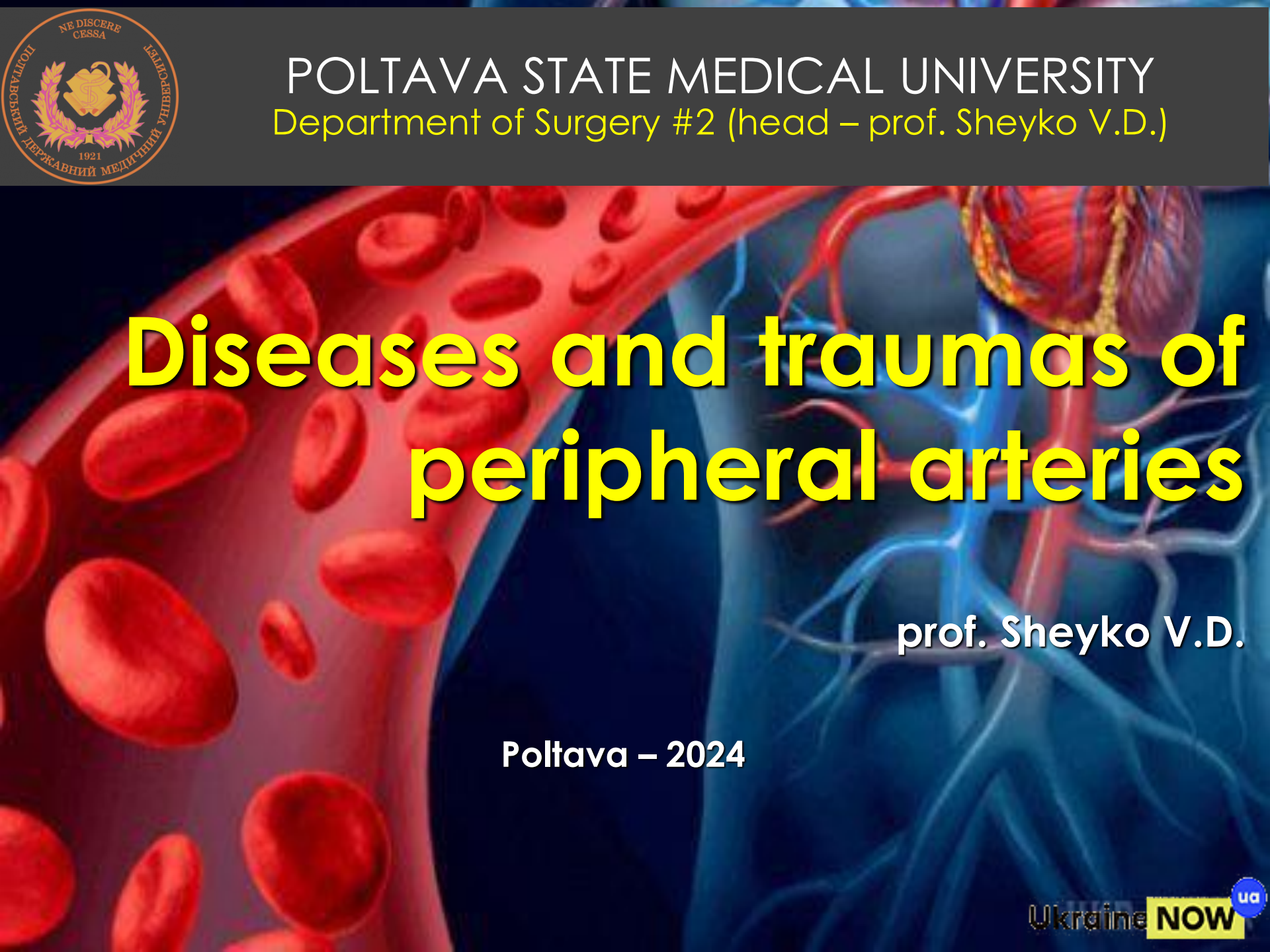
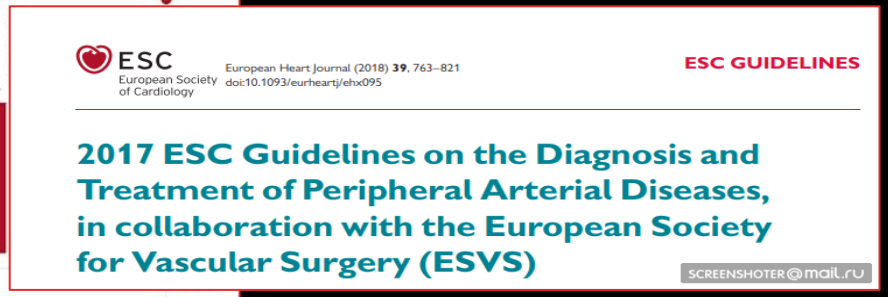
POLTAVA STATE MEDICAL UNIVERSITY
Department of Surgery #2 (head – prof. Sheyko V.D.)

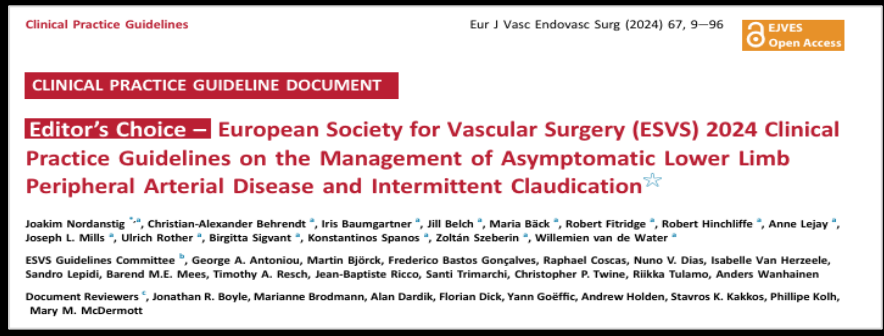


Diseases and traumas of peripheral arteries

prof. Sheyko V.D.

Poltava – 2024



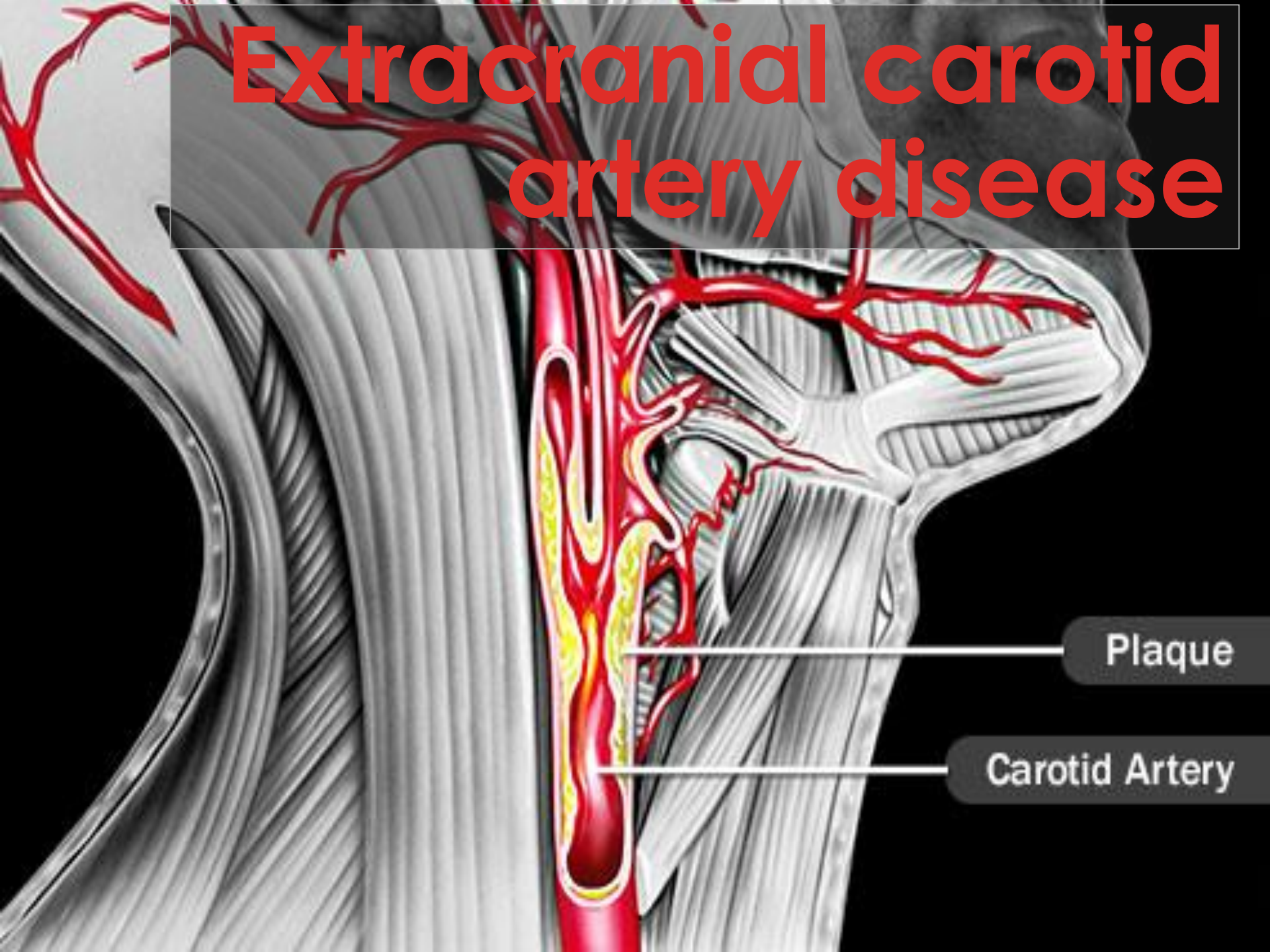


When a vascular territory is affected by atherosclerosis, not only is the corresponding organ endangered, but also the total risk of any CV event is increased.

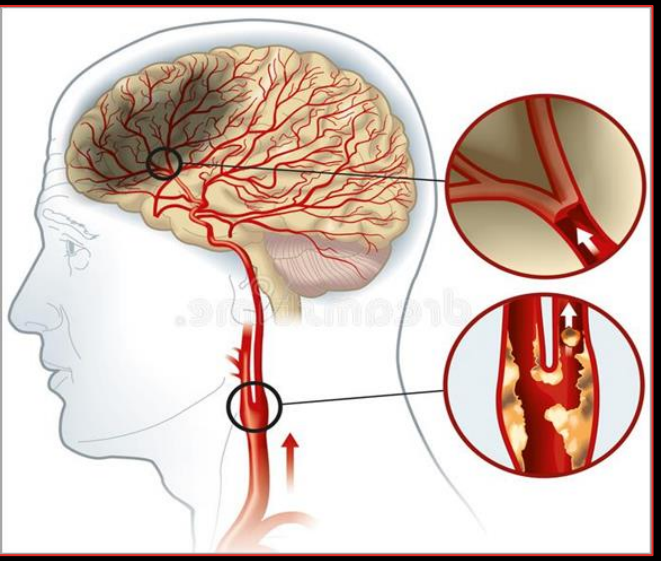
- Risk factors include smoking, hypertension, dyslipidaemia and diabetes.

Best medical therapy includes CV risk factor management, including optimal pharmacological therapy as well as non-pharmacological measures such as smoking cessation, healthy diet, weight loss and regular physical exercise.

Extracranial carotid artery disease



EXTRACRANIAL CAROTID ARTERY DISEASE



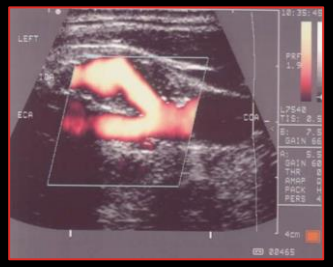
- of all strokes, 10–25% follow thromboembolism from a 50–99% internal carotid artery stenosis.
  - The majority of recently symptomatic patients will gain maximum benefit when carotid interventions are performed within 14 days of symptom onset.

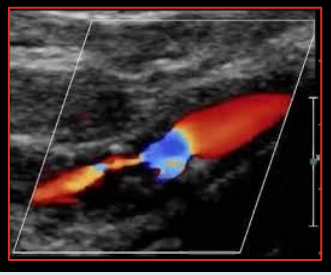
Clinical presentation

Transient ischaemic attack (TIA)	A brief episode of neurologic dysfunction resulting from focal temporary cerebral ischaemia, which is not associated with evidence of acute cerebral infarction.

- Systolic noise on carotid artery.

- Sympomatic disease – clinical signs were observed during last 6 month.
- Asympomatic disease – no clinical signs during last 6 month.





