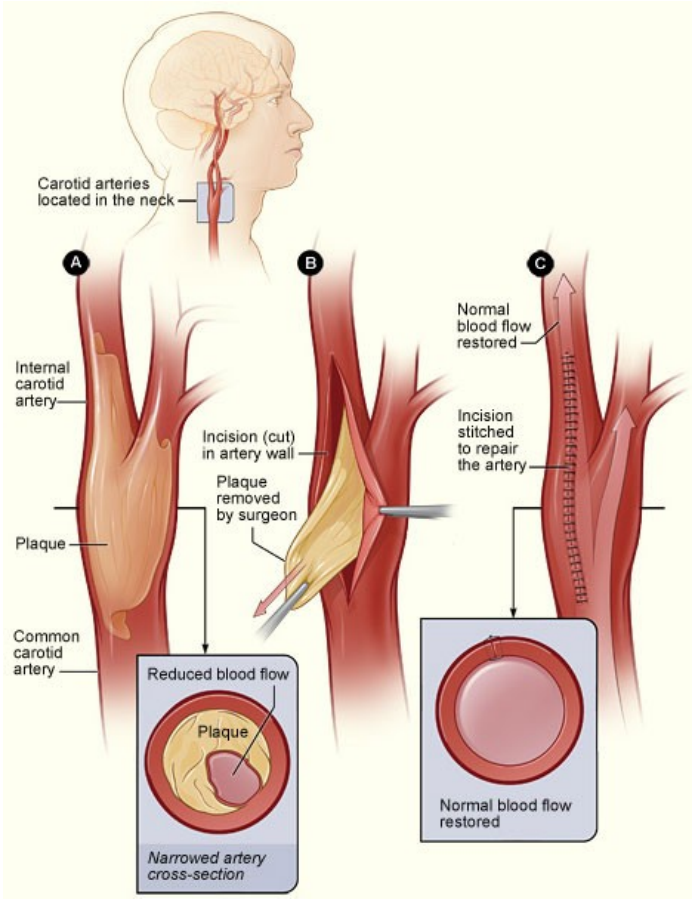
Asymptomatic patient

- **Carotid stenting**
  - **might be considered** in asymptomatic patients with **60-99% stenosis** and life expectancy exceeding 5 years [IIb,B].
  - The periprocedural stroke/death rate should be <3%
  - **might be considered** in „high-risk for surgery" patients [IIb,B]

„Best“ medical therapy

- Risk factor reduction and medical management
  - **antiplatelet therapy**
    - anticoagulation (if indicated for other condition)
  - **statin therapy**
- risk factor reduction
  - hypertension
  - diabetes mellitus
  - smoking cessation
  - alcohol cessation

Carotid endarterectomy - conventional



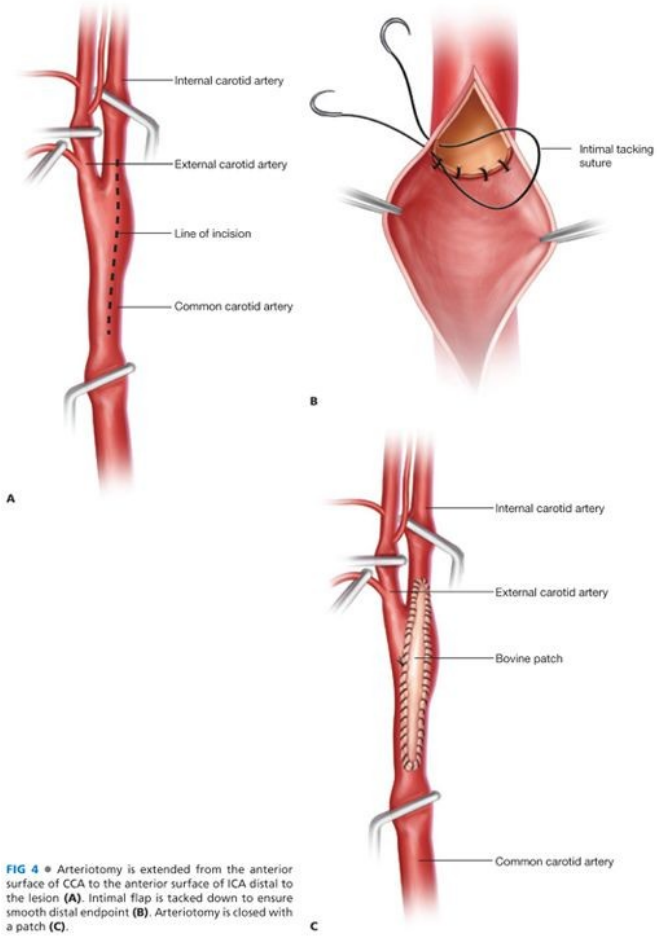
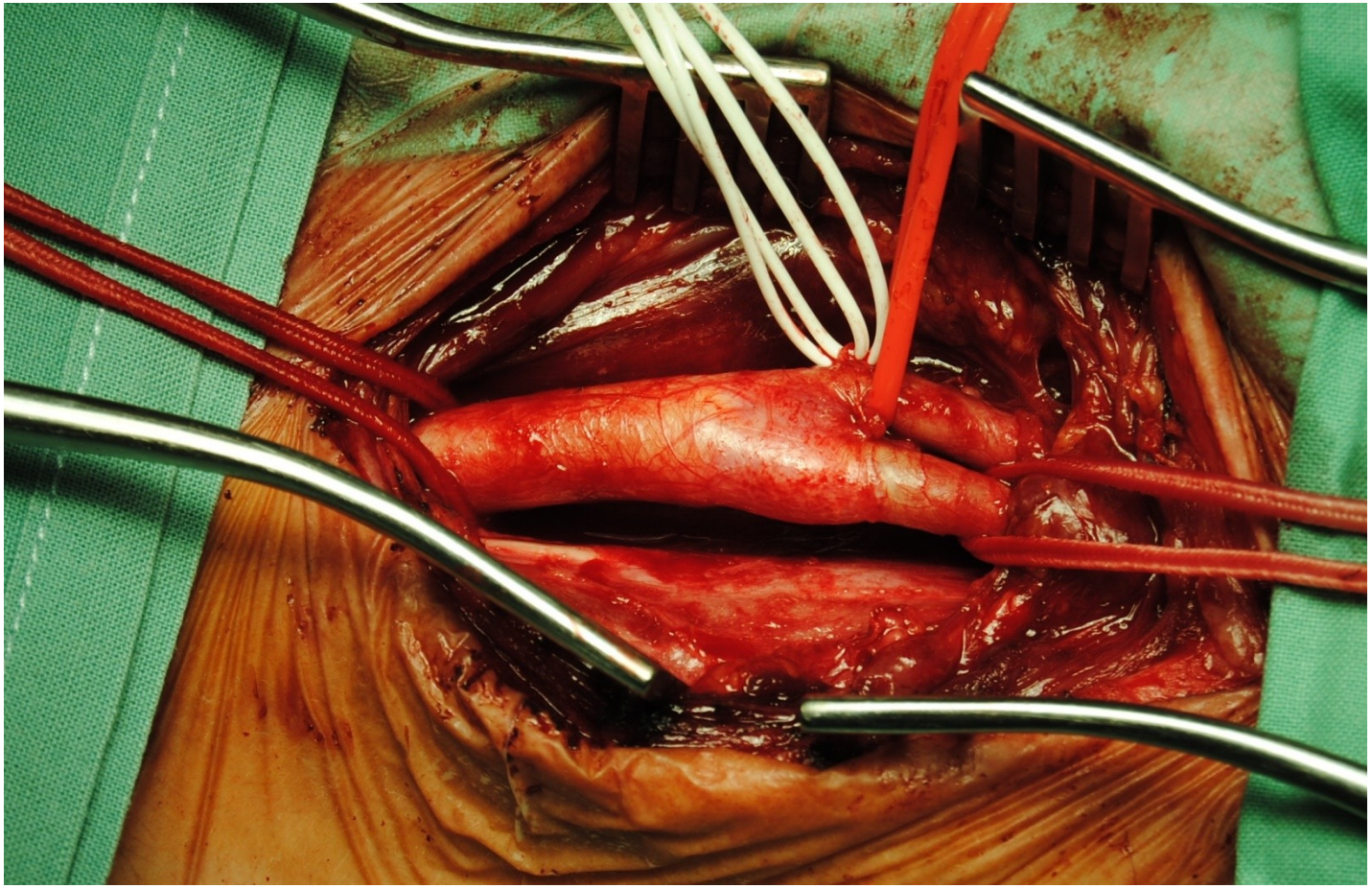


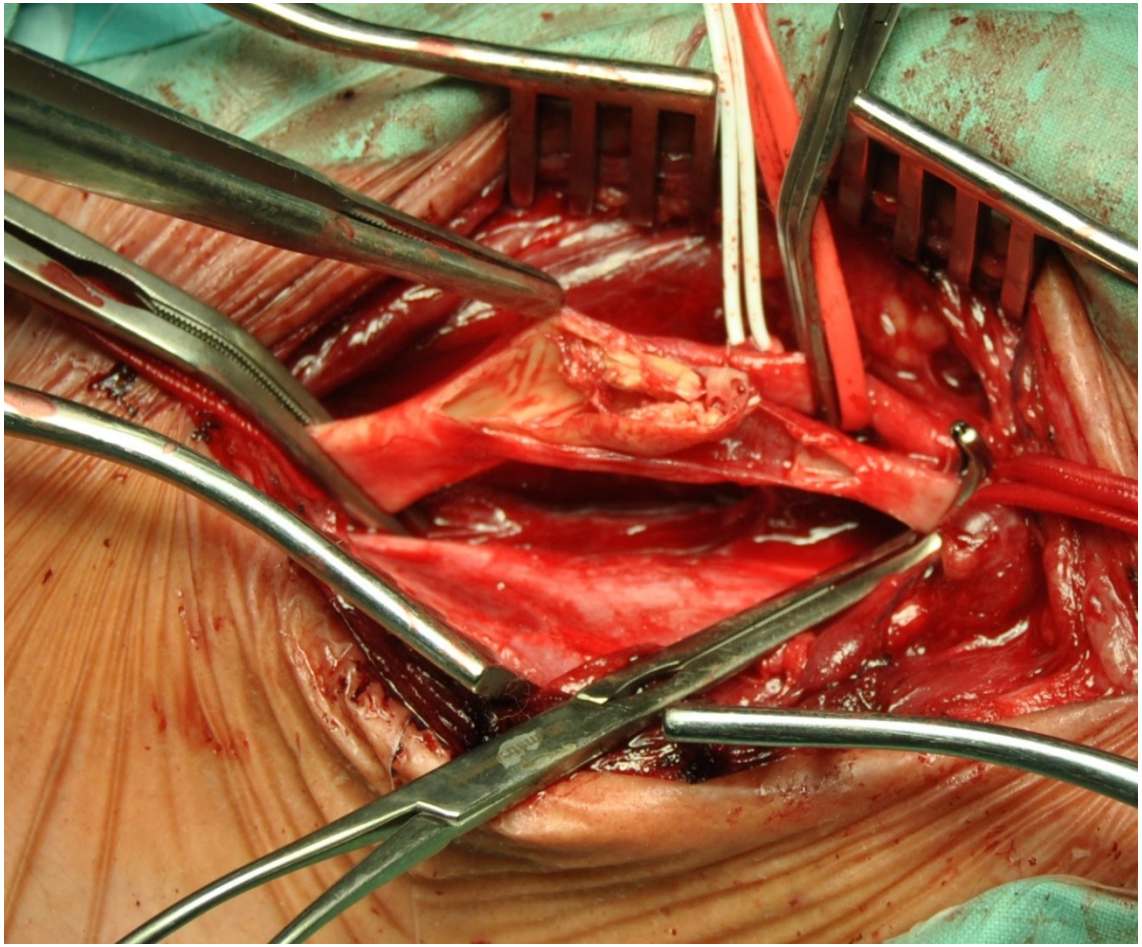
FIG 4 • Arteriotomy is extended from the anterior surface of CCA to the anterior surface of ICA distal to the lesion **(A)**. Intimal flap is tacked down to ensure smooth distal endpoint **(B)**. Arteriotomy is closed with a patch **(C)**.