IMAGING (US, CT, MRI)

- evaluation of stenosis (plague, thrombus, wall roughness
  - asymptomatic stenosis (risk of stroke)

DUS assesses two main parameters:

- anatomy: diameter/patency, wall thickness (stenosis, plague, thrombus, stent);
- function speed and direction od blood flow

Reveals subclinical arterial pathology (carotid plague – risk of stroke)

Color-coded DUS - three parameters:

- better evaluation of stenosis;
- better evaluation of blood flow due to color coding;
- more accurate vessels patency evaluation in color mode

Recommendations for imaging of extracranial carotid arteries

Recommendations	Class[a]	Level[b]
DUS (as first-line imaging), CTA and/or MRA are recommended for evaluating the extent and severity of extracranial carotid stenoses.[99]	I	B
When CAS is being considered, it is recommended that any DUS study be followed by either MRA or CTA to evaluate the aortic arch as well as the extra- and intracranial circulation.[99]	I	B
When CEA is considered, it is recommended that the DUS stenosis estimation be corroborated by either MRA or CTA (or by a repeat DUS study performed in an expert vascular laboratory).[99]	I	B

CAS = carotid artery stenting; CEA = carotid endarterectomy; CTA = computed tomography angiography; DUS = duplex ultrasound; MRA = magnetic resonance angiography.
[a]Class of recommendation.
[b]Level of evidence.

DIGITAL SUBTRACTION ANGIOGRAPHY

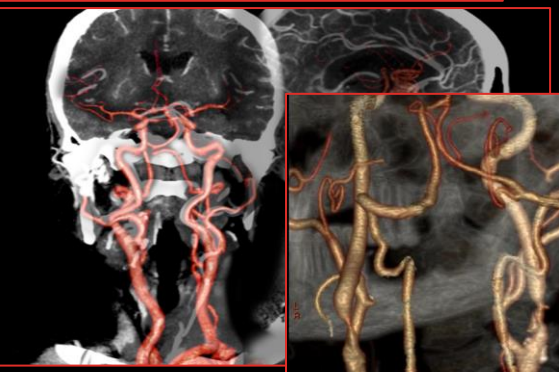
DSA(digital subtraction angiography) :

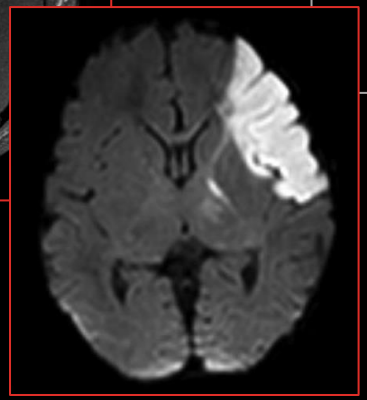
- invasive
- comparation of images before and after dye injection
- clear visualization of arteries, which can be digitally "extracted" from original images

Standard of visualization for:

- carotid and cerebral arteries
- mapping of cerebral blood flow
- below-the-knee arterial disease

COMPUTED TOMOGRAPHY ANGIOGRAPHY MAGNETIC RESONANCE ANGIOGRAPHY





- CT, CTA – small time for investigation; non-invasive
  - gives "roadmap" for orientation and strategy planning
    - Localization, situation above/below stenosis, stenosis severity.
  - high definition imaging and 3-D reconstruction
  - high grade chronic renal disease and iodine allergy are contraindications
  - exposure to radiation

- MRI, MRA
  - Non-iodine dye (gadolinium)
  - Vascular calcifications, potentially affecting revascularization procedures, can be underestimated
  - Endovascular stents are not evaluable by MRI

- CT is useful for differentiation between ischemic and hemorragic strokes
- MRI visualizes cerebral tissues ischemia

Extracranial carotid artery disease treatment

classic

eversive

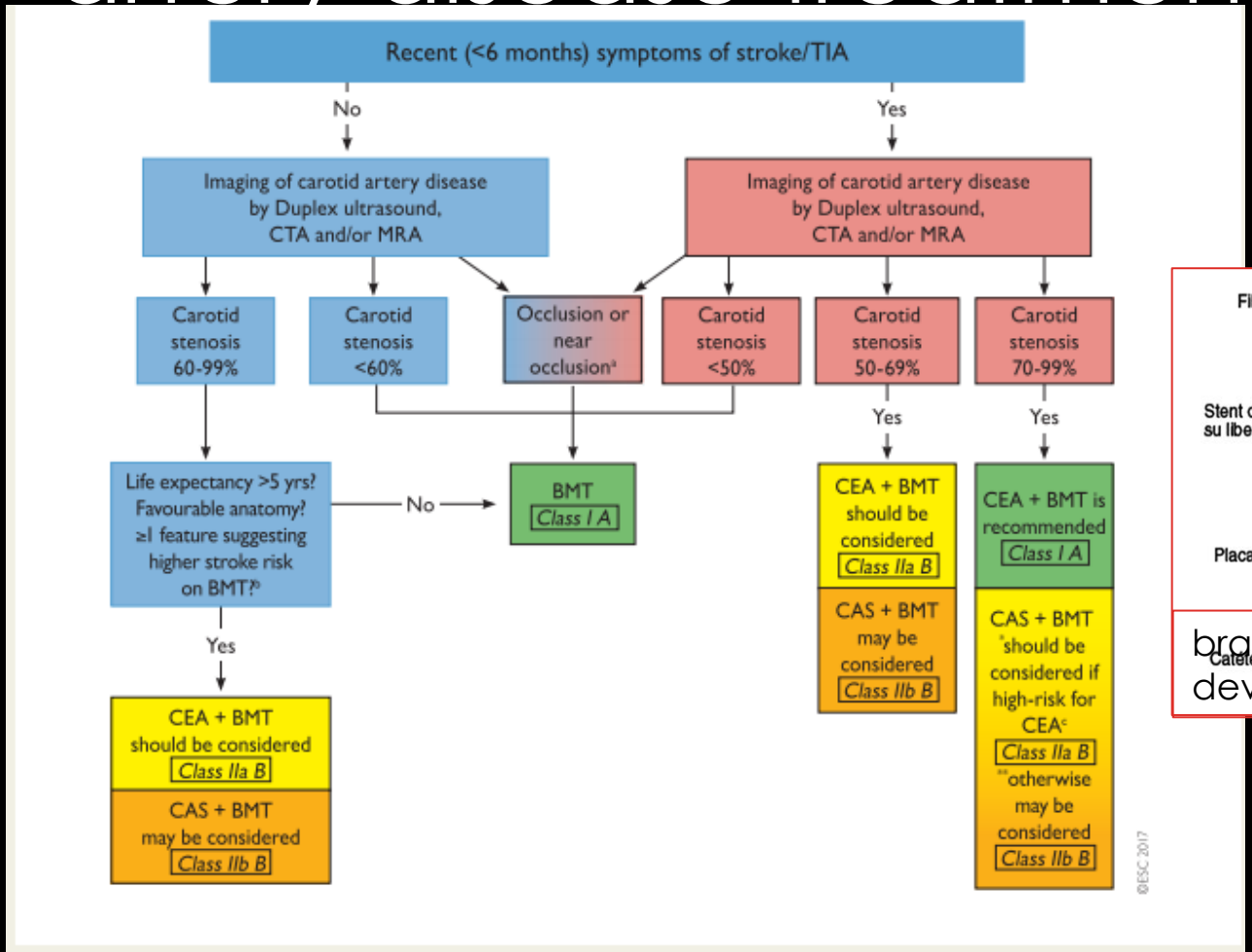
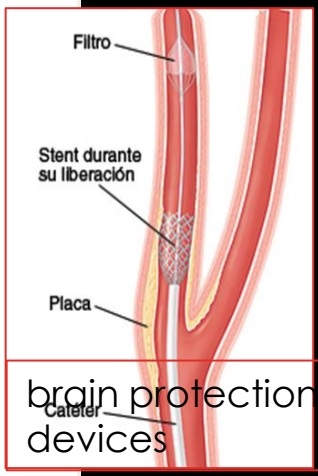


Figure 4 Management of extracranial carotid artery disease. BMT = best medical therapy; CAS = carotid artery stenting; CEA = carotid endarterectomy; CTA = computed tomography angiography; MRA = magnetic resonance angiography; TIA = transient ischaemic attack.
[a]With post-stenotic internal carotid artery narrowed to the point of near occlusion.
[b]See Table 4.
[c]Age > 80 years, clinically significant cardiac disease, severe pulmonary disease, contralateral internal carotid artery occlusion, contralateral recurrent laryngeal nerve palsy, previous radical neck surgery or radiotherapy and recurrent stenosis after CEA.



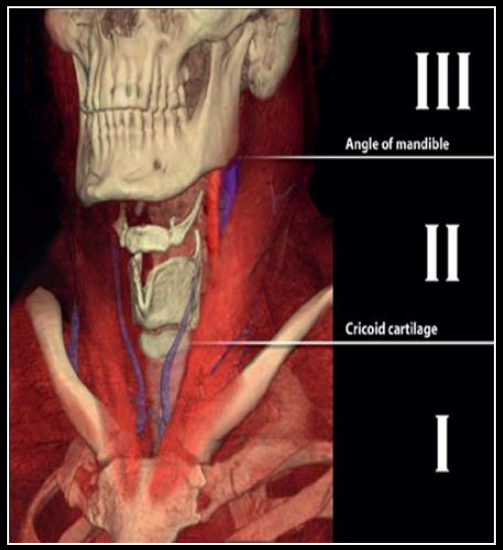
brain protection devices

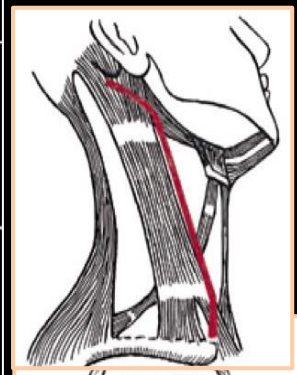
VASCULAR INJURIES OF NECK

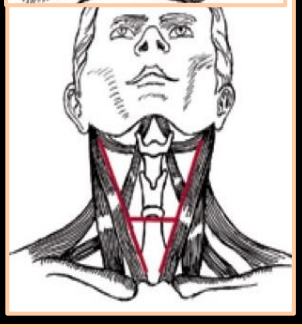
- Urgent help – hand tamponade,
  - Narrow wound channel – Foley tube
  - Mind airway patency.
- **Shock can be caused by spinal trauma.**

3 zones of neck injuries (Monson D.O. et al., 1969):

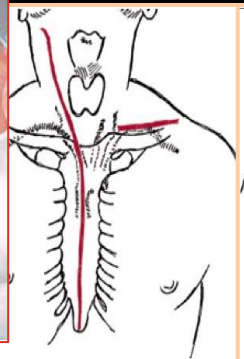
- *Zone 1 – upper aperture – cartilago cricoidea;*
- *Zone 2 – cartilage thyroidea – os hyoideus*
- *Zone 3 – near skull base*