Public domain image(s) and selected text provided courtesy of The National Heart, Lung, and Blood Institute (NHLBI) http://www.nhlbi.nih.gov
Source: https://thoracickey.com/carotid-surgery-interpositionendarterectomy-including-eversionligation/

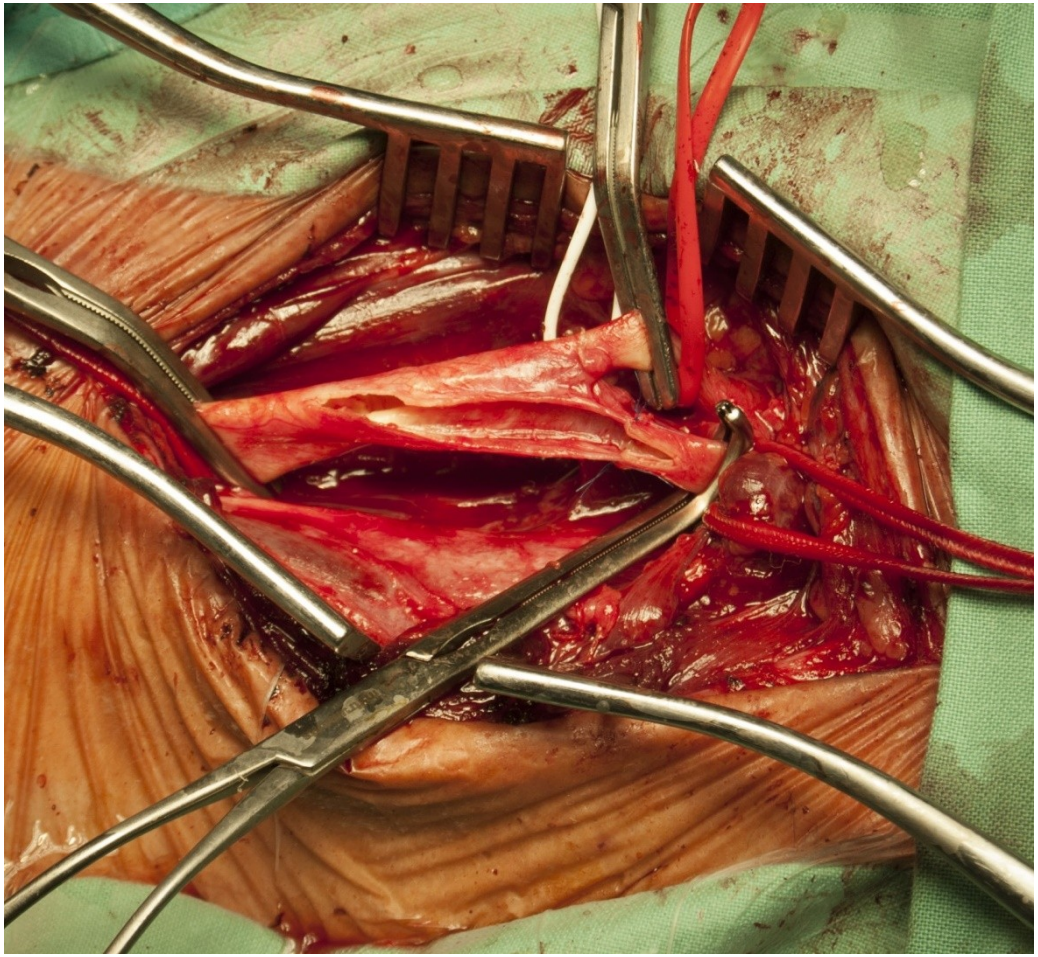
Carotid endarterectomy - conventional



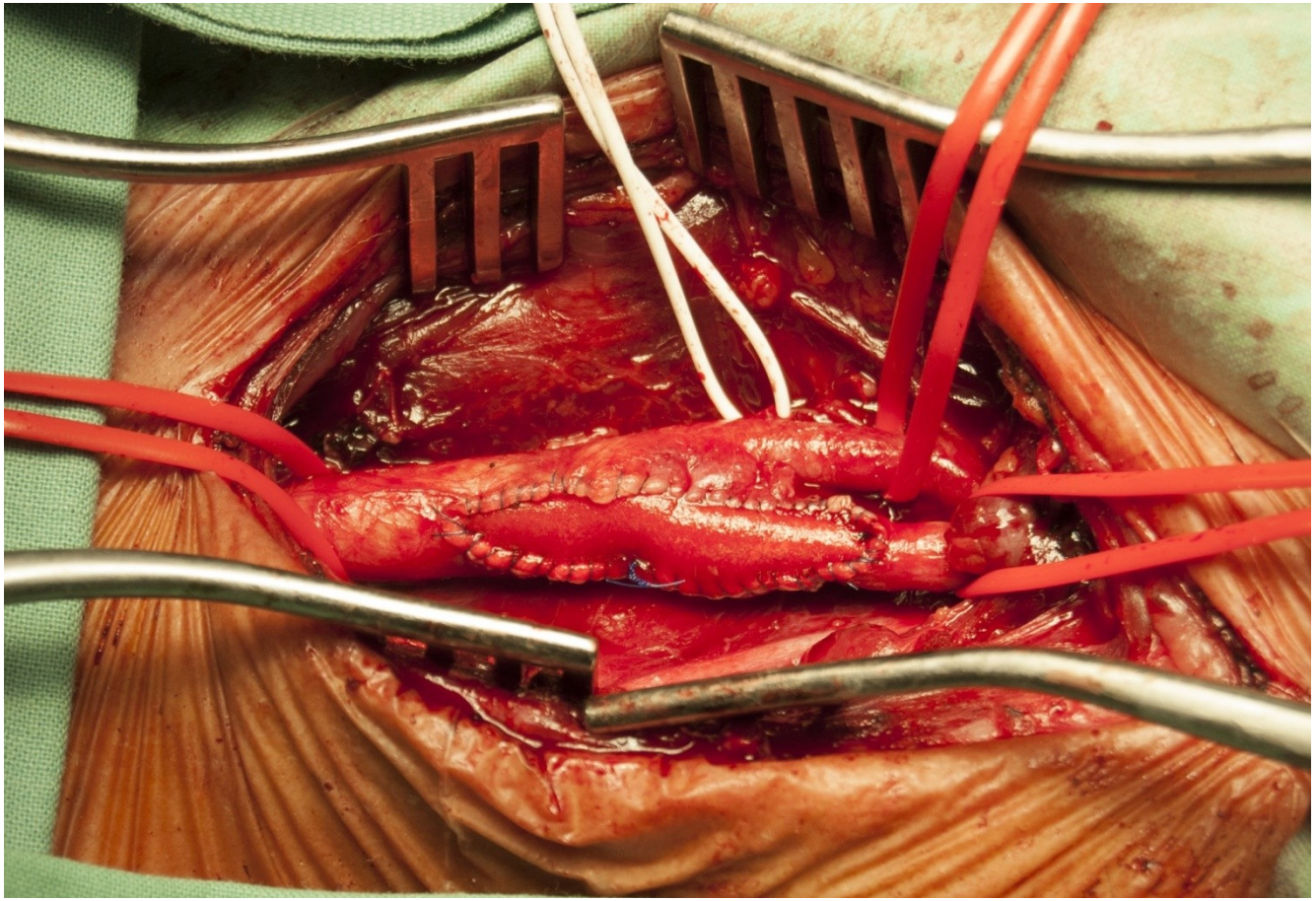
Carotid endarterectomy - conventional



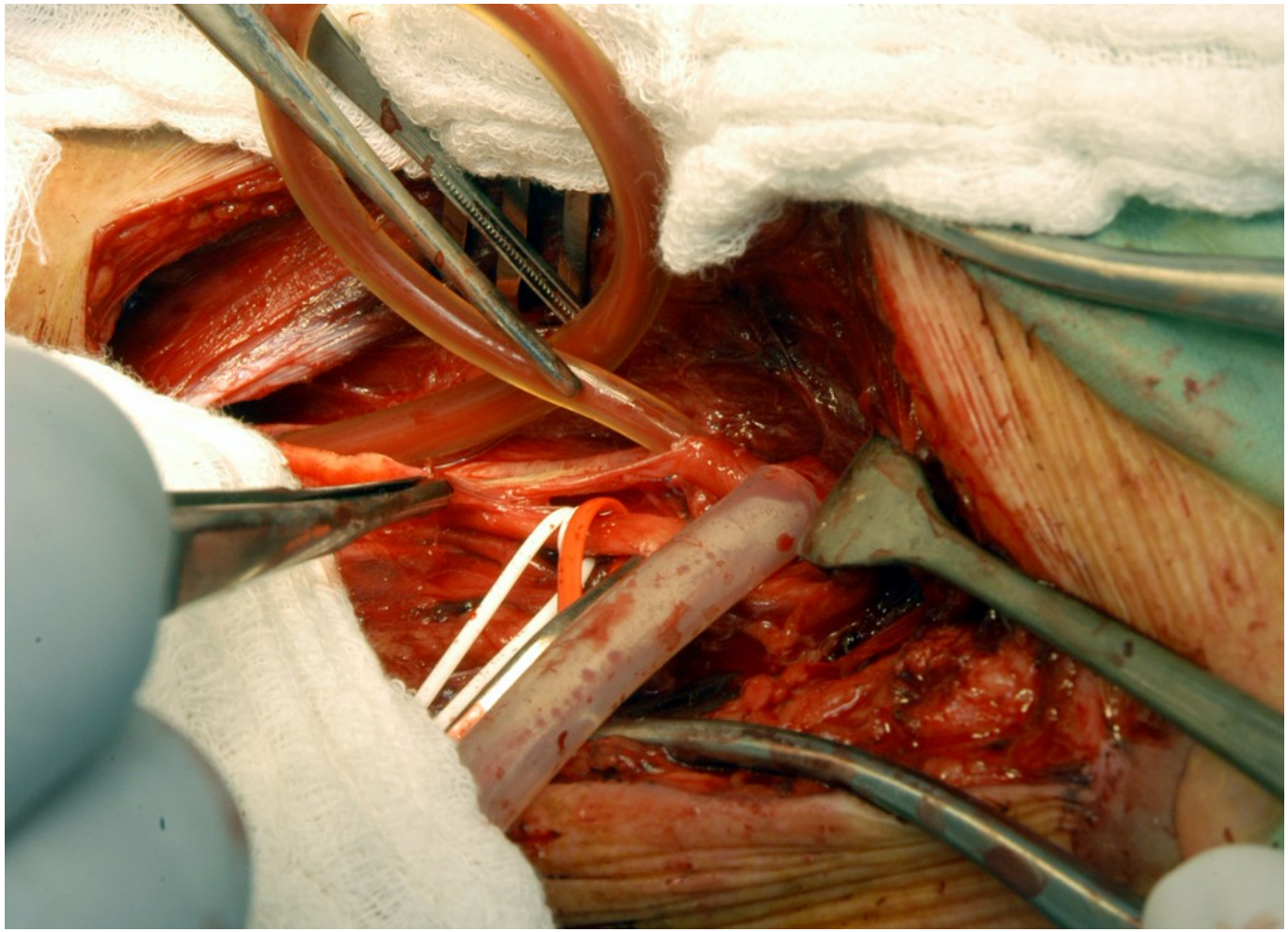
Carotid endarterectomy - conventional



Carotid endarterectomy - conventional



Carotid endarterectomy - shunting



Carotid endarterectomy - eversion

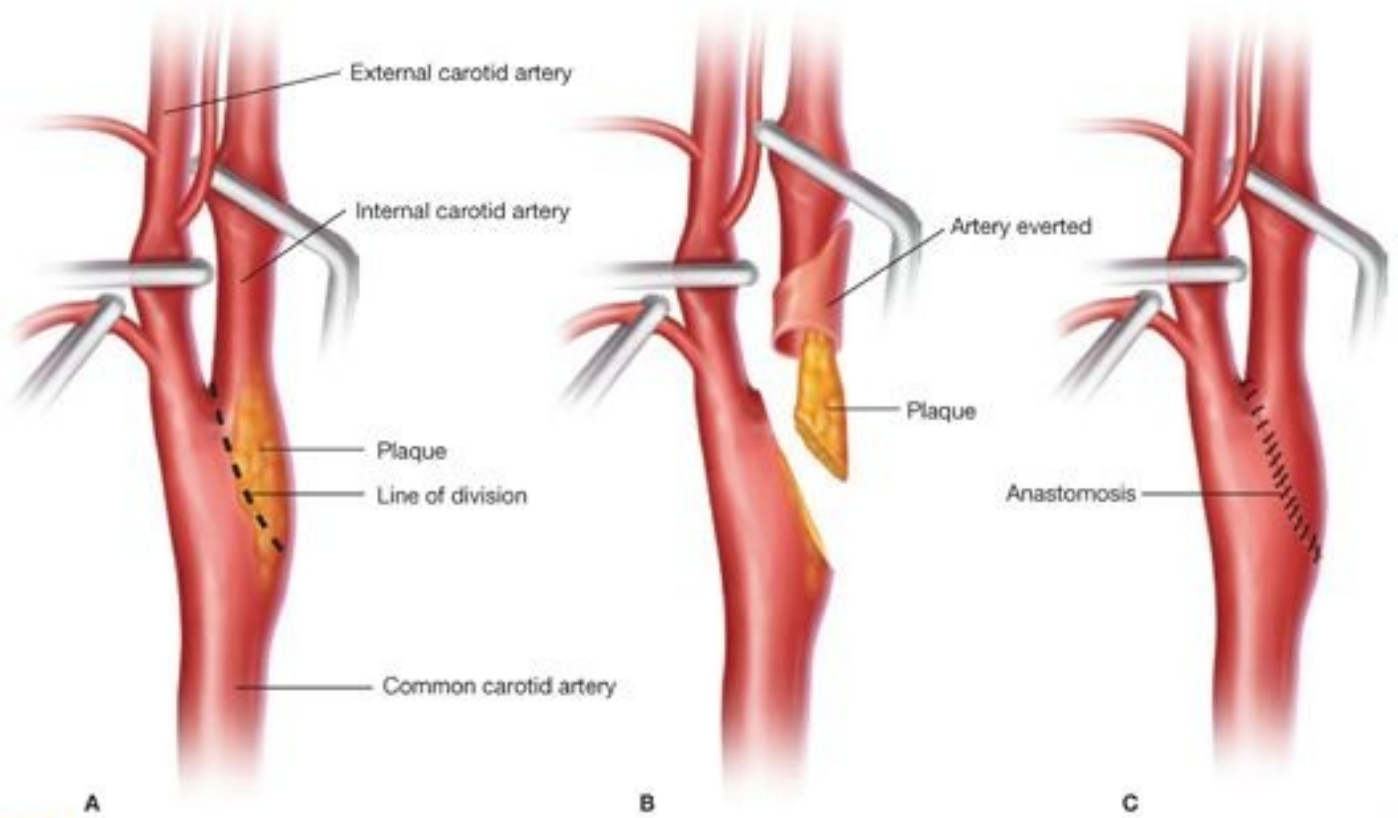
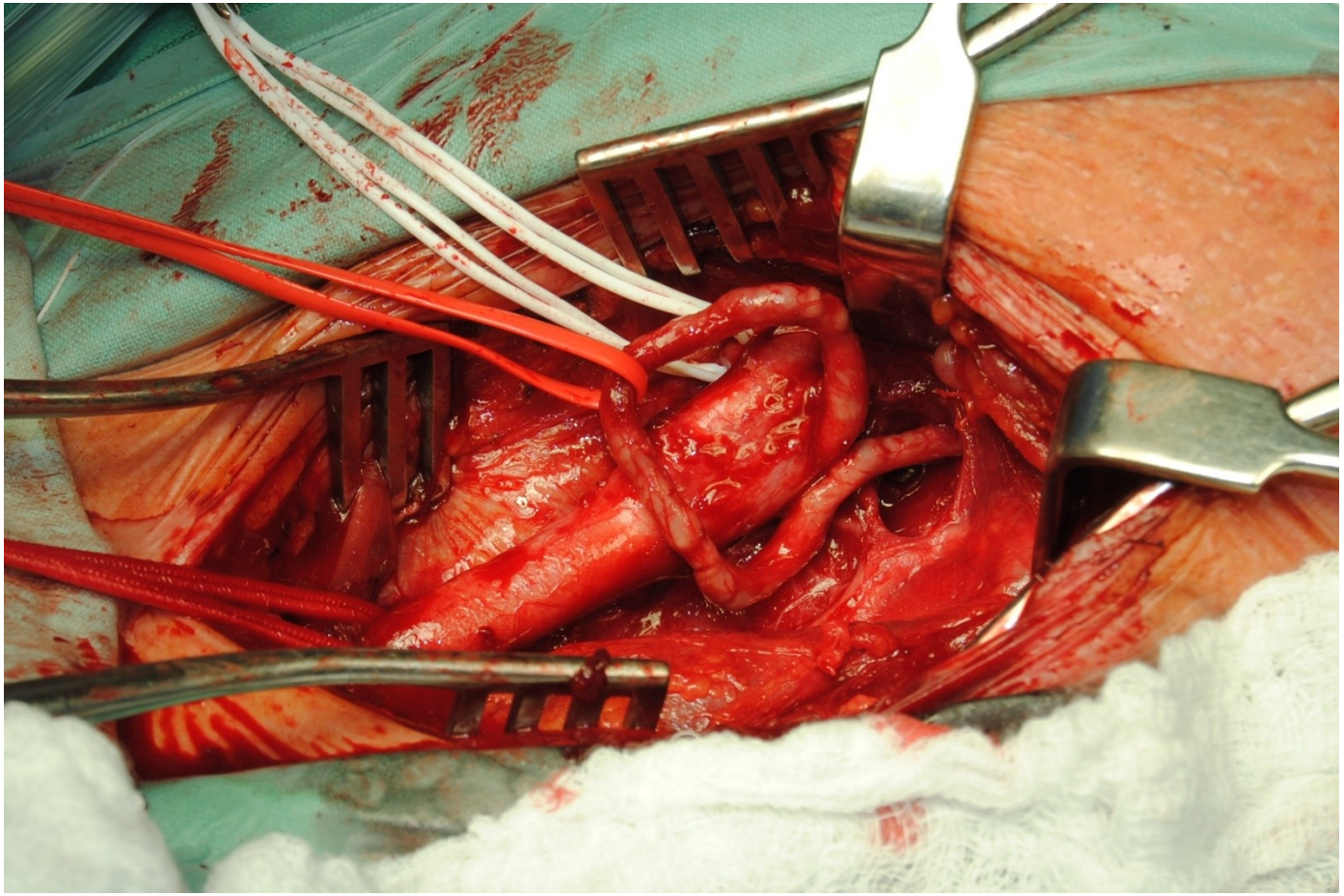


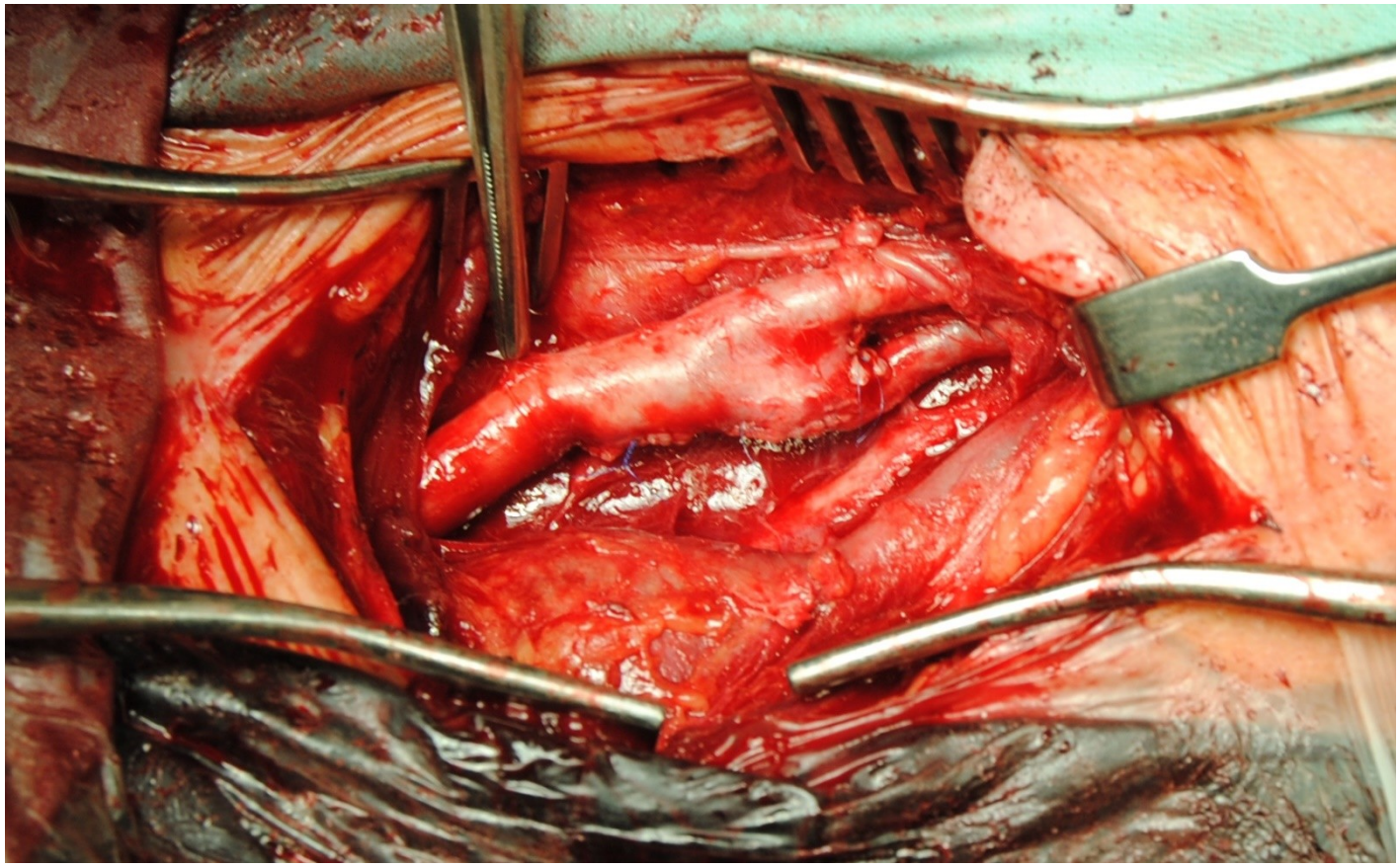