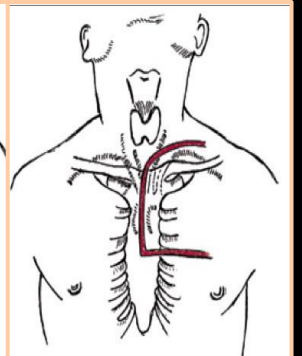






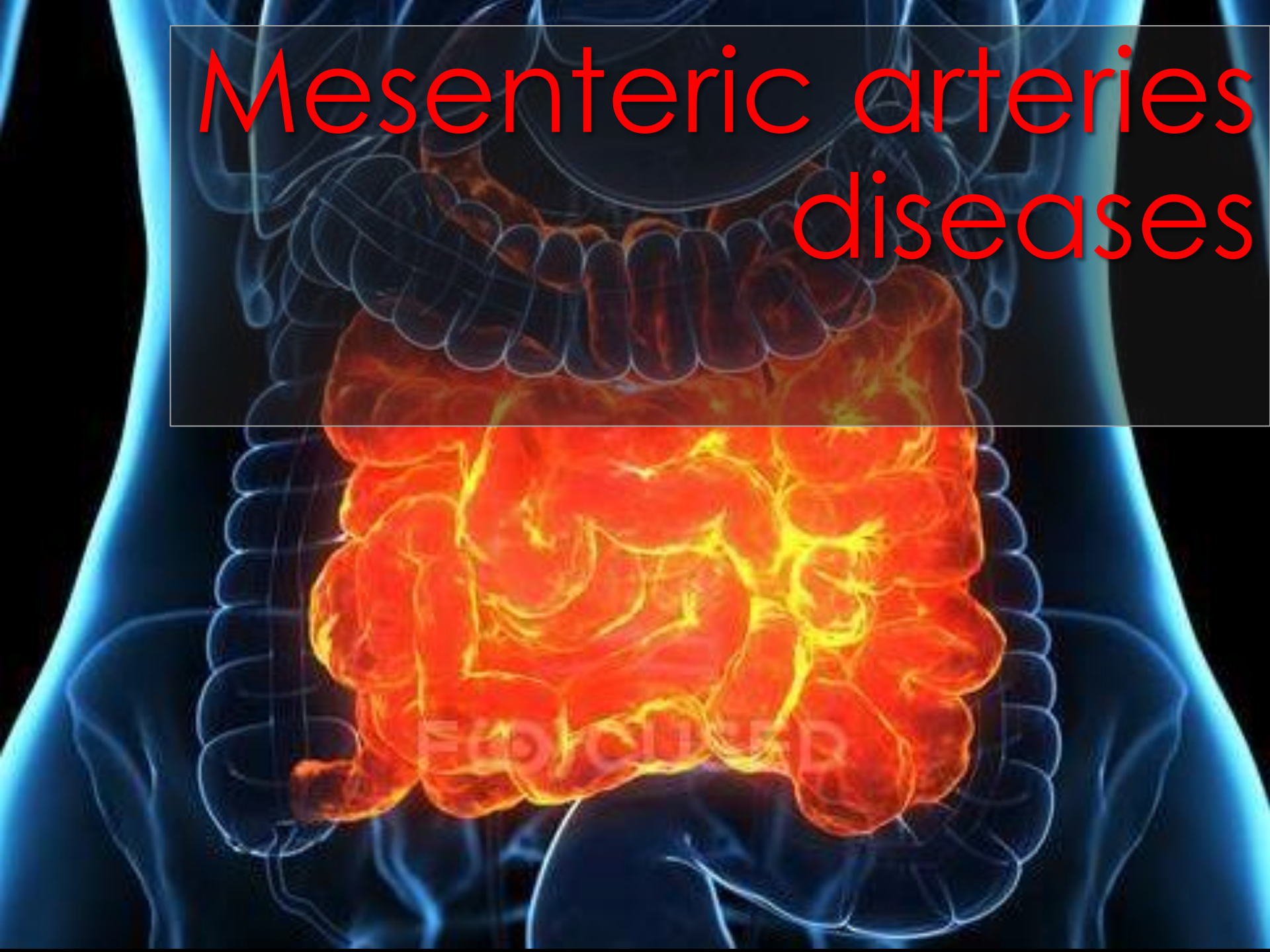
- ***Vascular injuries:***
  - *brachiocephalic trunc– reconstruction only;*
  - *subclavicular/axillar arteries – can be ligated;*
  - *external carotid artery– ligation,*
  - *common/internal carotid artery:*
    - *reconstruction – no neurological deficiency; retrograde blood flow present;*
    - *ligation – signs of ischemic brain injury are present.*



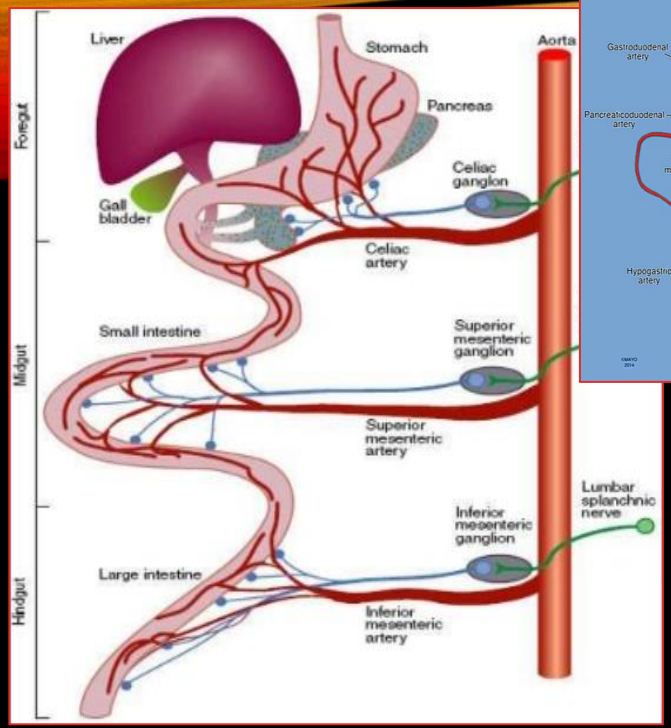


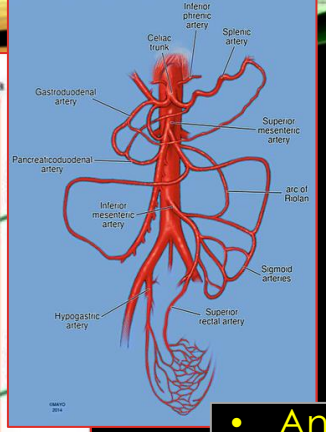
- ***Larynx:***
  - *Tracheostomy; delayed reconstruction.*
- **Esophagus:**
  - *Sutures, but proper drainage is much more important*

Mesenteric arteries diseases



MAIN WAYS OF BLOOD FLOW

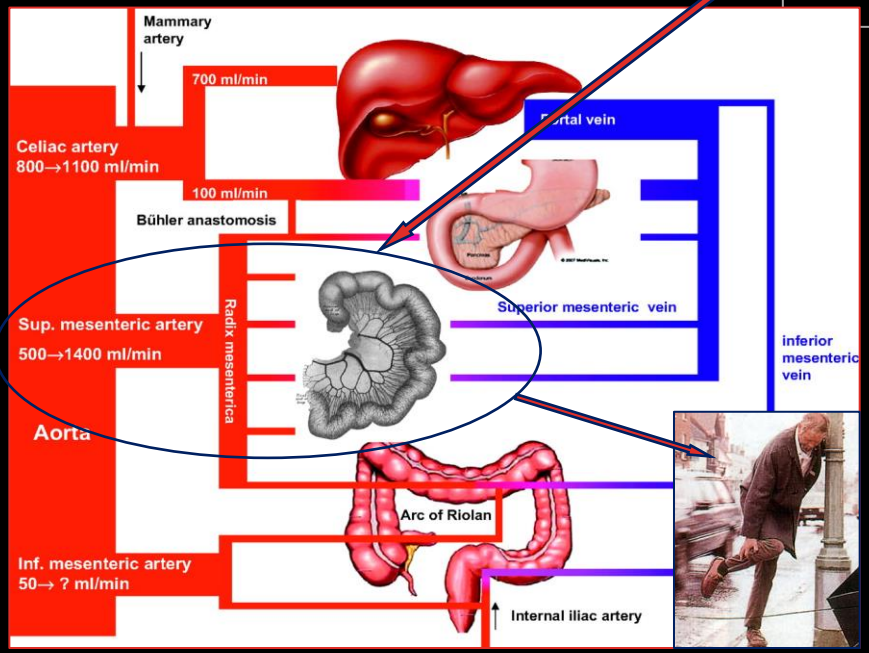


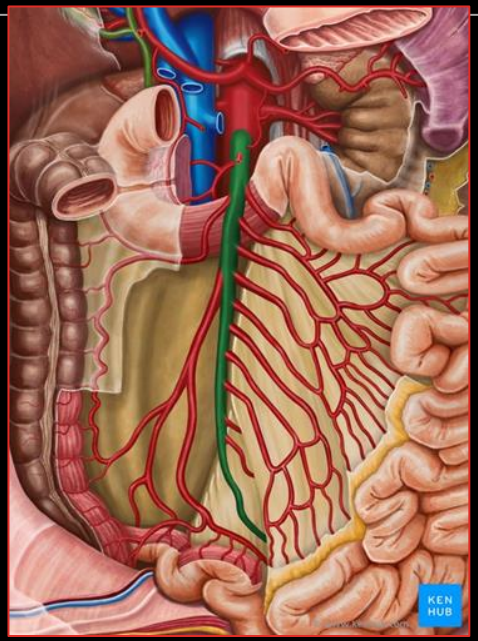


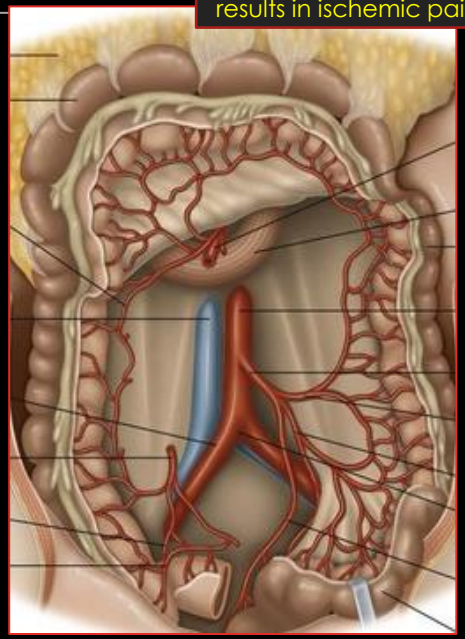
- Anastomoses between main arteries – central obstruction can be tolerated.
- AV-shunts in submucosal layer – necrosis of mucosa, while serous and muscle layers can be viable.

- Superior mesenteric artery bloodflow (SMA):
  - Increases after meals (15-20%),
  - Maximal during first hour after meals
  - Returns to baseline after 2-3 hours

Insufficient patency results in ischemic pain





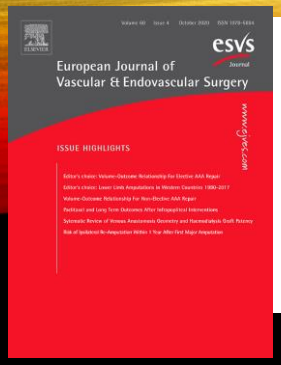


DEFINITIONS

- Acute, chronic and "acute during chronic" ischemia
  - Stenosis or compression, thrombosis or embolism.

- Chronic mesenteric artery disease includes stenosis or chronic occlusion of the coeliac trunk or the mesenteric arteries, which lasts more than 3 month.
  - Main sign – postprandial abdominal pain
  - weight loss, food aversion,
  - diarrhoea or constipation.

- Acute mesenteric ischaemia(AMI) – sudden stoppage of bloodflow:
  - Main sign severe abdominal pain with minimal findings at examination,
    - embolism – minutes, thrombosis – ≥1 hour;
    - SMA occlusion (CT/IMA – seldom, low clinical importance).
  - Peritonitis after bowel necrosis (≥24 hours from pain onset).

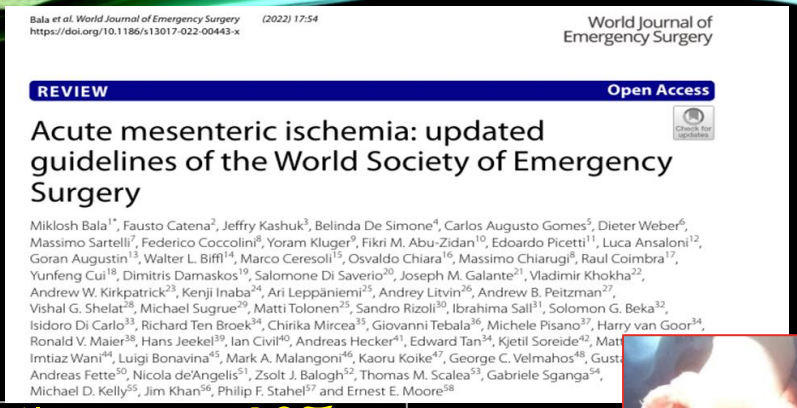



Eur J Vasc Endovasc Surg (2017) 53, 460–510

Editor's Choice – Management of the Diseases of Mesenteric Arteries and Veins

Clinical Practice Guidelines of the European Society of Vascular Surgery (ESVS)

Writing Committee [a], M. Björck, M. Koelemay, S. Acosta, F. Bastos Goncalves, T. Kölbel, J.J. Kolkman, T. Lees, J.H. Lefevre, G. Menyhei, G. Oderich,
ESVS Guidelines Committee [b], P. Kolh, G.J. de Borst, N. Chakfe, S. Debus, R. Hinchliffe, S. Kakkos, I. Koncar, J. Sanddal Lindholt, M. Vega de Ceniga, F. Vermassen, F. Verzini,
Document Reviewers [*], B. Geelkerken, P. Gloviczki, T. Huber, R. Naylor


Bala *et al. World Journal of Emergency Surgery* (2022) 17:54
https://doi.org/10.1186/s13017-022-00443-x