FIG 5 • Carotid eversion endarterectomy. The ICA is divided from the CCA in an oblique line **(A)**. The divided ICA is everted on itself until the plaque endpoint is encountered and the plaque is removed from the ICA **(B)**. Following endarterectomy, the ICA is reverted and reattached to the CCA **(C)**.

Source: https://thoracickey.com/carotid-surgery-interpositionendarterectomy-including-eversionligation/

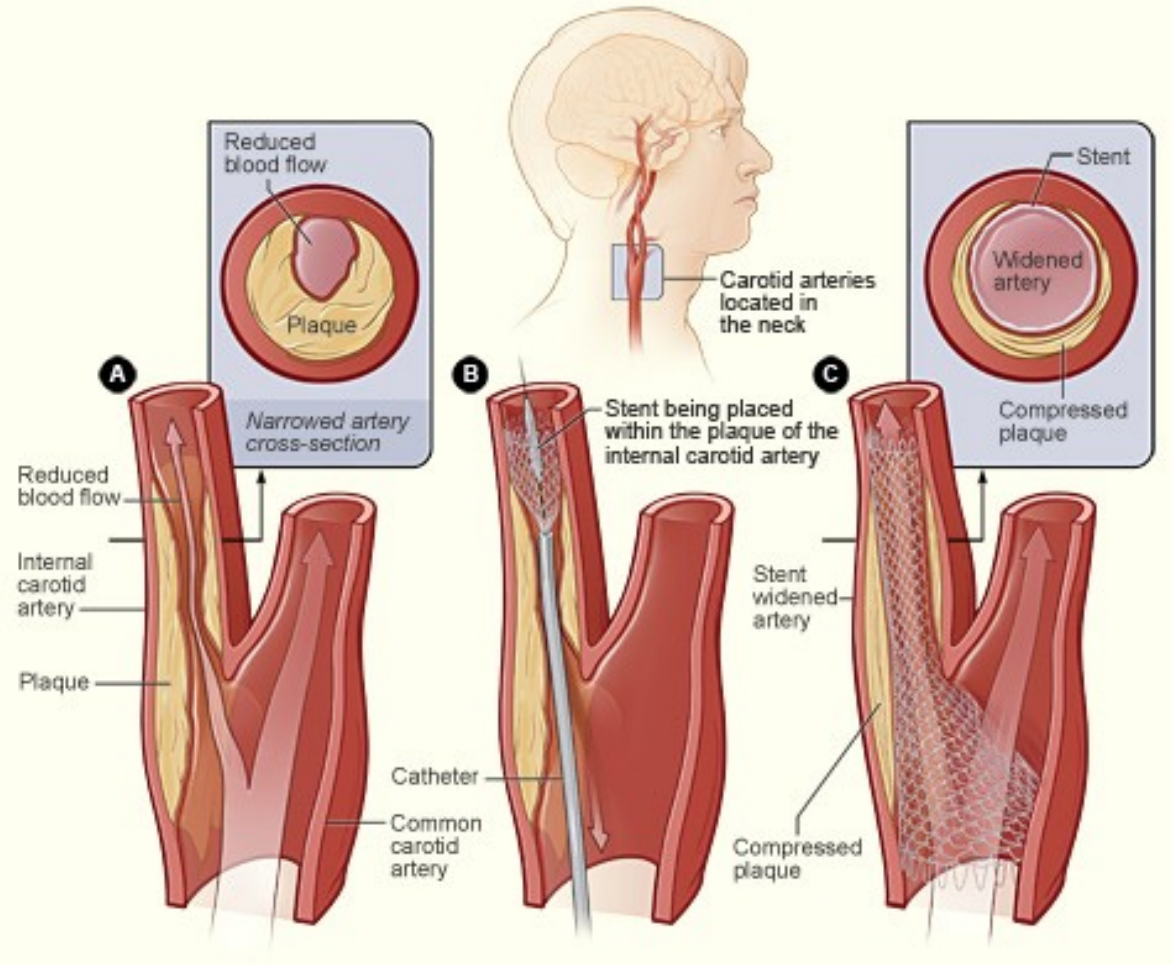
Carotid endarterectomy - eversion



Carotid endarterectomy - eversion



Carotid artery stenting



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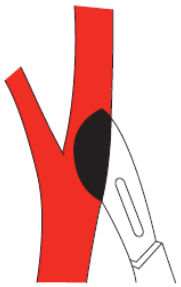
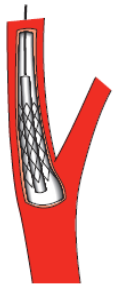
Carotid artery stenting