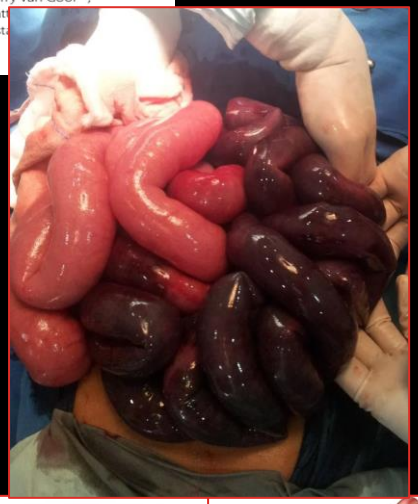
World Journal of Emergency Surgery

REVIEW Open Access

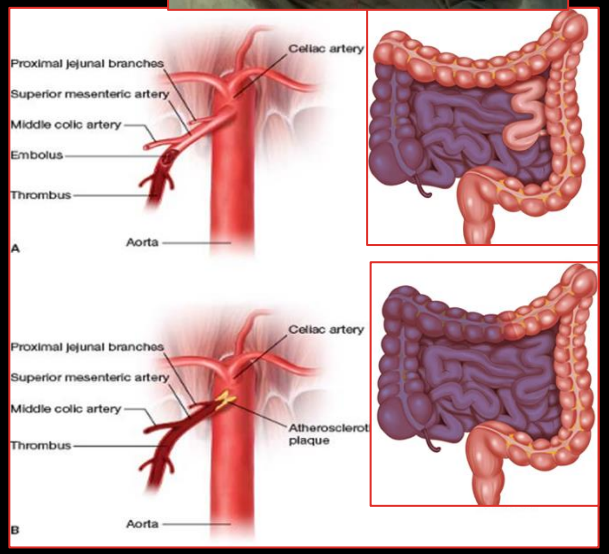
Acute mesenteric ischemia: updated guidelines of the World Society of Emergency Surgery

Miklosh Bala[1*], Fausto Catena[2], Jeffry Kashuk[3], Belinda De Simone[4], Carlos Augusto Gomes[5], Dieter Weber[6], Massimo Sartelli[7], Federico Coccolini[8], Yoram Kluger[9], Fikri M. Abu-Zidan[10], Edoardo Picetti[11], Luca Ansaloni[12], Goran Augustin[13], Walter L. Biffl[14], Marco Ceresoli[15], Osvaldo Chiara[16], Massimo Chiarugi[8], Raul Coimbra[17], Yunfeng Cui[18], Dimitris Damaskos[19], Salomone Di Saverio[20], Joseph M. Galante[21], Vladimir Khokha[22], Andrew W. Kirkpatrick[23], Kenji Inaba[24], Ari Leppäniemi[25], Andrey Litvin[26], Andrew B. Peitzman[27], Vishal G. Shelat[28], Michael Sugrue[29], Matti Tolonen[25], Sandro Rizoli[30], Ibrahima Sall[31], Solomon G. Beka[32], Isidoro Di Carlo[33], Richard Ten Broek[34], Chirika Mircea[35], Giovanni Tebala[36], Michele Pisano[37], Harry van Goor[34], Ronald V. Maier[38], Hans Jeekel[39], Ian Civil[40], Andreas Hecker[41], Edward Tan[34], Kjetil Soreide[42], Matt[ ], Imtiaz Wani[44], Luigi Bonavina[45], Mark A. Malangoni[46], Kaoru Koike[47], George C. Velmahos[48], Gust[ ], Andreas Fette[50], Nicola de'Angelis[51], Zsolt J. Balogh[52], Thomas M. Scalea[53], Gabriele Sganga[54], Michael D. Kelly[55], Jim Khan[56], Philip F. Stahel[57] and Ernest E. Moore[58]

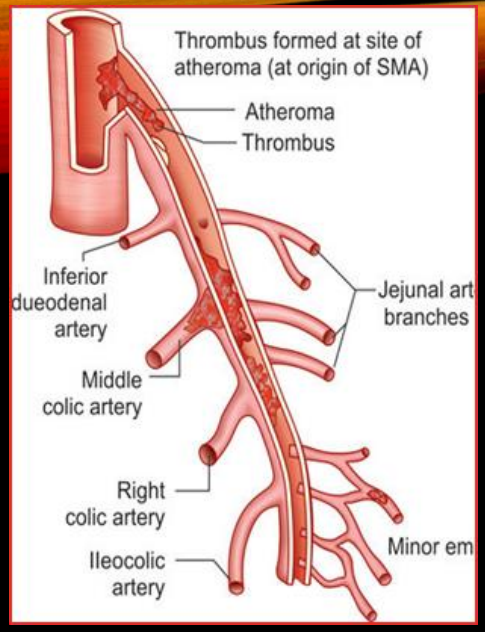
- AMI – patients >70 years old: AMI causes 10% of acute abdomen and 31% of urgent laparotomies.
  - 70% patients with AMI have atherosclerosis.
- Morbidity 7-13 per 100 000 (Sweden, Finland data)



- Obstruction appears in the places of physiological stenosis distally from first arterial branches *(aa. panreatoduodenales inf, jejunalis (1-2), colica med.)*:
  - some centimeters from AMA are unaffected so proximal parts of ileum and colon also stay viable.



DIAGNOSIS

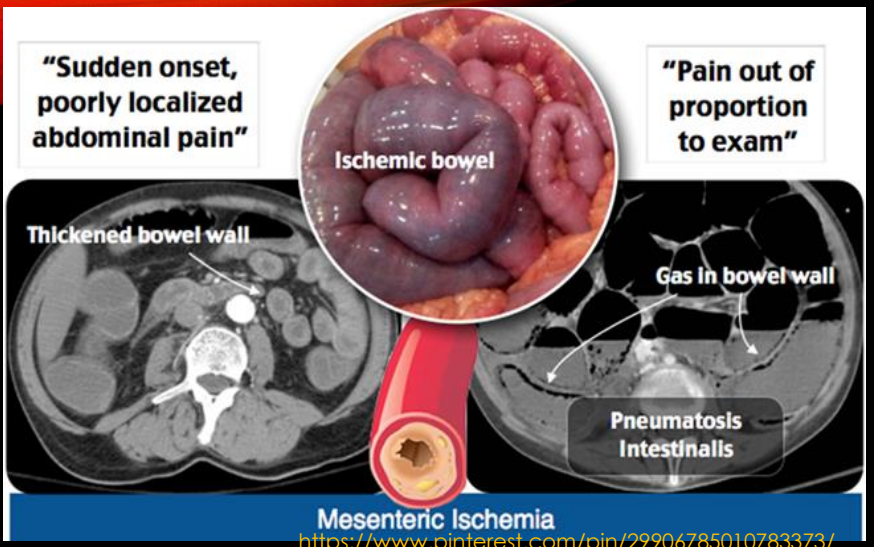


- Anamnesis:
  - Atherosclerosis with multi/single site artery disease (coronary, cerebral, renaletc.)
  - Atrium fiblillation + acute abdominal pain are very suspicious for AMI.
  - Symptoms of CMI: postprandial abdominal pain; weight loss; food aversion; diarrhoea or constipation

- Typical (approx. 80%) clinical triad:
  - severe abdominal **pain with minimal findings** at examination
  - bowel emptying (often both vomiting and diarrhoea)
  - the presence of a source of embolus (AF, etc.) or
    - presence of atherosclerosis of any localization

- Laboratory indicator is D-dimer (reference value <250 ng/ml):
  - Extremely high values is thrombosis marker – not specific for AMI.
  - Normal values – AMI can be excluded (sensitivity 95%).

VISUALISATION



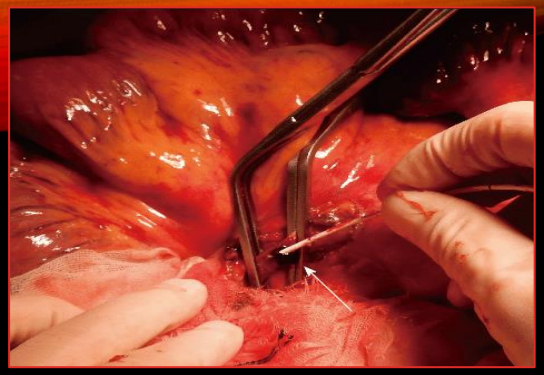
https://www.pinterest.com/pin/29906785010783373/

- CT with intravenous enhancement is the best visualization for AMI:
  - Native, arterial and venous phases with 1 mm slices;
  - Infarction signs – no contrast accumulation in the bowel wall, gas in the v. porta or bowel wall.
- Even patients with impaired renal function or increased creatinine values should undergo CT if there is a suspicion of acute SMA occlusion, accepting the risk of contrast induced renal failure, to improve diagnostic accuracy and chances of survival due to better accuracy of diagnostic.
- Presence of vascular pathology precedes the intestinal pathology (occlusion is primary; gangrene is secondary)

- Embolism:
  - Middle or distal part of SMA,
  - Oval shaped filling defect surrounded by contrast
  - No calcification in the affected place.
- Thrombosis:
  - clot (long and patchy defect) superimposed on a heavily calcified occlusive lesion at the origin of the SMA.

- Duplex ultrasound (DUS) :
  - an operator-dependent imaging modality
  - may not be possible to obtain accurate assessments around the clock.

SURGICAL APPROACHES IN AMI

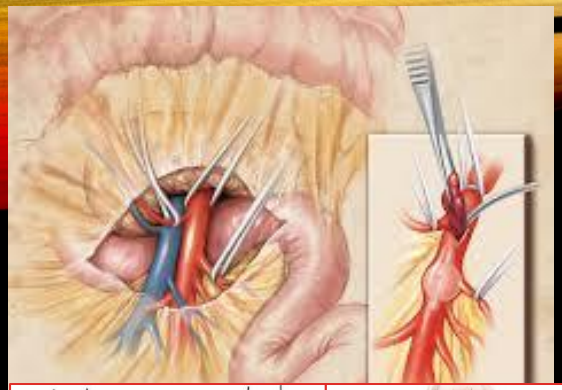


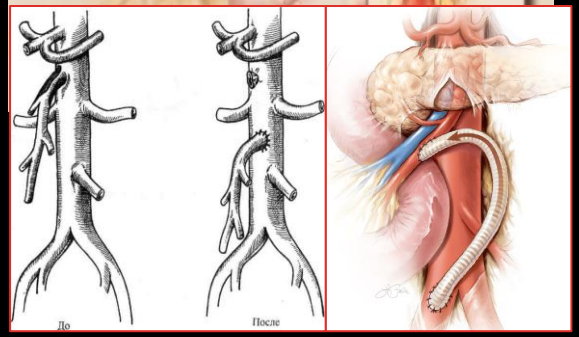
- Revascularisation – deblocage of intestinal bloodflow.
- Open surgery – peritonitis.

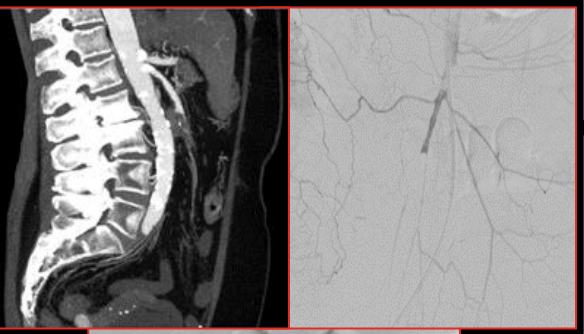
- Optimal approach – vascular surgery centers with operation room:
  - Revascularisation(open or endovascular)
    - Superior to ANY bowel surgery.
  - bowel resection
    - Without revascularisation – enterostomy with further programmed laparotomies.
    - After revascularisation– anastomosis – associated with less mortality and milder small bowel syndrome.
  - programmed laparotomy (48-72 hours):
    - Assessment of small bowel viability
    - Can be made repeatedly

- Signs of bowel ischemia/necrosis:
  - patchy cyanosis,
  - reddish black discolouration,
  - decreased or absent peristalsis,
  - no palpable pulsation in the mesentery

Ischemic changes are more extensive on the mucosal side



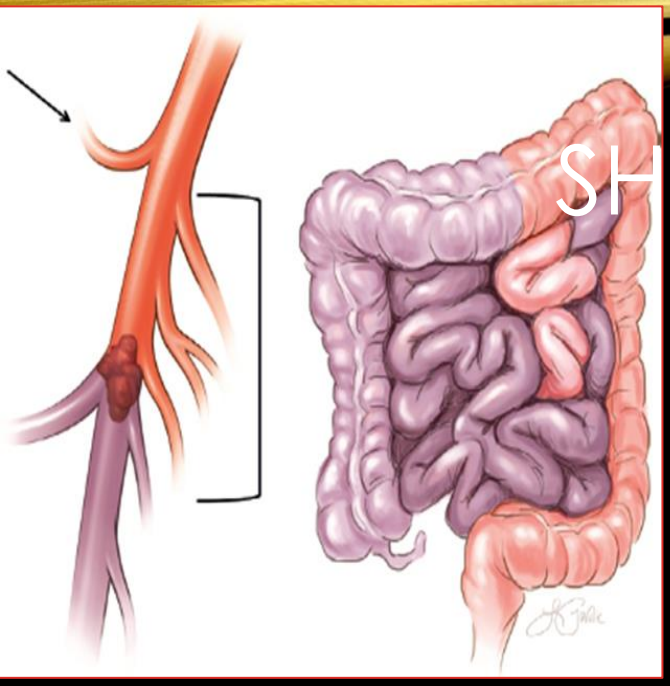




SURGICAL APPROACHES IN AMI: REVASCULARISATION

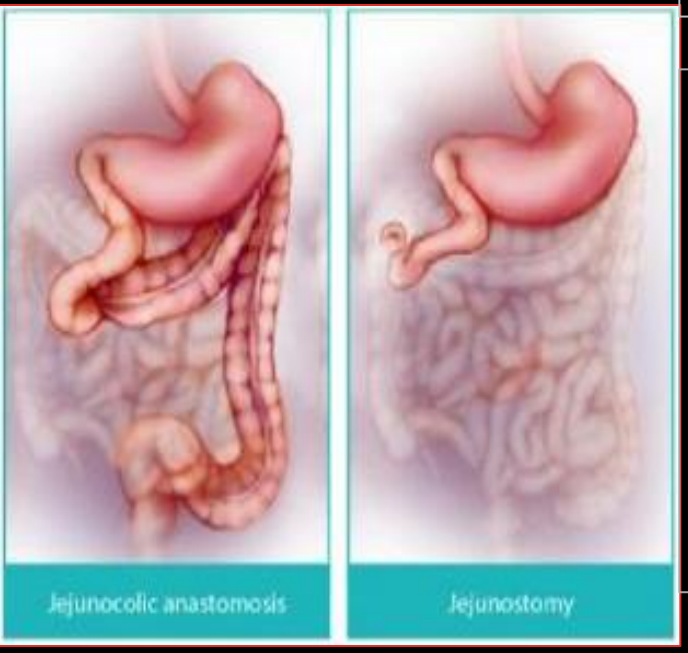
- Open revascularization of SMA after laparotomy on account of peritonitis:
  - Exposition of SMA in the mesocolon down from pancreatic body.
  - Loss of pulsation shows place of occlusion
- Embolus – open and balloon assisted embolectomy.
- Thrombosis –
  - SMA re-implantation into the infrarenal aorta;
  - thromboendarterectomy with patch angioplasty;
  - bypass distal to the occlusive atherosclerotic lesion with autovein or synthetic prothesis
- Success must be proved with angiography, Doppler US or pulsation resumption.

- Endovascular revascularization :
  - femoral (keep in mind possibility of sharp downward angle between the aorta and the SMA) and brachial routes can be used;
  - retrograde approach through the exposed SMA if antegrade one fails.
- Endovascular procedures:
  - aspiration embolectomy.
  - local thrombolysis and aspiration
  - antegrade/retrograde recanalization and stenting after aspiration/thrombolysis
- Endovascular is BETTER than open due to lower resection rates and lower mortality



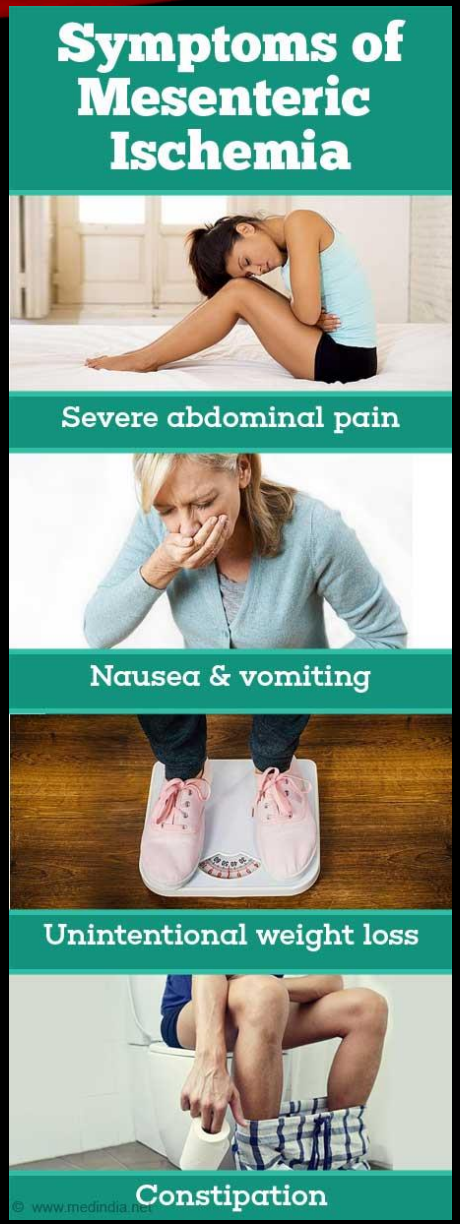
SHORT BOWEL SYNDROME

- Bowel infarction/gangrene :
  - In 50% of case any of three sections affected – jejunum, ileum and ascend colon;
  - In 30% of cases two from abovementioned are affected.
- Subtotal gangrene – consider palliative approach:
  - Extended gangrene dictates subtotal small bowel resection combined with ascending and half of transverse colon removal,
  - Severe short bowel syndrome associated with high mortality in old patients.
    - Operation is inexpedient because of ethical considerations



- Short bowel syndrome
  - The length of small bowel that is sufficient to allow enteral nutrition depends mainly on the ileocaecal valve:
    - 50 cm suffices with
    - 100 cm without the ileocaecal valve
  - The length of remaining colon affects the quality of life in these patients.
  - Adaptation can take up to 1 year (small bowel will become hypertrophic with enlarged villi and increased absorption capacity)
- Parenteral nutrition temporary or constantly
- The outcome of intestinal transplantation is slowly improving.

CHRONIC MESENTERIC ISCHAEMIA



- CMI is rare pathology – collateral bloodflow can compensate stenosis of main trunk.
  - single mesenteric artery stenosis is symptomatic in 18% of cases,
  - typical clinic develops when two or more mesenteric arteries involved.

- Clinical signs:
  - postprandial abdominal pain:
    - arises in 20-30 min after meal; lasts 1-2 hours.
  - food aversion and weight loss (severe cases).
- Diagnosis is often delayed –
  - patients undergo investigations for possible malignancy or are classified as having functional abdominal disorders.

- Functional classes of CMI
  - I stage – light postprandial abdominal pain,
  - II stage. – evident postprandial abdominal pain, signs are present without food intake;
  - III stage – constant abdominal pain, significant weight loss.

DIAGNOSIS

- Auscultation – epigastric bruit.

- Angiography - the gold standard for the diagnosis of mesenteric occlusive disease.
  - Diagnostic and treatment procedure
    - measurement of mean arterial pressure gradient across the lesion
    - invasive treatment with potential complications
- Computed tomography angiography sensitivity - 96%, specificity - 94%;
  - the imaging method of choice in CMI
  - helps to exclude other causes of chronic abdominal pain,
  - evaluation of the collateral circulation,
  - helps to plan proper endovascular intervention.

- Median arcuate ligament syndrome (MALS): often asymptomatic (symptoms can be seen in young patients).

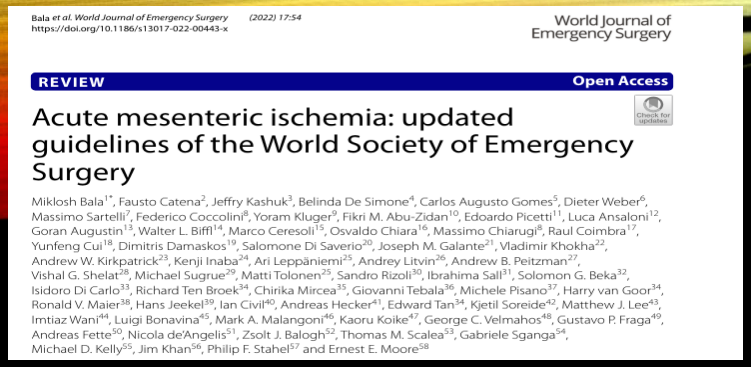
- Functional evaluation of mesenteric circulation
  - objectively characterizes CMI severity
  - cumulative gastrointestinal bloodflow (in portal vein) be diminished after a test meal in healthy patients.

CMI TREATMENT

- Medical treatment has no use in patients with CMI:
  - associated with clinical deterioration, bowel infarction, and risk of sepsis from catheter related complications.
- Revascularisation is indicated in patients who develop symptoms of CMI :
  - relief of symptoms
  - improving quality of life
  - restoration of normal weight
  - improving survival by prevention of bowel infarction.

- Endovascular revascularisation :
  - SMA is the main primary target,
  - CA or IMA revascularization can be performed when the SMA is chronically occluded and not suitable for recanalization.
- Open surgery - bypass placement:
  - unfavorable mesenteric lesions,
  - failed percutaneous intervention,
  - recurrent in-stent stenosis/occlusion.

- In patients after revascularization for CMI, antiplatelet therapy is recommended (I;A)
- In patients after endovascular revascularization for CMI, dual antiplatelet therapy might be considered for 3-12 months (IIb;C)



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World Journal of Emergency Surgery

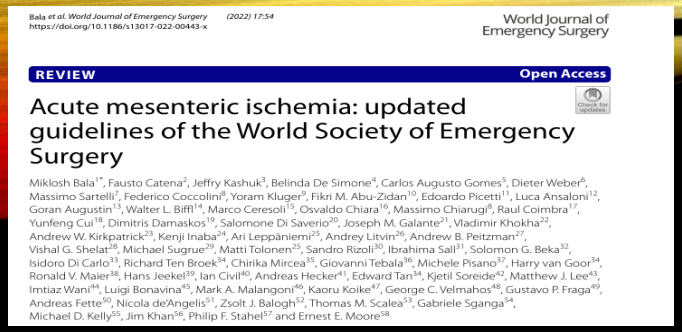
REVIEW Open Access

Acute mesenteric ischemia: updated guidelines of the World Society of Emergency Surgery

Miklosh Bala[1*], Fausto Catena[2], Jeffry Kashuk[3], Belinda De Simone[4], Carlos Augusto Gomes[5], Dieter Weber[6], Massimo Sartelli[7], Federico Coccolini[8], Yoram Kluger[9], Fikri M. Abu-Zidan[10], Edoardo Picetti[11], Luca Ansaloni[12], Goran Augustin[13], Walter L. Biffl[14], Marco Ceresoli[15], Osvaldo Chiara[16], Massimo Chiarugi[8], Raul Coimbra[17], Yunfeng Cui[18], Dimitris Damaskos[19], Salomone Di Saverio[20], Joseph M. Galante[21], Vladimir Khokha[22], Andrew W. Kirkpatrick[23], Kenji Inaba[24], Ari Leppäniemi[25], Andrey Litvin[26], Andrew B. Peitzman[27], Vishal G. Shelat[28], Michael Sugrue[29], Matti Tolonen[25], Sandro Rizoli[30], Ibrahima Sall[31], Solomon G. Beka[32], Isidoro Di Carlo[33], Richard Ten Broek[34], Chirika Mircea[35], Giovanni Tebala[36], Michele Pisano[37], Harry van Goor[34], Ronald V. Maier[38], Hans Jeekel[39], Ian Civil[40], Andreas Hecker[41], Edward Tan[34], Kjetil Soreide[42], Matthew J. Lee[43], Imtiaz Wani[44], Luigi Bonavina[45], Mark A. Malangoni[46], Kaoru Koike[47], George C. Velmahos[48], Gustavo P. Fraga[49], Andreas Fette[50], Nicola de'Angelis[51], Zsolt J. Balogh[52], Thomas M. Scalea[53], Gabriele Sganga[54], Michael D. Kelly[55], Jim Khan[56], Philip F. Stahel[57] and Ernest E. Moore[58]