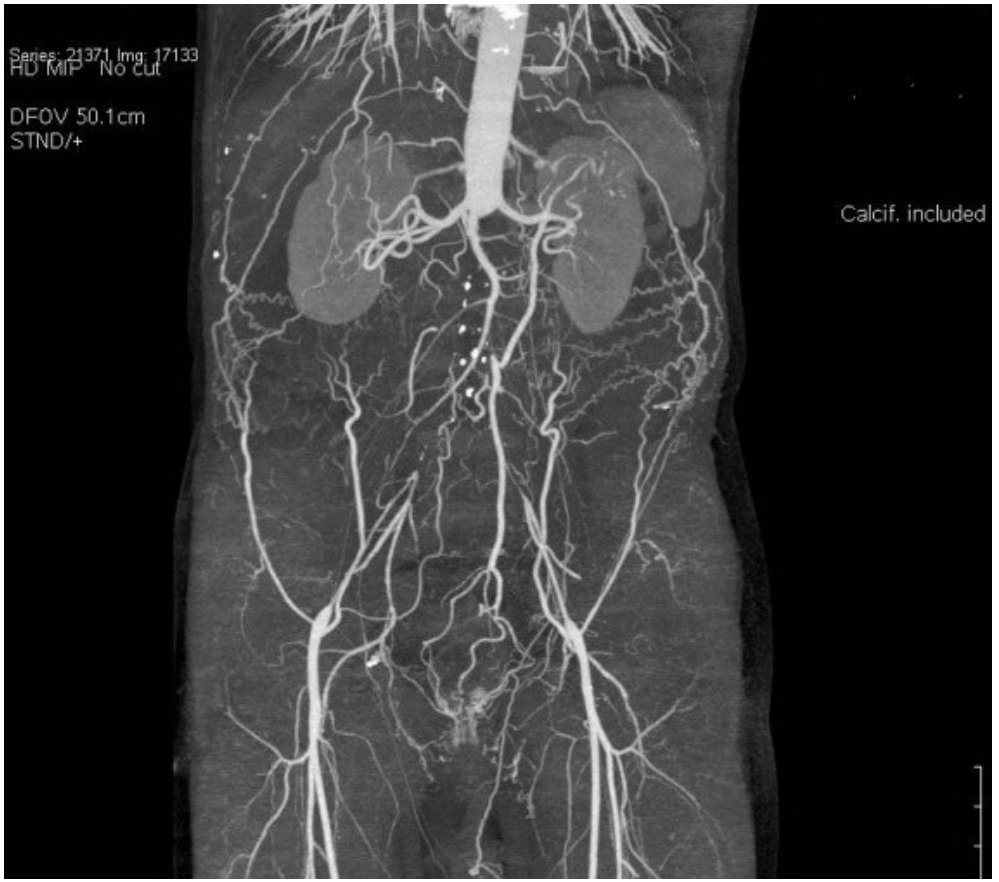
NIHR HTA/BUPA Foundation/University of Oxford

Asymptomatic Carotid Surgery Trial (ACST-2)



A large, simple randomised trial to compare carotid endarterectomy versus carotid artery stenting to prevent stroke

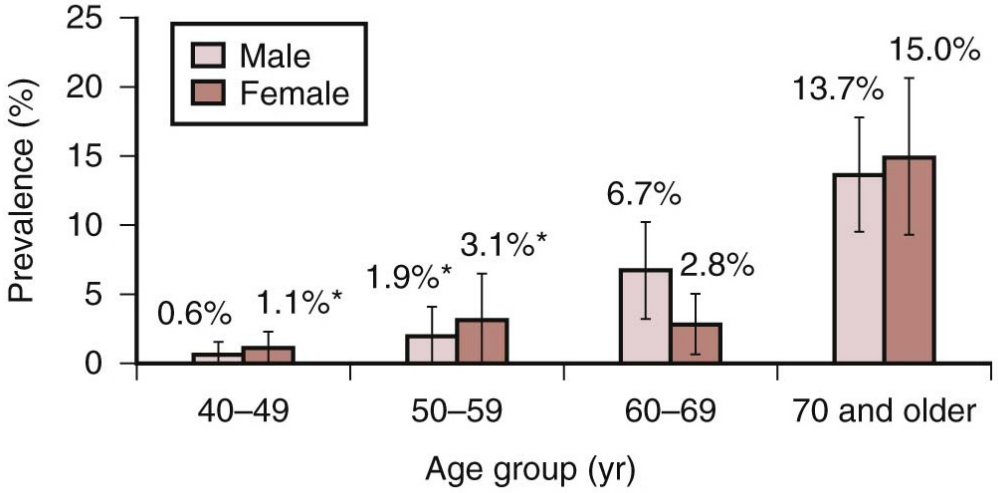
Peripheral artery disease (PAD)



Epidemiology

- **Prevalence of PAD based on ABI**

- 0.9% in <50yo
- 14.5% in >70yo



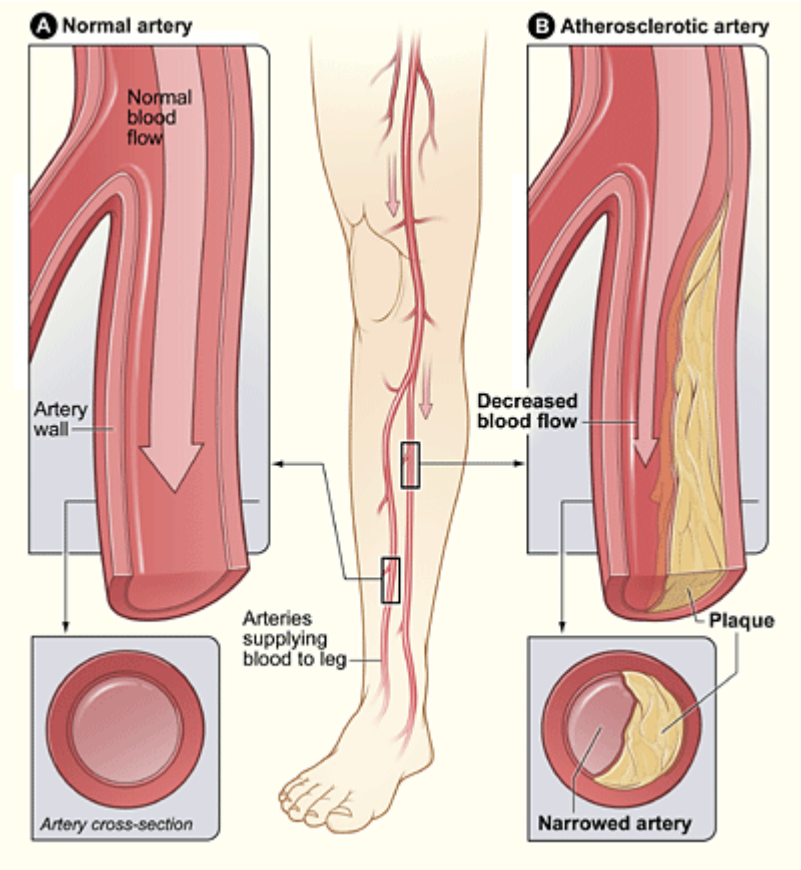
- **Prevalence of intermittent claudication**
  - symptomatic to asymptomatic ratio is **1:3-4**

National Health and Nutrition Examination Survey (NHANES) from 1999 to 2000

Pathogenesis

- **narrowed arteries** (most commonly due to atherosclerosis) **limit blood flow** to extremities

- extremities (usually legs) don't receive enough blood to keep up with demand, especially during physical exertion



Source: https://www.nhlbi.nih.gov/health/health-topics/topics/pad

Clinical presentation

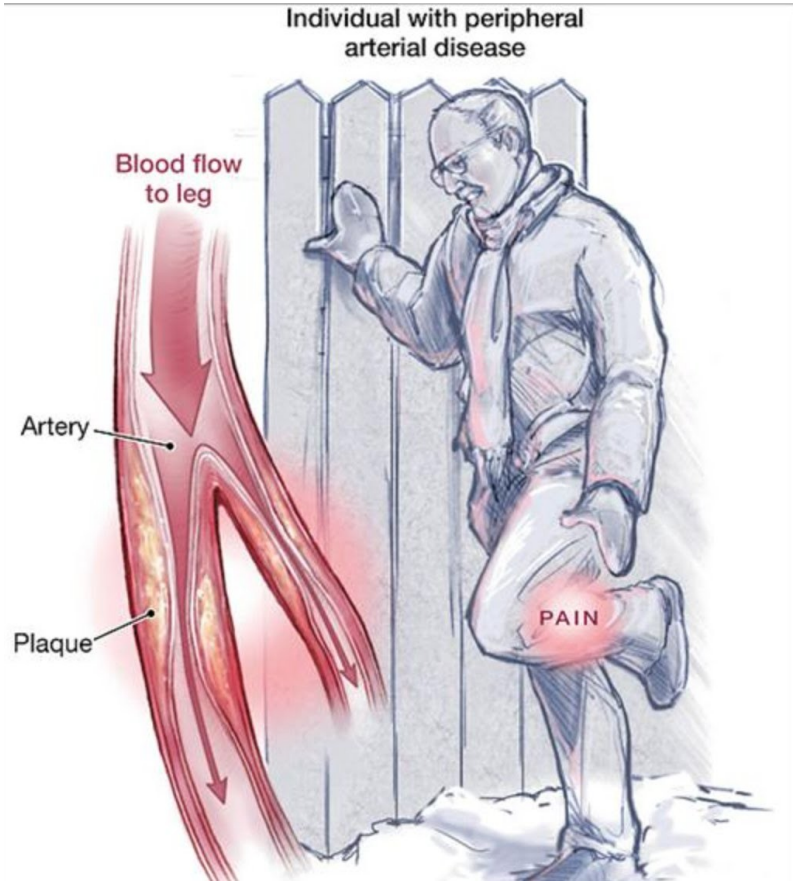
- **I. Asymptomatic**
- **II. Intermittent claudication (IC)**

Critical limb threatening ischemia (CLTI)

- III. Ischemic rest pain
- IV. Ulceration or gangrene

Claudication

- described as **pain, discomfort**, numbness, or tiredness in the legs that occurs **during walking**
- **relieved by rest** (minutes)
- in the
  - calf
  - buttocks
  - hips
  - thighs
  - feet



Source: https://guysandgoodhealth.com/2017/05/20/fruits-and-veggies-may-lower-risk-of-blockages-in-leg-arteries-aha/

Clinical presentation

- I. Asymptomatic
- II. Intermittent claudication

CLTI

- **III. Ischemic rest pain**
- **IV. Ulceration or gangrene**

Fontaine vs. Rutherford classification

Fontaine		Rutherford		
Stage	Clinical	Grade	Category	Clinical
I	Asymptomatic	0	0	Asymptomatic
IIa	Mild claudication	I	1	Mild claudication
IIb	Moderate to severe claudication	I	2	Moderate claudication
		I	3	Severe claudication
III	Ischemic rest pain	II	4	Ischemic rest pain
IV	Ulceration or gangrene	III	5	Minor tissue loss
		III	6	Major tissue loss

Fate of the leg

- **Asymptomatic**
  - **progression of PAD is identical to patients with intermittent claudication**
  - symptomatology depends on the level of activity of the subject
  - **should be managed medically** in **the same way** as those with symptoms of intermittent claudication

Fate of the leg

- **Intermittent claudication / asymptomatic**
  - **PAD is progressive**
  - **clinical course is** surprisingly **stable**
  - **only 25% of patients** with IC **deteriorate**
  - **major amputation is a relatively rare outcome**
    - less than 5% over a 5-year period.

Fate of the leg

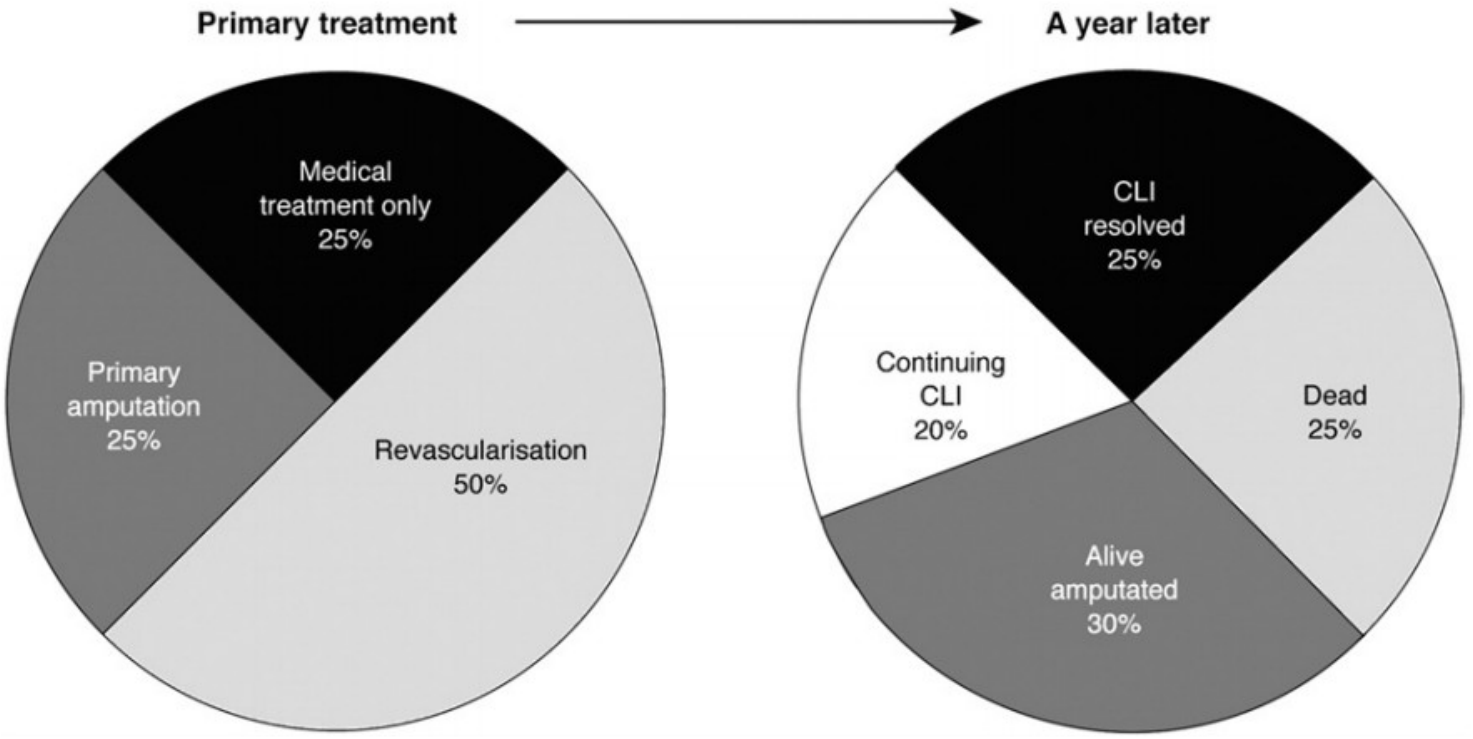


Fig. A5. Fate of the patients presenting with chronic critical leg ischemia. CLI – critical limb ischemia.