WSES 2022 UPDATED GUIDELINES

- **Severe abdominal pain out of proportion to physical examination fndings should be assumed to be AMI until disproven. (Strong recommendation based on low-quality evidence 1C**)
- Clinical scenario and risk factors diferentiate AMI as mesenteric arterial emboli, mesenteric arterial thrombosis, NOMI, or mesenteric venous thrombosis. (Weak recommendation based on low-quality evidence 1C)
- Plain X-ray is not recommended in evaluating patients for intestinal ischemia. (Strong recommendation based on moderate-quality evidence 1B)
- Tere are no laboratory parameters that are sufciently accurate to conclusively identify the presence or absence of ischemic or necrotic bowel, although elevated l-lactate, leukocytosis, and D-dimer may assist. (Weak recommendation based on moderatequality evidence 2B)
- **Computed tomography angiography (CTA) should be performed without delay in any patient with suspicion for AMI. (Strong recommendation based on high-quality evidence 1A**
- Non-occlusive mesenteric ischemia (NOMI) should be suspected in critically ill patients with abdominal pain or distension requiring vasopressor support and evidence of multiorgan dysfunction. (Weak recommendation based on low-quality evidence 2C)
- **When the diagnosis of AMI is made, fluid resuscitation should commence immediately to enhance visceral perfusion. Electrolyte abnormalities should be corrected, and nasogastric decompression initiated. (Strong recommendation based on moderate-quality evidence 1B)**
- **Broad-spectrum antibiotics should be immediately administered. (Strong recommendation based on moderate-quality evidence 1C)**
- **Prompt laparoscopy/laparotomy should be done for patients with an overt peritonitis. (Strong recommendation based on low-quality evidence 1C)**



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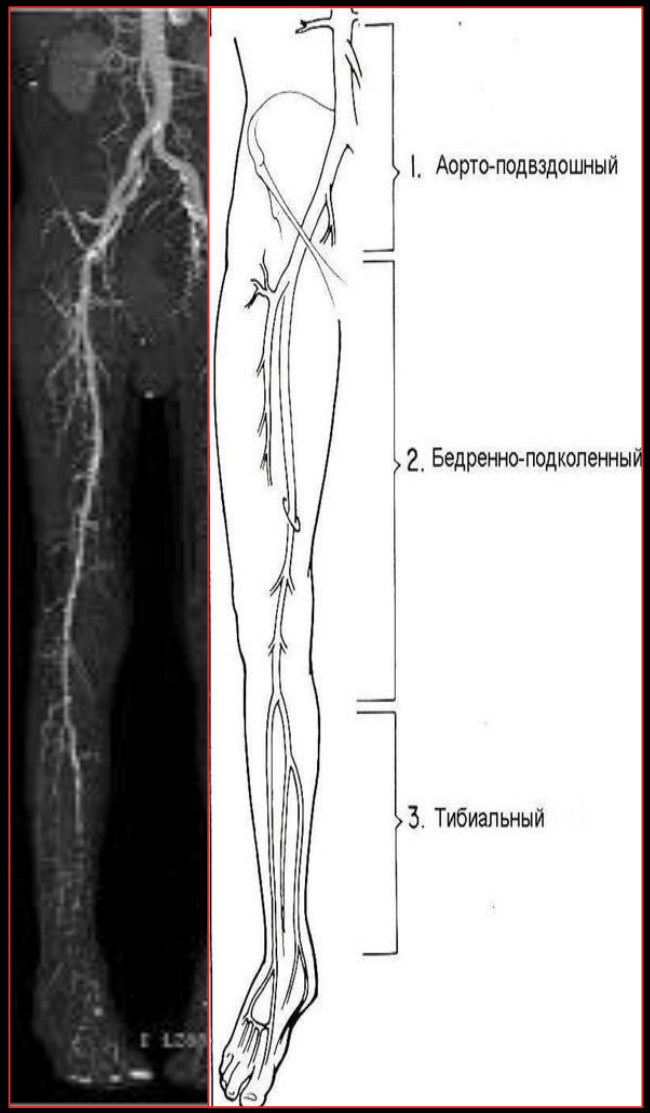
WSES 2022 UPDATED GUIDELINES

- **Endovascular revascularization procedures are the primary option in cases of arterial occlusion when sufficient expertise is available. (Strong recommendation based on low-quality evidence 1C)**
- **Damage control surgery (DCS) with temporary abdominal closure is an important adjunct for patients who require intestinal resection allowing reassessment of bowel viability and in situations of severe abdominal sepsis. (Strong recommendation based on low-quality evidence 1B)**
- **Mesenteric venous thrombosis can often be successfully treated with a continuous infusion of unfractionated heparin. (Strong recommendation based on moderate-quality evidence 1B)**
- When NOMI is suspected, the focus is to correct the underlying cause and improve mesenteric perfusion. Infarcted bowel should be resected promptly. (Strong recommendation based on low-quality evidence 1C)
- **Postoperative intensive care of AMI patients is directed toward the improved intestinal perfusion and the prevention of a multiple organ failure. (Strong recommendation based on low-quality evidence 1C)**
- **Treatment of AMI is optimal in a dedicated center using a focused care bundle and a multidisciplinary team. (Strong recommendation based on low-quality evidence 1C)**
- Patients with short bowel syndrome following extensive bowel resection should have restoration of digestive continuity in association with hormonal therapy to optimize absorptive function and achieve nutritional autonomy. (Weak recommendation, low-quality evidence 1C)
- In case of massive gut necrosis, a careful assessment of the patients underlying comorbidities and advanced directives is advisable to find the optimal therapeutic strategy which could include palliation. (Weak recommendation, low-quality evidence 1C)
- **Patients undergoing revascularization should have surveillance imaging and long-term anticoagulation. (Strong recommendation based on moderate-quality evidence 1B)**


Lower extremity
artery disease
(LEAD)

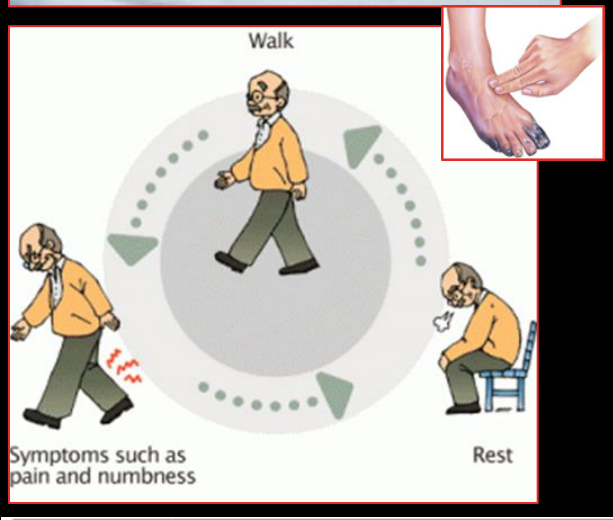
LOWER EXTREMITY ARTERY DISEASE



LEAD morbidity is about 2-3% of population

- Intermittent claudication – 0,4-14%
- severe chronic limb ischaemia – 0,25%
- asymptomatic – up to 22%
- In 5 years after IC onset: 20% will have stroke or myocardial infarction with mortality 10-15%.

- Main etiology:
  - Atherosclerosis about 90%;
  - Autoimmune/Inflammatory conditions (systemic lupus erythematosus, rheumatoid arthritis)
  - Diabetes
  - Raynaud's disease



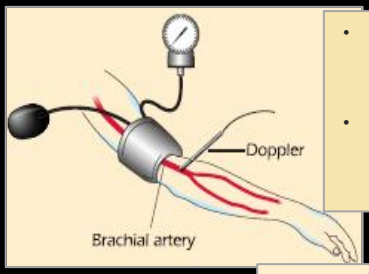
CLINICAL PRESENTATION

- Intermittent claudication is pain affecting the calf, that is induced by exercise and relieved by rest (Fontaine or Rutherford classifications).
- Calf hair loss, dry skin;
- Lower limb muscle atrophy;
- Sensory loss, paresthesia;
- Low/absent pulsation of lower limb arteries.

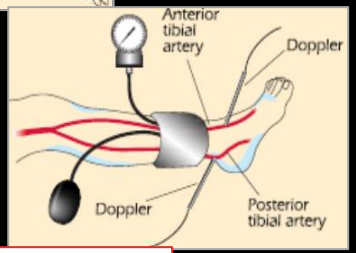
Fontaine classification				**Rutherford classification**		
Stage		Symptoms		Grade	Category	Symptoms
I		Asymptomatic	⇔	0	0	Asymptomatic
II	IIa	Non-disabling intermittent claudication	⇔	I	I	Mild claudication
				I	2	Moderate claudication
	IIb	Disabling intermittent claudication		I	3	Severe claudication
III		Ischaemic rest pain	⇔	II	4	Ischaemic rest pain
IV		Ulceration or gangrene	⇔	III	5	Minor tissue loss
				III	6	Major tissue loss

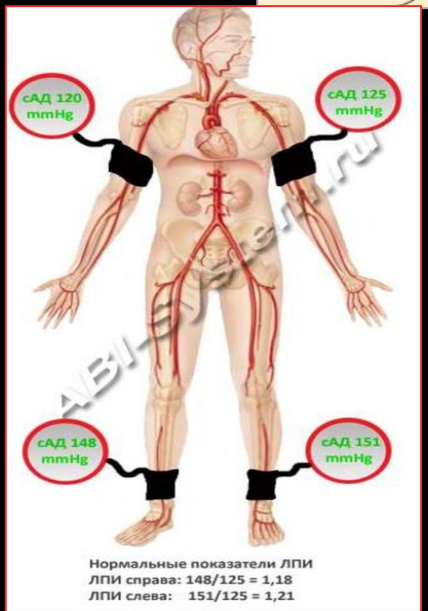
ABI = SBP on the posterior and the anterior tibial (or dorsalis pedis) arteries / SBP on the brachial artery.

THE ANKLE-BRACHIAL INDEX(ABI)

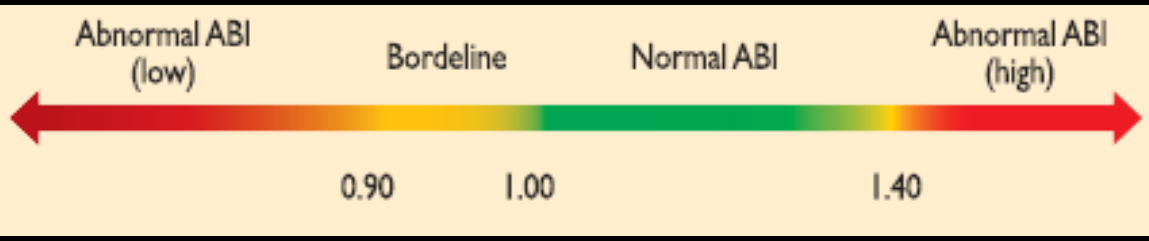


- One should use Doppler probe (5-10 Mhz) and manual (not automated) BP cuffs to measure ABI.
- ABI for each leg is calculated by dividing the highest ankle SPB by the highest arm SPB.



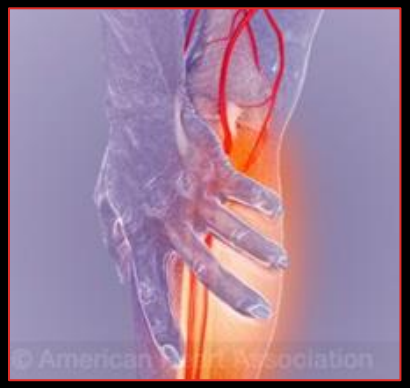


- ABI is the first diagnostic test, which should be run after clinical examination



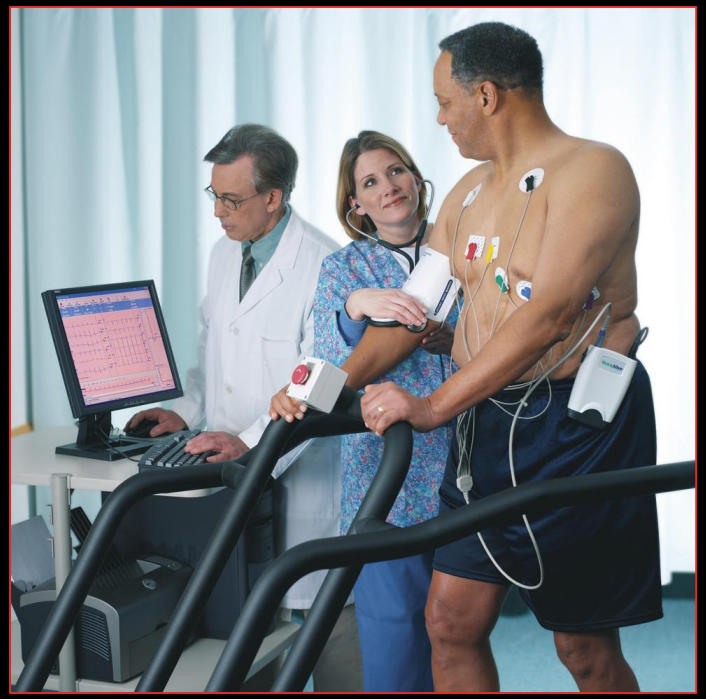
- ABI = 0.90: sensitivity - 75%, specificity – 86% for LEAD diagnostic.
  - Diabetes and chronic kidney disease can affect ABI values
- ABI 0,90–1,00 in symptomatic patients should be supplemented by Doppler ultrasound
- ABI >1,40 – should be supplemented by Doppler ultrasound (arterial stiffening due to calcification).
- ABI <0,9 and >1,4 – a strong marker of total and CV death (2-to 3-fold increased risk if below 0,9)
- ABI > 1,4 – high risk of death

TREADMILL TEST

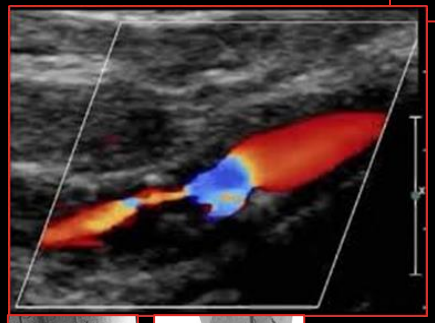


Strandness protocol

- Speed of 3 km/h and 10% slope –
  - test is stopped when the patient is unable to walk further because of pain, defining maximal walking distance
  - post-exercise ankle SBP decrease >30 mmHg or a post-exercise ABI decrease >20% are diagnostic for LEAD.
- functional assessment of moderate stenosis.
- proofs the ischemic origin of pain in lower extremities.