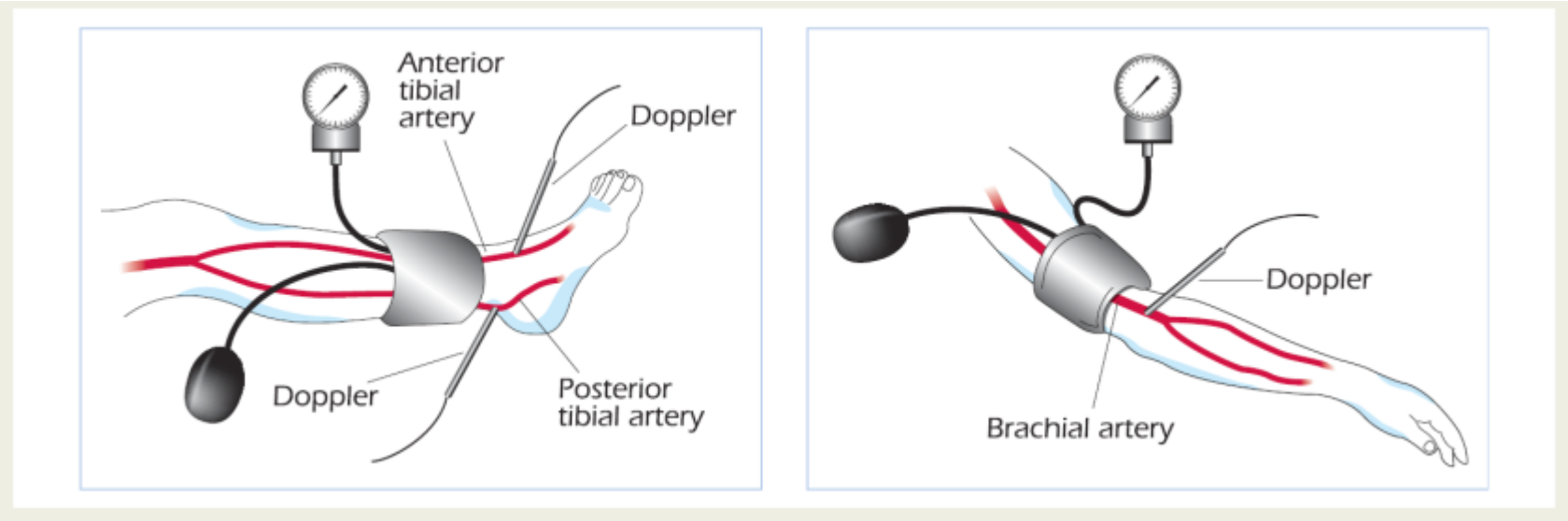
Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FG; TASC II Working Group. Inter-Society Consensus for the Management of Peripheral Arterial Disease (T
Vasc Surg. 2007 Jan;45 Suppl S:S5-67.

Clinical assessment

- **History**
- clinical presentation of illness
  - claudication
  - rest pain
  - ulcers
- atherosclerosis
  - risk factors

- **Physical findings**
- lower limb examination
  - pulses (bruits & thrills)
  - sensory and motor functions
  - ulcers / gangrenes / infection
  - foot color and temperature
  - capillary refill
  - Buerger's test
- ABI measurement

Ankle-brachial index - ABI



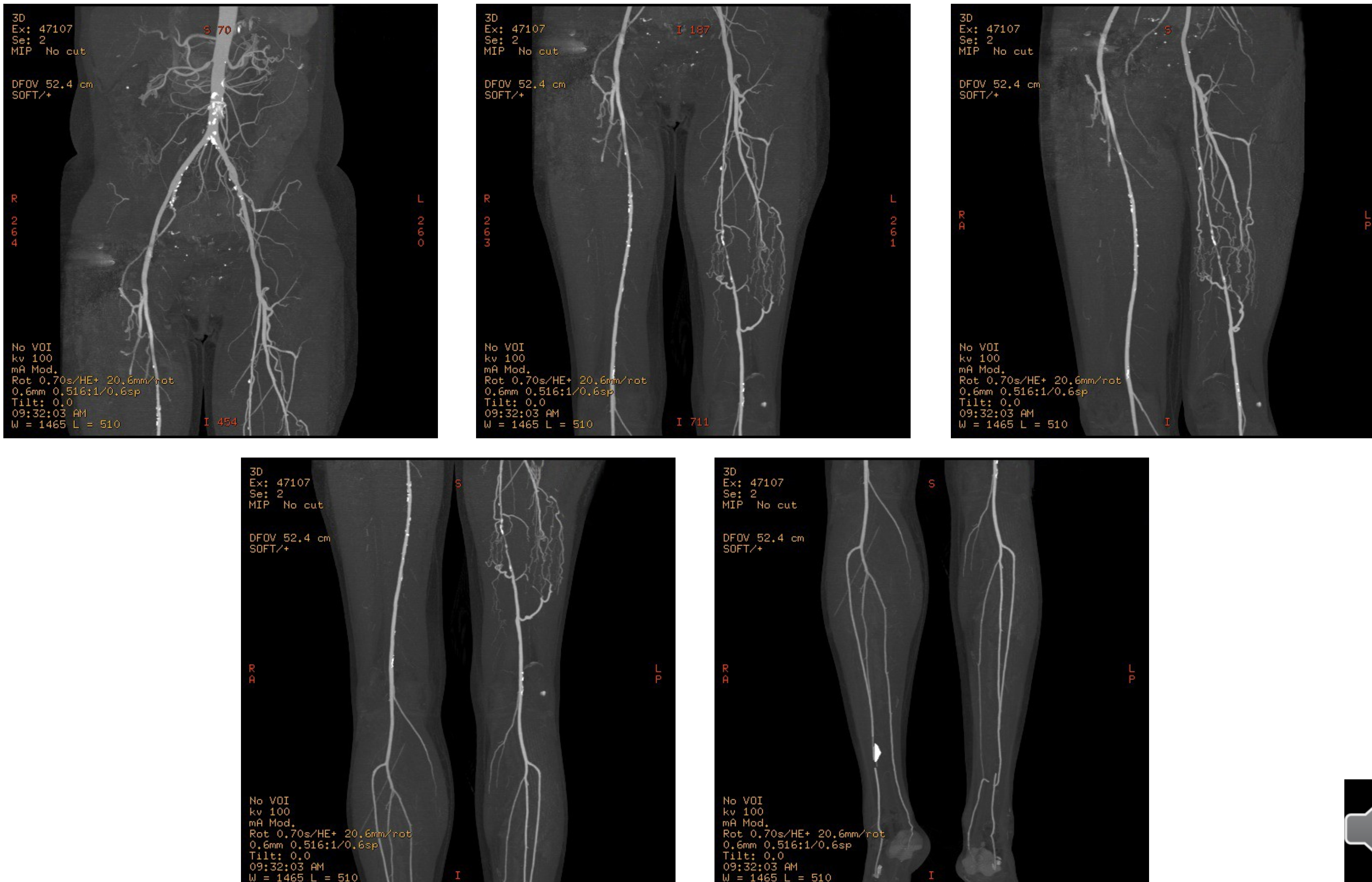
European Stroke Organisation, Tendera M, Aboyans V, Bartelink ML, Baumgartner I, Clément D, Collet JP, Cremonesi A, De Carlo M, Erbel R, Fowkes FG, Heras M, Kownator Ostergren J, Poldermans D, Riambau V, Roffi M, Röther J, Sievert H, van Sambeek M, Zeller T; ESC Committee for Practice Guidelines. ESC Guidelines on the diagnosis and tr peripheral artery diseases: Document covering atherosclerotic disease of extracranial carotid and vertebral, mesenteric, renal, upper and lower extremity arteries: the Task Fo Diagnosis and Treatment of Peripheral Artery Diseases of the European Society of Cardiology (ESC). Eur Heart J. 2011 Nov;32(22):2851-906. doi: 10.1093/eurheartj/ehr211. Ep Aug 26.

Ankle-brachial index - ABI

Diagnosis

- **duplex ultrasonography**
- **CT angiography**
- magnetic resonance angiography
  - price, availability, imaging limitations
- **digital subtraction angiography**
  - specific indications (CT/MRI artifacts, below the knee arteries, planned endovascular intervention)

CT angiography



Treatment

- „best“ medical therapy
- endovascular interventions
- surgical procedures

How do we choose the proper treatment?

- **symptoms** – significant disability, presence of critical ischemia
- **functional status** of the patient
- **comorbid conditions**

- **favorable risk-benefit ratio** (anatomical pattern of disease, target vessel, conduit availability)

- **patient preferences**
- **expected durability of offered procedures!!!**

How do we choose the proper treatment?

- 2017 **ESC Guidelines** on the Diagnosis and Treatment of Peripheral Arterial Diseases, **in collaboration with the European Society for Vascular Surgery**

Intermittent claudication

- **Supervised exercise training is recommended** [I,A]
- **Unsupervised exercise training is recommended** when supervised exercise training is not feasible or available. [I,C]
- **When daily life activities are compromised** despite exercise therapy, **revascularization should be considered.** [IIa,C]
- **When daily life activities are severely compromised**, **revascularization should be considered** in association with exercise therapy. [IIa,B]

Chronic limb-threatening ischemia

- for limb salvage, **revascularization is indicated whenever feasible** [I,B]

- for **infra-popliteal revascularization**
  - **bypass using** the great saphenous **vein** is indicated [I,A]
  - **endovascular** therapy **should be considered** [IIa,B]

- **stem cell/gene therapy is not indicated** [III,B]

„Best“ medical therapy

- Risk factor reduction and medical management
  - antiplatelet therapy
    - anticoagulation (if indicated for other condition)
  - statin therapy
  - **exercise therapy !!!**
  - **vasodilators**
- risk factor reduction
  - hypertension
  - diabetes mellitus
  - smoking cessation
  - alcohol cessation

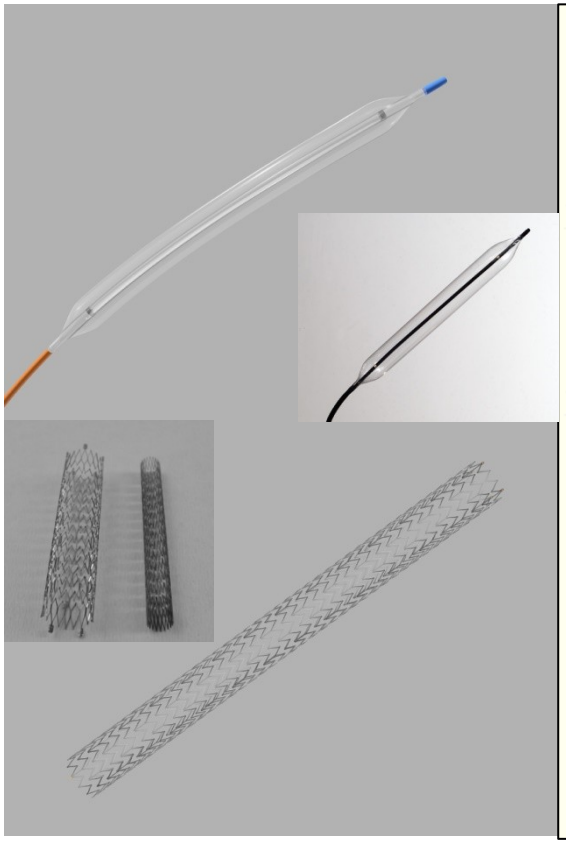
Structured exercise therapy

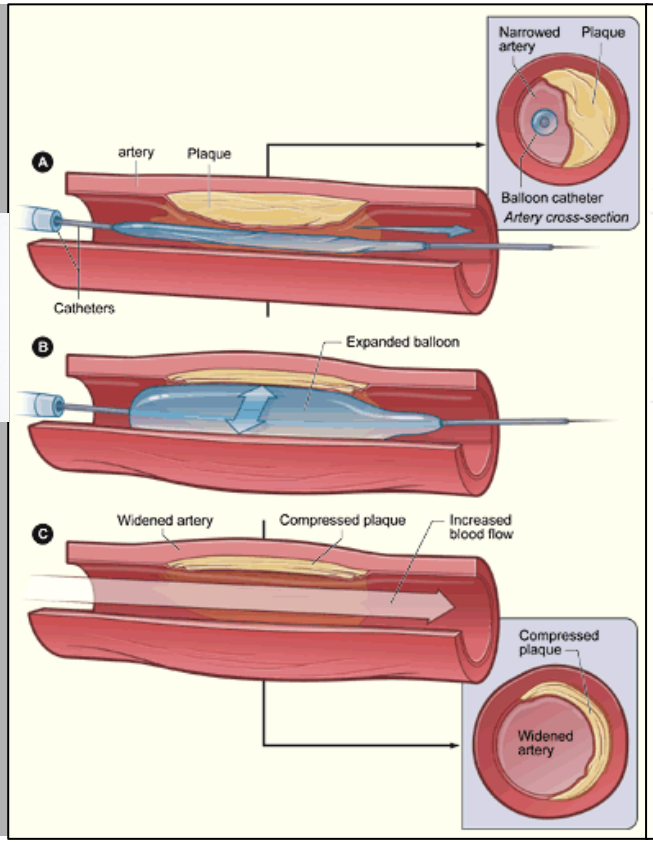
- involves **intermittent bouts of walking** to moderate-to-maximum claudication, alternating with periods of rest
- is performed for a **minimum of 30–45 min/session**; sessions are performed **at least 3 times/wk** for a **minimum of 12 wk**

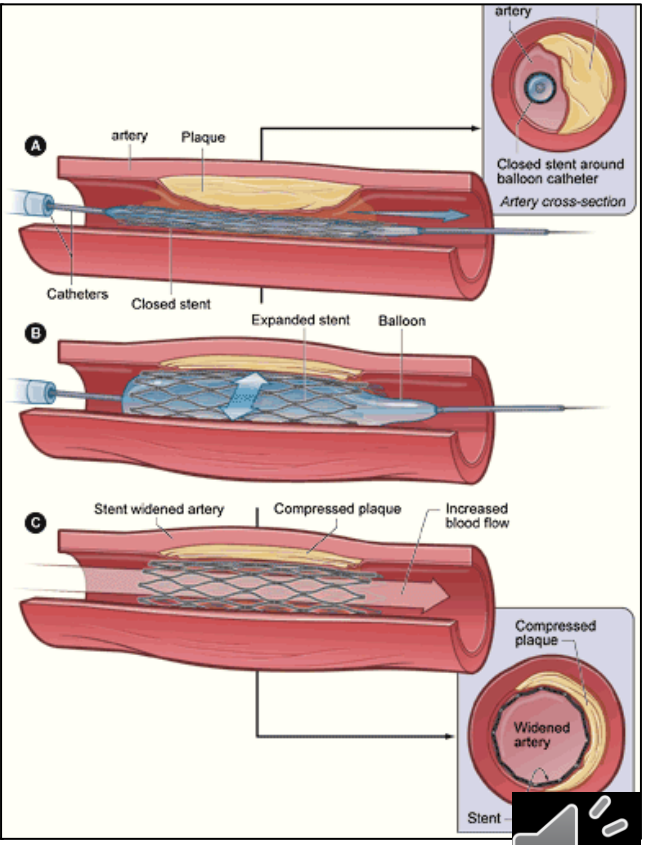
- **two options**
  - Supervised exercise program
  - Structured community- or home-based exercise program

Endovascular interventions

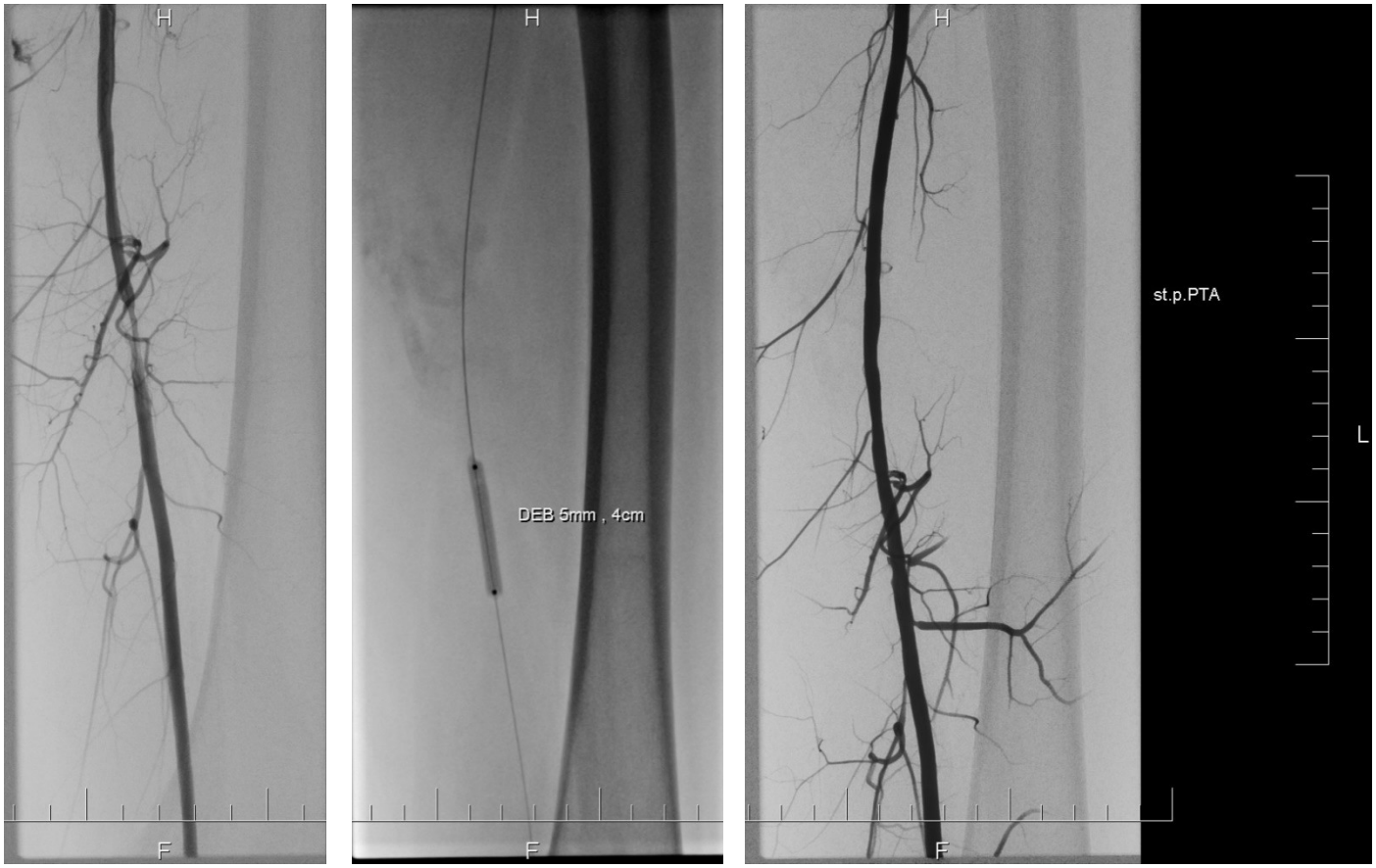
- **PTA or PTA + stenting**







PTA



PTA (Stenting)