IMAGING METHODS



- Ultrasound (85–90% sensitivity and >95% specificity to detect stenosis >50%):
  - extensive information on arterial anatomy and hemodynamics
  - BUT does not present as a roadmap the entire vasculature

- Digital subtraction angiography
  - guides percutaneous peripheral interventional procedures
  - identification of patent arteries for distal bypass
  - often needed for below-the-knee arteries, especially in patients with CLTI

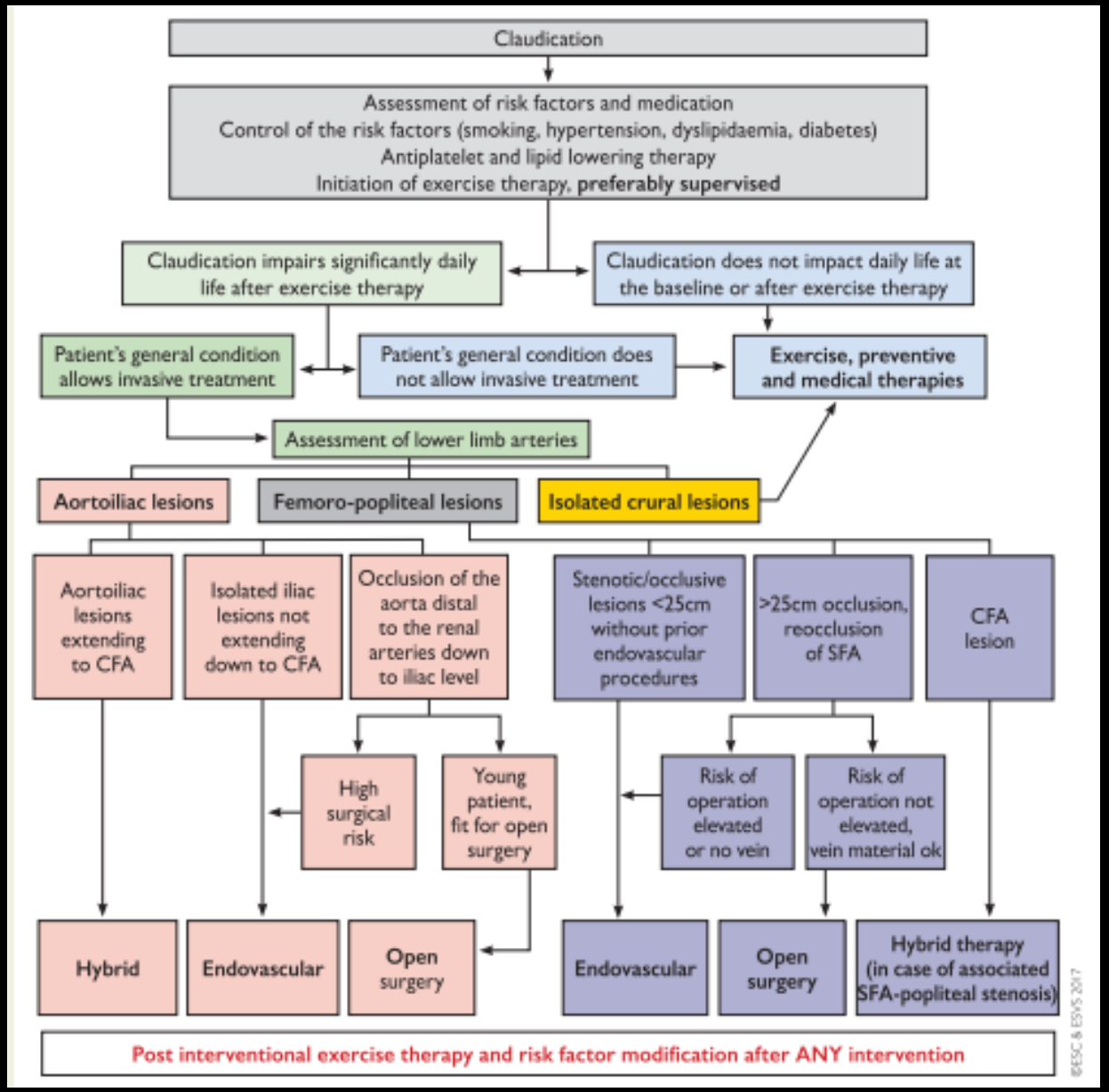
- Computed tomography angiography (96% sensitivity and 98% specificity for stenosis >50%):
  - visualization of calcifications, clips, stents, bypasses and concomitant aneurysms
- Magnetic resonance angiography:
  - ~95% sensitivity and specificity for diagnosing segmental stenosis and occlusion
  - tends to overestimate the degree of stenosis
  - cannot visualize arterial calcifications, poor visualization of metal stents

MANAGEMENT OF INTERMITTENT CLAUDICATION

- Exercise therapy:
  - improves symptoms, quality of life and increases maximal WD.
- Pharmacotherapy:
  - antihypertensive drugs (verapamil)
  - statins
  - anti-platelet agents
  - prostanoids (prostaglandins I2 and E1)
  - cilostazol, naftidrofuryl, pentoxifylline, buflomedil, carnitine and propionyl-L-carnitine - effects on WD, if any, are generally mild to moderate, data is limited.
- Revascularization – limited durability:
  - stent/bypass thrombosis (in 1-5 years),
  - may be associated with mortality and morbidity
    - **bypass** – higher length of hospital stay and complications, but sufficient results also last longer
  - Patients selection:
    - no effect after 3 months of exercise therapy+statins;
    - daily life activities are severely compromised.

Recommendations	Class[a]	Level[b]
On top of general prevention, statins are indicated to improve walking distance.[30,278]	I	A
In patients with intermittent claudication:		
• supervised exercise training is recommended[273,287–289]	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 is severely compromised, revascularization should be considered in association with exercise therapy.[288,290]	IIa	B

MANAGEMENT OF INTERMITTENT CLAUDICATION



MANAGEMENT OF INTERMITTENT CLAUDICATION

Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II, 2007)

Classification of aorto-iliac lesions and femoral popliteal lesions.

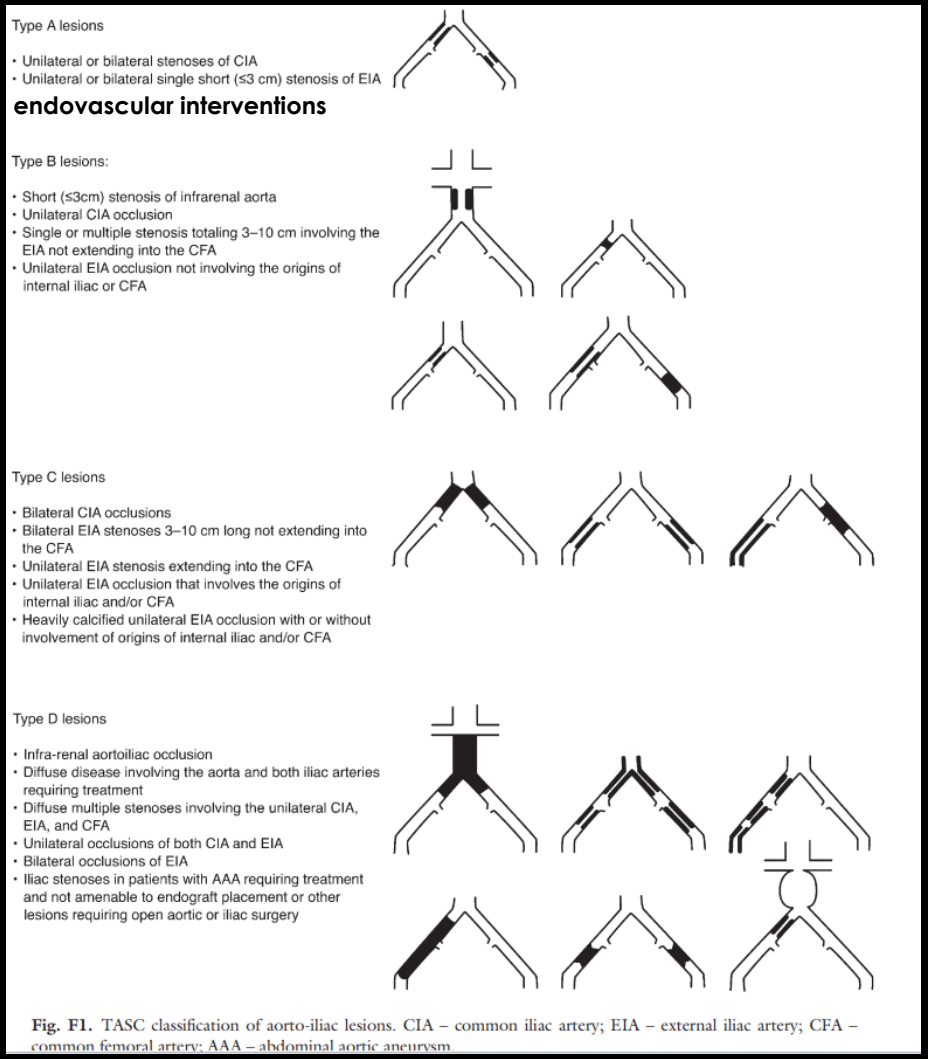


Fig. F1. TASC classification of aorto-iliac lesions. CIA – common iliac artery; EIA – external iliac artery; CFA – common femoral artery; AAA – abdominal aortic aneurysm.

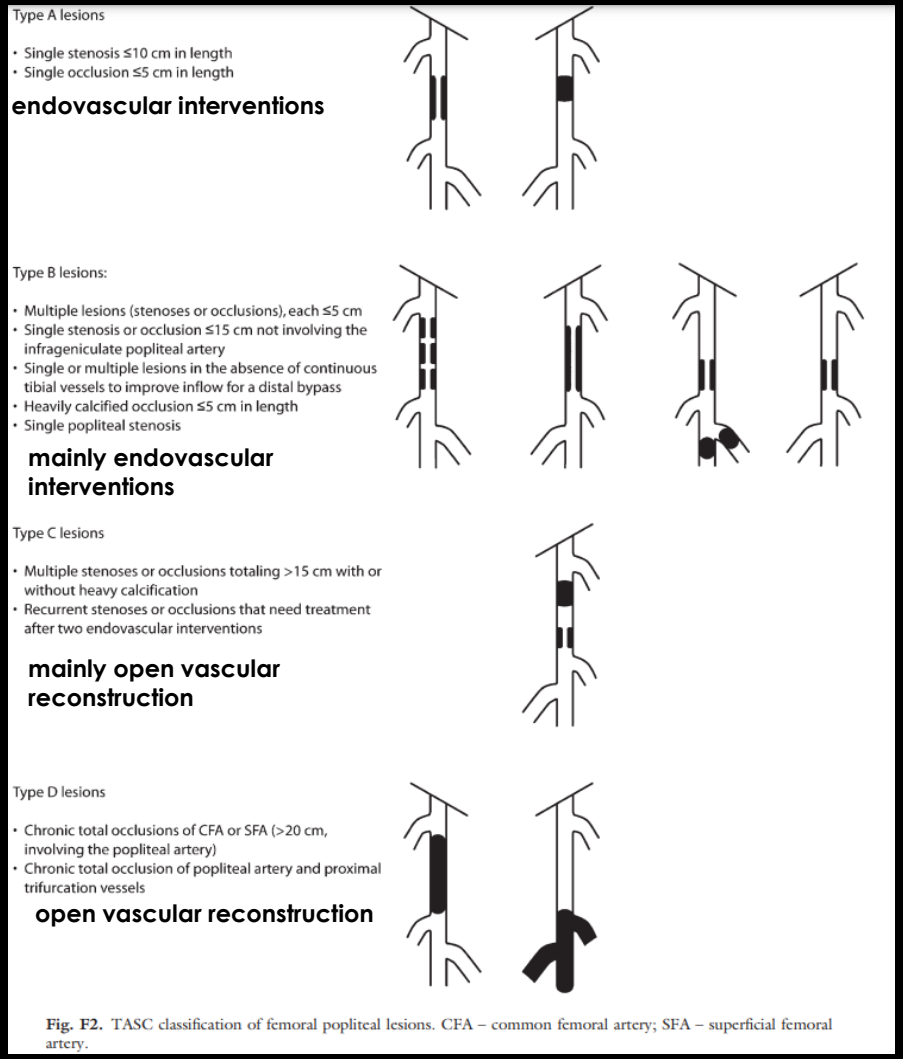


Fig. F2. TASC classification of femoral popliteal lesions. CFA – common femoral artery; SFA – superficial femoral artery.