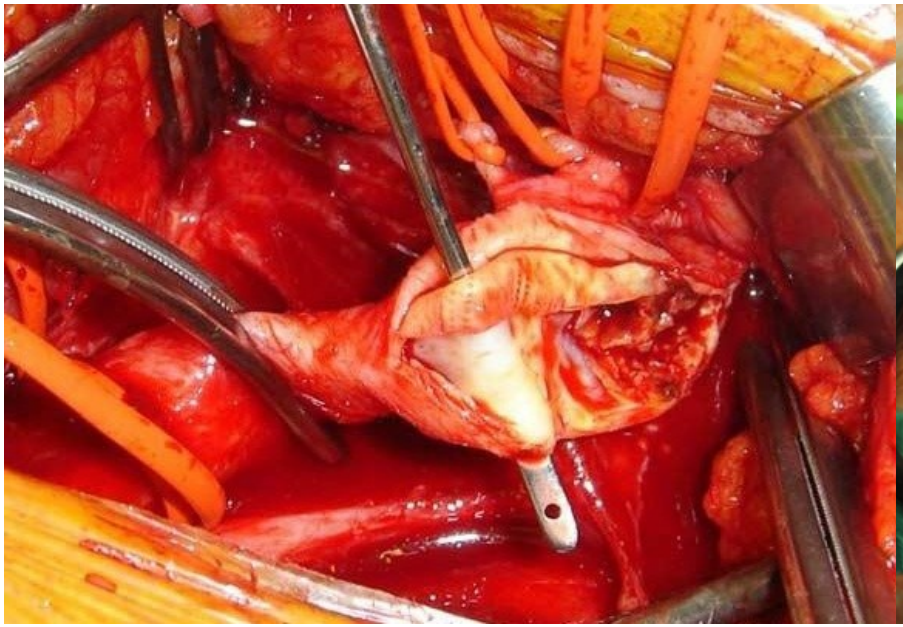
Surgical procedures

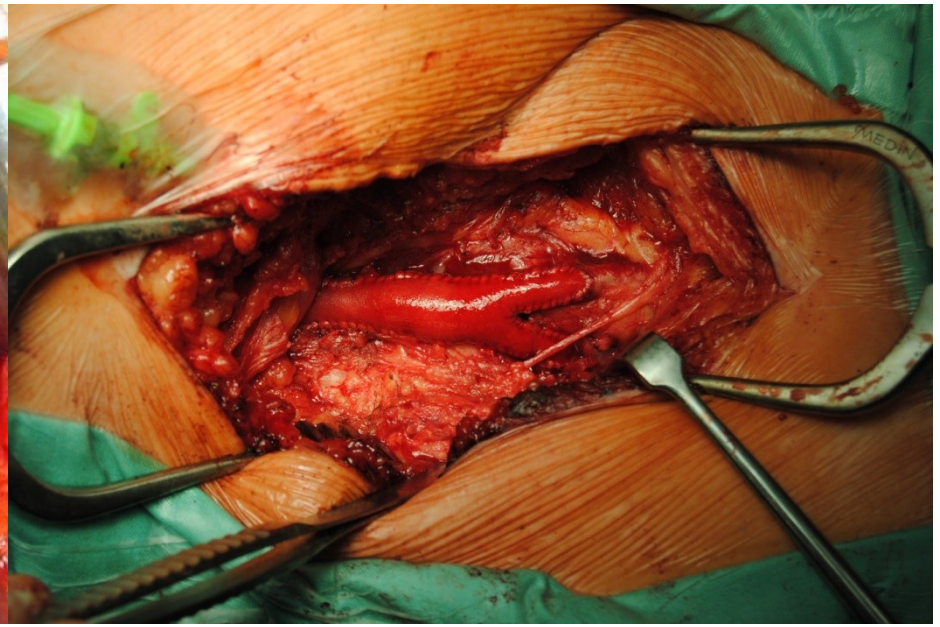
- Endarterectomy
- Patch angioplasty

- Bypass
  - anatomic
  - extraanatomic

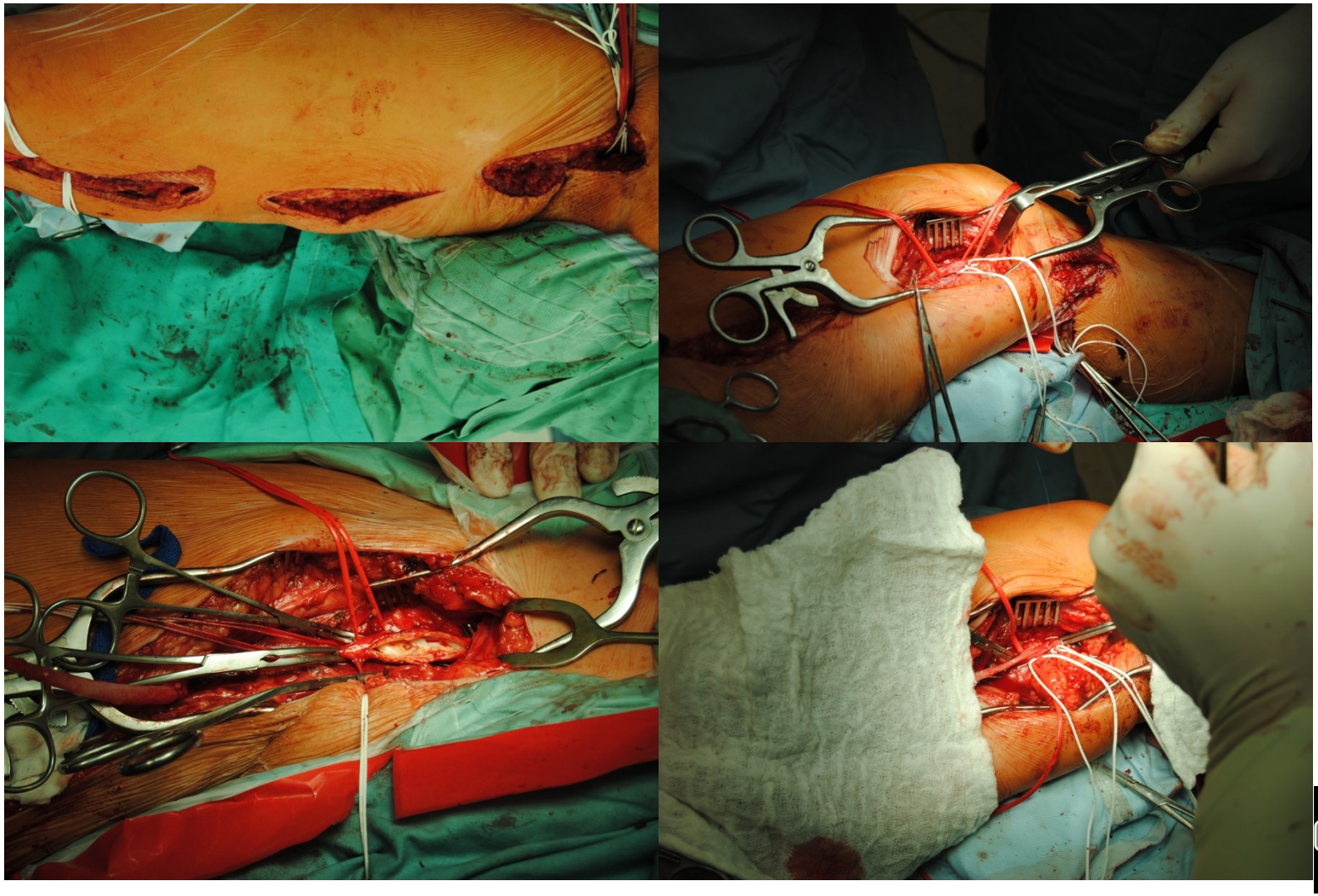
- Hybrid procedures

Endarterectomy & patch angioplasty

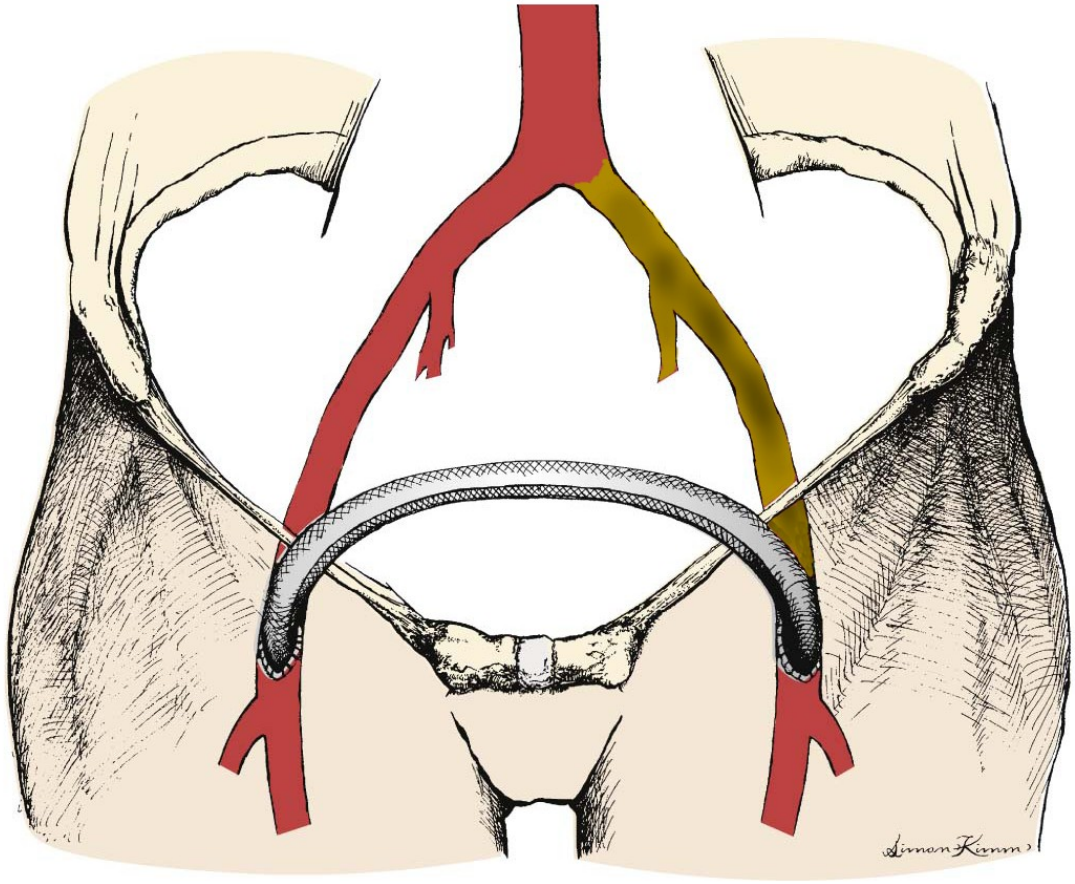




Proximal femoropopliteal bypass



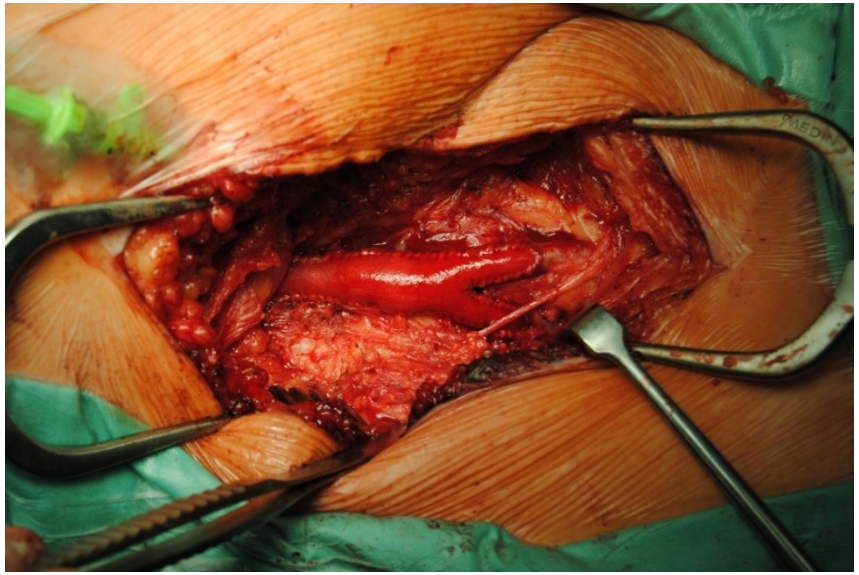
Bypass extranatomic



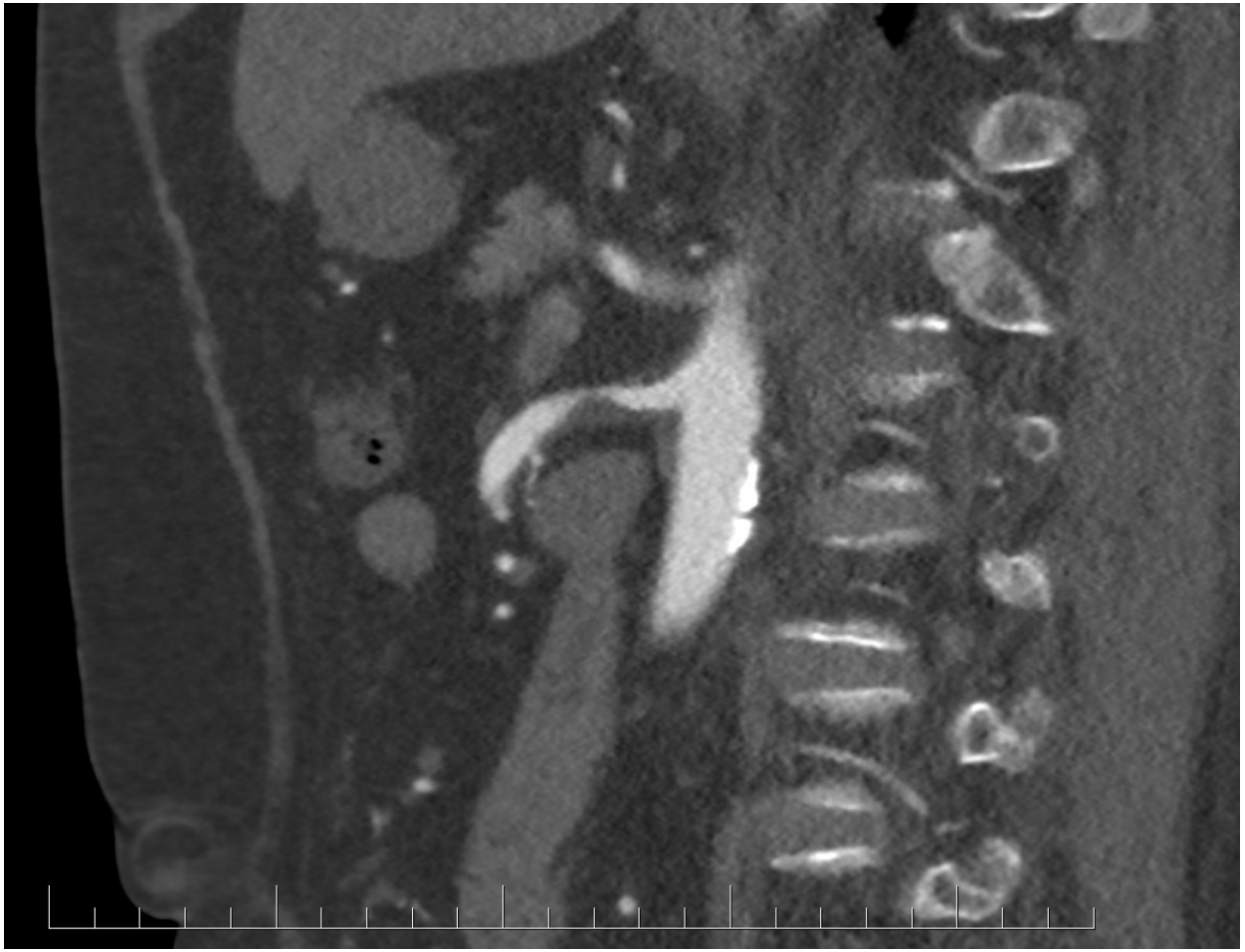
Source: Ruhterford's Vascular Surgery 8th Edition, edited

Hybrid procedure =

+



Chronic mesenteric ischemia (CMI)



Epidemiology

- **asymptomatic occlusive disease** of the visceral arteries is **a common finding in elderly patients**

- **estimated the prevalence 6 to 10 %**

- the exact **incidence of chronic mesenteric ischemia** is **not known**

Pathophysiology

- **atherosclerosis** is the most common cause

- **median arcuate ligament syndrome**
  - a separate entity that may lead to symptoms of CMI
  - compression of the celiac artery by the median arcuate ligament

- **majority of patients with symptoms** of CMI have significant **stenosis or occlusion of at least two** of the three **mesenteric arteries**

Pathophysiology

- **20% of the cardiac output** goes through the **mesenteric arteries** under normal conditions

- **after** the ingestion of a **meal blood flow is elevated** during the next 3 to 6 (up to 2000 mL/min)

- **duration** of these responses **depend on the type and quantity of a meal**

Clinical presentation

- **postprandial abdominal pain**
  - often occurs 15 to 45 minutes after a meal
  - patients typically develop **"food fear"**

- **progressive weight loss**
  - is a common finding
  - changes in bowel habits, nausea, and vomiting are less common

Clinical presentation

- **physical examination is usually nonspecific**
  - **undernourishment or cachexia**
  - **an abdominal bruit** can sometimes be auscultated
  - bowel sounds are frequently hyperactive
  - guarding and rebound tenderness are usually absent

- **typical patient**
  - female with a median age 65 (40-90)
  - 3-4 : 1 female-to-male ratio

Clinical assessment

- **History**
- clinical presentation of present illness
- atherosclerosis
  - risk factors

- **Physical findings**
- cachexia
- abdominal bruit (up to 50 % of patients
- female with a median age 65 (40-90)

Diagnosis

- **DUS**
  - useful tool for diagnosis of visceral ischemic syndromes
  - excellent for median arcuate ligament syndrome as well

- **CT**
  - accurate imaging modality
  - can rule out other diagnoses
  - important for intervention planning

- MRI

Diagnosis

- **digital subtraction angiography**
  - usually for planned endovascular intervention
- endoscopy
- gastric tonometry

Treatment

- conservative
  - no role in symptomatic mesenteric artery disease

- **endovascular interventions**

- **surgical procedures**

- 2017 Clinical Practice **Guidelines of the European Society of Vascular Surgery**
- 2017 **ESC Guidelines** on the Diagnosis and Treatment of Peripheral Arterial Diseases, **in collaboration with the European Society for Vascular Surgery**

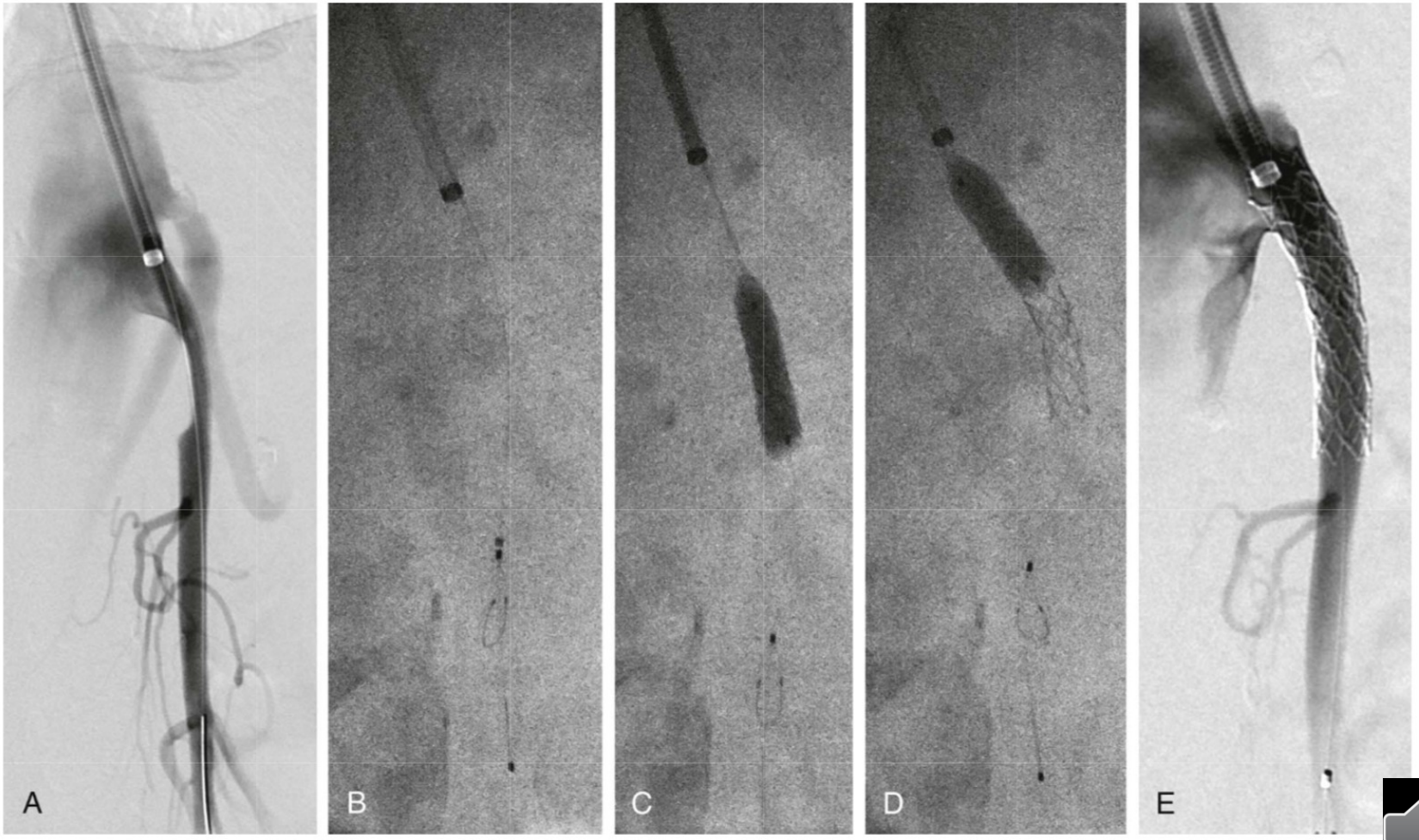
Treatment

- In patients with suspected CMI, occlusive **disease of a single mesenteric artery makes the diagnosis unlikely** and a careful search for alternative causes should be considered. [IIa,C]
- In patients with **symptomatic multivessel CMI, revascularization is recommended** [I,C/B]
- In patients with symptomatic multivessel CMI, it is **not recommended to delay revascularization** in order to improve the nutritional status. [III,C]

Treatment

- In patients with CMI, needing revascularization, the **superior long term results of open surgery must be offset against a possible early benefit of endovascular intervention** with regard to peri-procedural mortality and morbidity. [I,B]

PTA + stenting

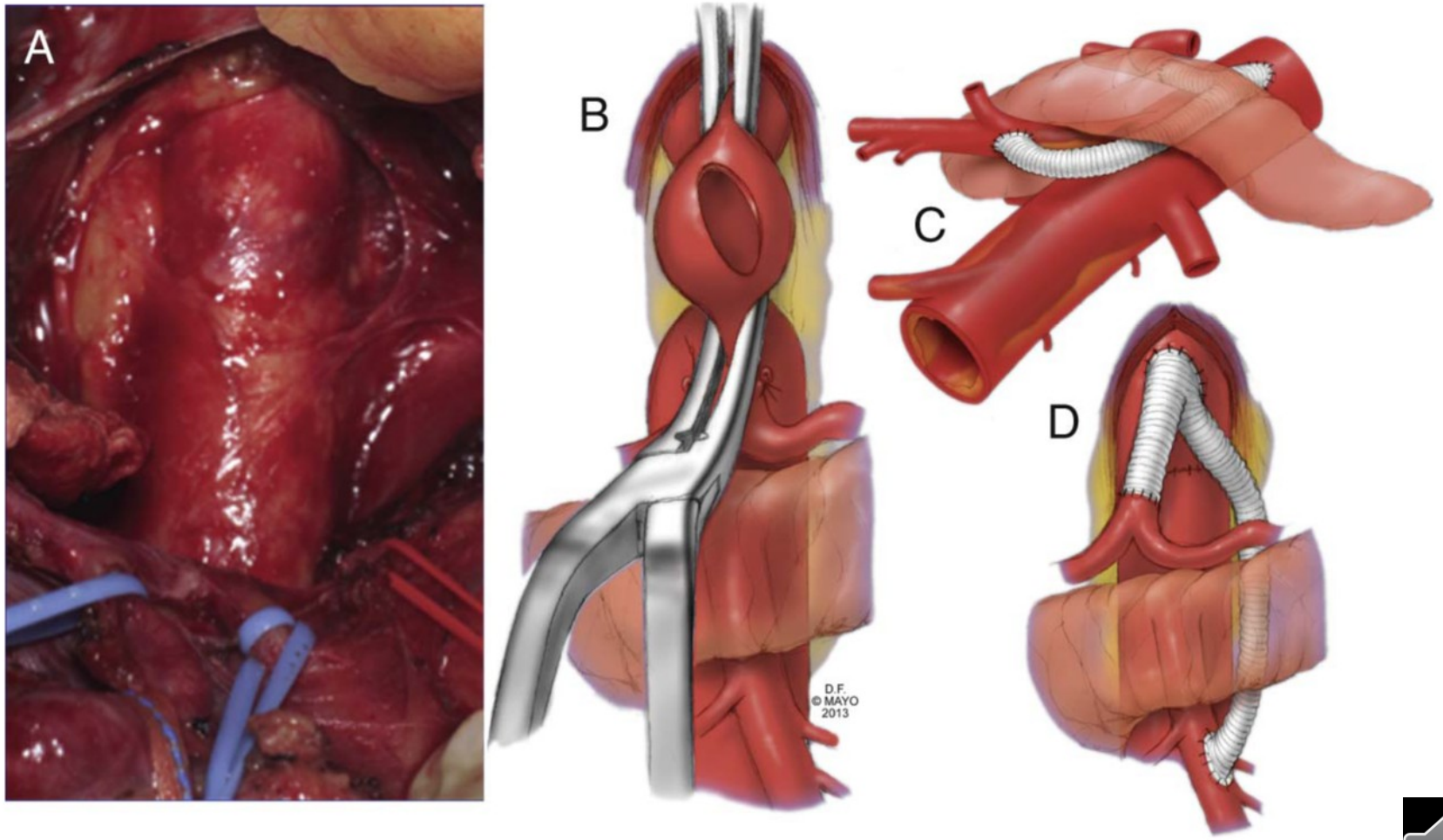


Source: Ruhterford's Vascular Surgery 8th Edition

Surgical procedures

- **Antegrade Mesenteric Bypass**
- **Retrograde Mesenteric Bypass**
- Mesenteric **bypass offers**
  - improved patency
  - lower rates of re-interventions
  - better freedom from recurrent symptoms
- Transaortic endarterectomy – rare

Antegrade mesenteric bypass



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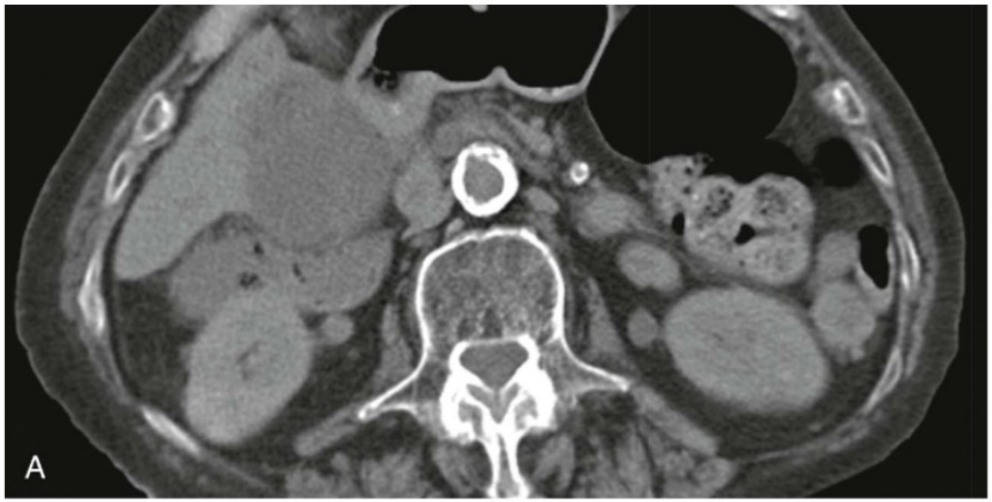
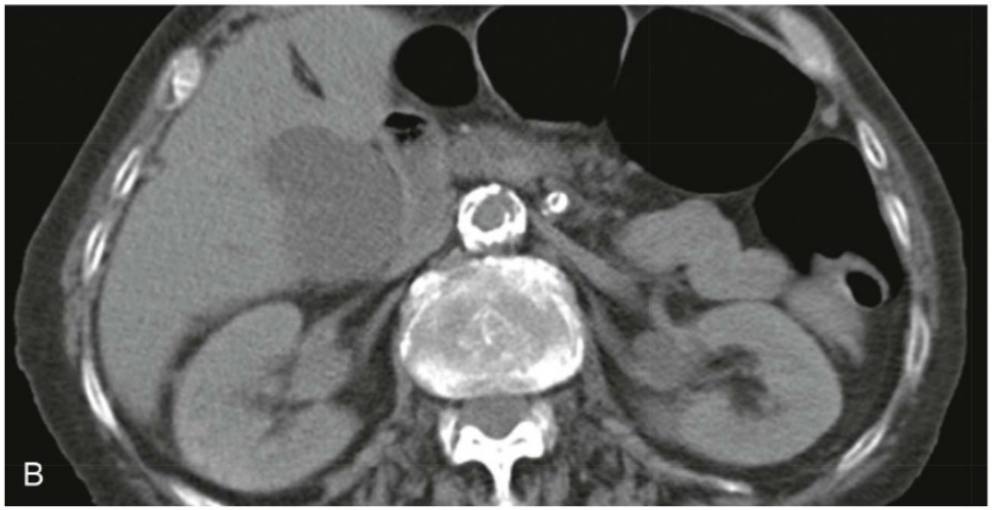
Retrograde mesenteric bypass





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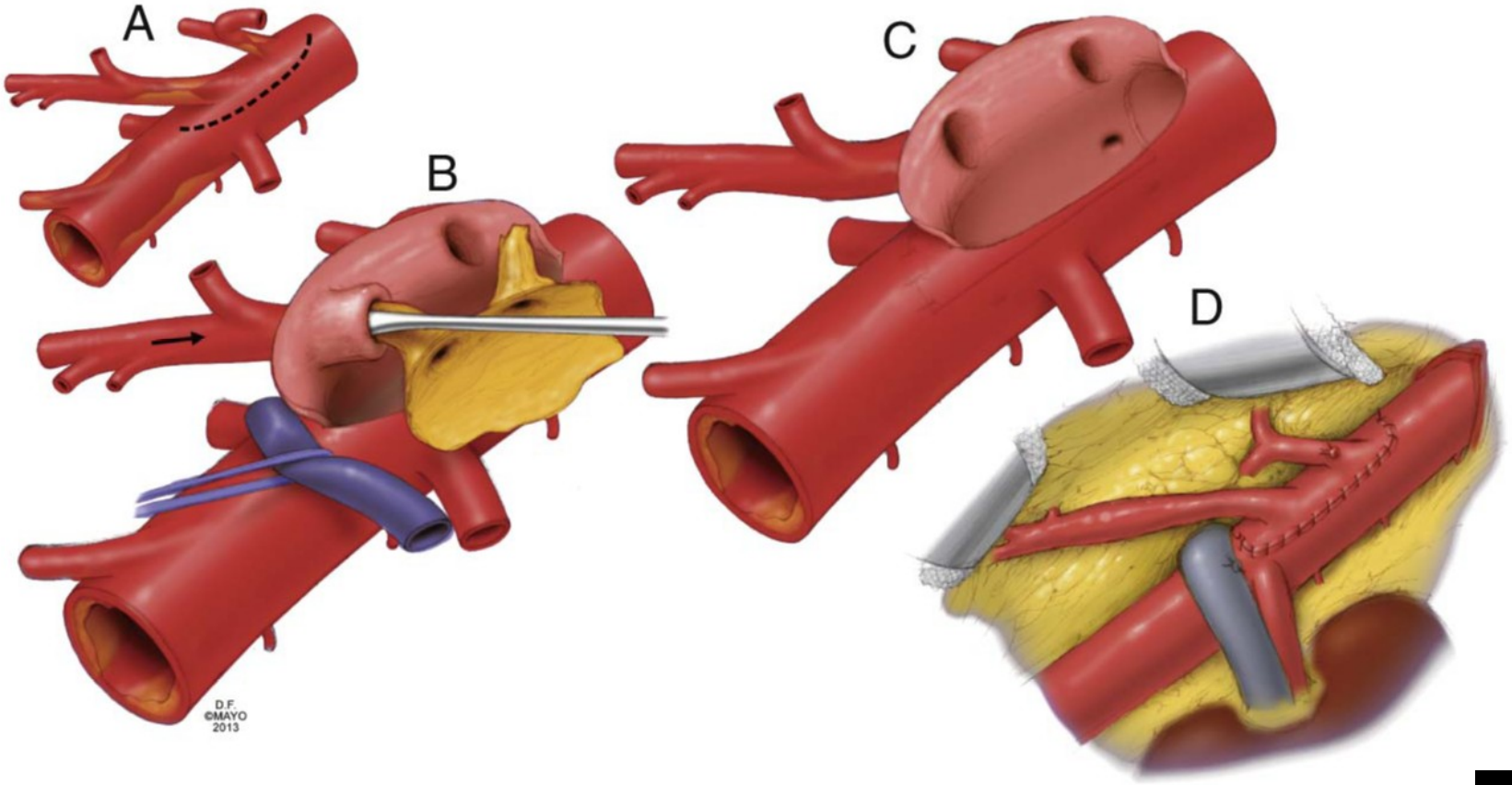
Thank you for your attention!



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