CHRONIC LIMB-THREATENING ISCHAEMIA

Patterns with a threatened limb viability related to several factors

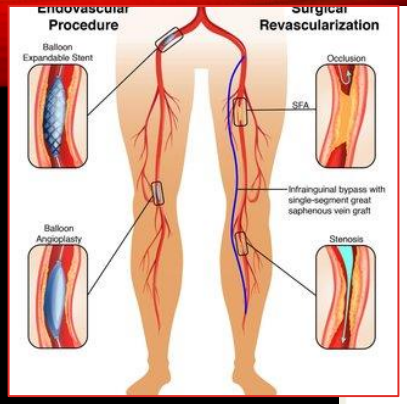
- 'critical' implies that treatment is urgent to avoid limb loss, while some patients can keep their legs for long periods of time even in the absence of revascularization
- in 50–70% diabetes is predominant
- risk of amputation often depends presence of infected wound

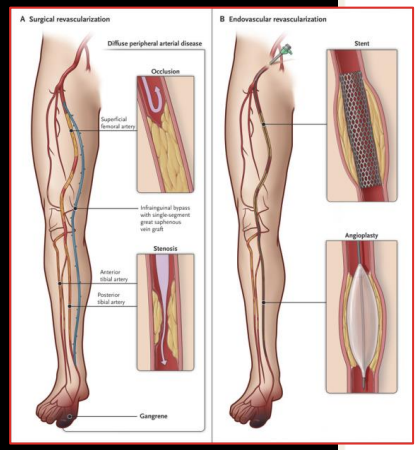
Component	Score	Description		
W (Wound)	0	No ulcer (ischaemic rest pain)		
	1	Small, shallow ulcer on distal leg or foot without gangrene		
	2	Deeper ulcer with exposed bone, joint or tendon ± gangrenous changes limited to toes		
	3	Extensive deep ulcer, full thickness heel ulcer ± calcaneal involvement ± extensive gangrene		
I (Ischaemia)		ABI	Ankle pressure (mmHg)	Toe pressure or $TcPO_2$
	0	≥0.80	> 100	≥60
	1	0.60–0.79	70–100	40–59
	2	0.40–0.59	50–70	30–39
	3	<0.40	<50	<30
fI (foot Infection)	0	No symptoms/signs of infection		
	1	Local infection involving only skin and subcutaneous tissue		
	2	Local infection involving deeper than skin/subcutaneous tissue		
	3	Systemic inflammatory response syndrome		

Estimate risk of amputation at 1 year for each combination																
	Ischaemia - 0				Ischaemia - 1				Ischaemia - 2				Ischaemia - 3			
W-0	VL	VL	L	M	VL	L	M	H	L	L	M	M	L	M	M	H
W-1	VL	VL	L	M	VL	L	M	H	L	M	H	H	M	M	H	H
W-2	L	L	M	H	M	M	H	H	M	H	H	H	H	H	H	H
W-3	M	M	H	H	H	H	H	H	H	H	H	H	H	H	H	H
	fI-0	fI-1	fI-2	fI-3	fI-0	fI-1	fI-2	fI-3	fI-0	fI-1	fI-2	fI-3	fI-0	fI-1	fI-2	fI-3

fI = foot infection; H = high-risk; L = low-risk; M = moderate risk; VL = very low risk; W = wound

MANAGEMENT OF PATIENTS WITH CLTI





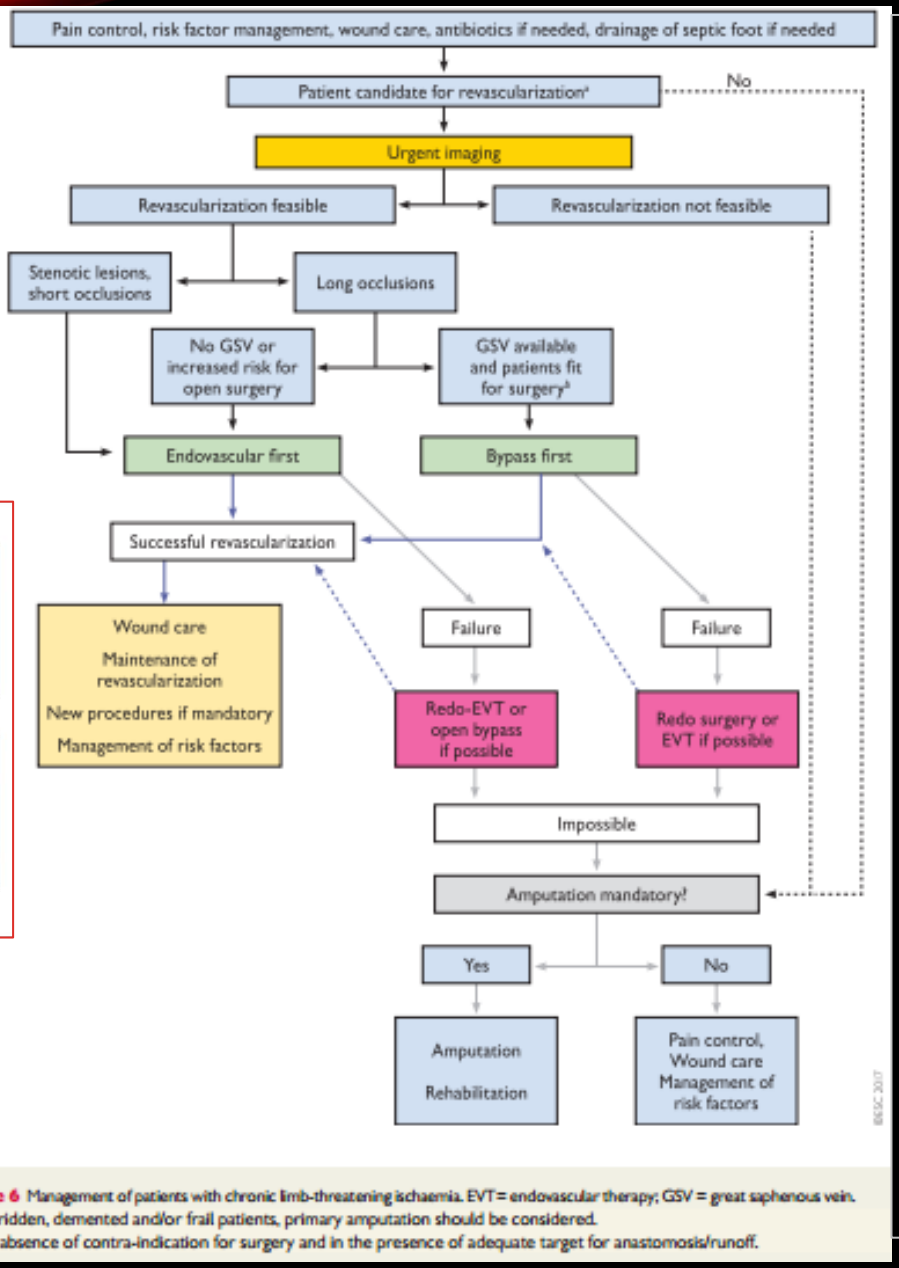


Figure 6 Management of patients with chronic limb-threatening ischaemia. EVT = endovascular therapy; GSV = great saphenous vein.
[a]In bedridden, demented and/or frail patients, primary amputation should be considered.
[b]In the absence of contra-indication for surgery and in the presence of adequate target for anastomosis/runoff.

- **Aorto-iliac segment**– hybrid procedures (eg. proximal and distal stenting simultaneously)
- **Femoro-popliteal segment** – strategy depends on lesion complexity (endovascular or bypass)
- **Infra-popliteal segment** short occlusions – endocvascular; long occlusion – bypass.

AMPUTATIONS

- Minor amputation– up to the forefoot level.
  - removes necrotic tissues with minor consequences on patient's mobility
  - revascularization is needed before amputation to improve wound healing
- Major amputation
  - infragenicular level should be preferred exept bedridden – femoral level
  - extensive necrosis or infectious gangrene
  - non-ambulatory patients with severe comorbidities which makes revascularization impossible
- Secondary amputation – after revascularization:
  - revascularization has failed,
  - limb continues to deteriorate because of infection or necrosis despite proper revascularization

Eur J Vasc Endovasc Surg (2020) 59, 173—218

CLINICAL PRACTICE GUIDELINE DOCUMENT

Editor's Choice – European Society for Vascular Surgery (ESVS) 2020 Clinical Practice Guidelines on the Management of Acute Limb Ischaemia

Martin Björck [*,a], Jonothan J. Earnshaw [a], Stefan Acosta [a], Frederico Bastos Gonçalves [a], Frederic Cochennec [a], E.S. Debus [a], Robert Hinchliffe [a], Vincent Jongkind [a], Mark J.W. Koelemay [a], Gabor Menyhei [a], Alexei V. Svetlikov [a], Yamume Tshomba [a], Jos C. Van Den Berg [a]

ESVS Guidelines Committee [b], Gert J. de Borst, Nabil Chakfé, Stavros K. Kakkos, Igor Koncar, Jes S. Lindholt, Riikka Tulamo, Melina Vega de Ceniga, Frank Vermassen

ACUTE LIMB ISCHEMIA

- Acute limb ischemia (ALI) is a rapid decrease in lower limb blood flow due to acute occlusion of peripheral artery or bypass graft, and in ALI not only limbs but also life prognosis will be poor **unless quick and appropriate treatment is given**.
  - incidence - 1–1.5 per 10,000 individuals per year

Blue toe syndrome

- acute toe and fingers ischemia in case of proximal arteries embolism
- toe/finger(s)/foot are cyanotis

- Etiology: embolism and thrombosis:
  - embolism (46%), atherosclerotic lesion (24%), thrombosis (20%)
    - the most common site of embolism is the femoral artery,
  - thrombosis of stent/graft (10%)
  - aortic dissection
  - traumas including vessel compression

Lower limbs embolism – 78%
Upper limbs embolism– 22%

- **Symptoms, 5Ps:**
  - pain,
  - pulselessness,
  - pallor,
  - paresthesia,
  - paralysis.

- **Embolism** develops without collateral circulation presents with sudden and severe symptoms.
- **Thrombosis** arises from an underlying chronic occlusive lesion often progressing relatively gradually because of the development of collateral circulation, which gives some time for treatment.

SEVERITY EVALUATION OF ALI

- TASC II (visual changes) and Rutherford (clinical signs) classifications:

Rutherford classification

Category	Description/Prognosis	Findings		Doppler signal	
		Sensory loss	Muscle weakness	Arterial	Venous
I. Viable	Not immediately threatened	None	None	Audible	Audible
II. Threatened					
a. Marginally	Salvageable if promptly treated	Minimal (toes) or none	None	Inaudible	Audible
b. Immediately	Salvageable with immediate revascularization	More than toes, associated rest pain	Mild, moderate	Inaudible	Audible
III. Irreversible	Major tissue loss or permanent nerve damage inevitable	Profound, anesthetic	Profound, paralysis	Inaudible	Inaudible

In ALI patients irreversible changes occur:

- in nerves – after 4–6 hours,
- In muscles – after 6–8 hours,
- In skin – after 8–12 hours.

6 hours – critical time gap for effective revascularization

DIAGNOSIS OF ALI

- medical history,
- visual examination,
- palpation + Doppler examination
- vascular ultrasonography
- angiography
- contrast-enhanced CT
  - severe renal dysfunction and/or allergy – simple CT for aneurysms and arterial calcification detection
  - whole-body examination for detection of affected area and embolus origin

- Ankle blood pressure:
  - ≤50 mm Hg + any of 5Ps = ALI
  - ≥50 mm Hg = severity classification I, but NOT ALI.

6 hours – critical time gap for effective revascularization

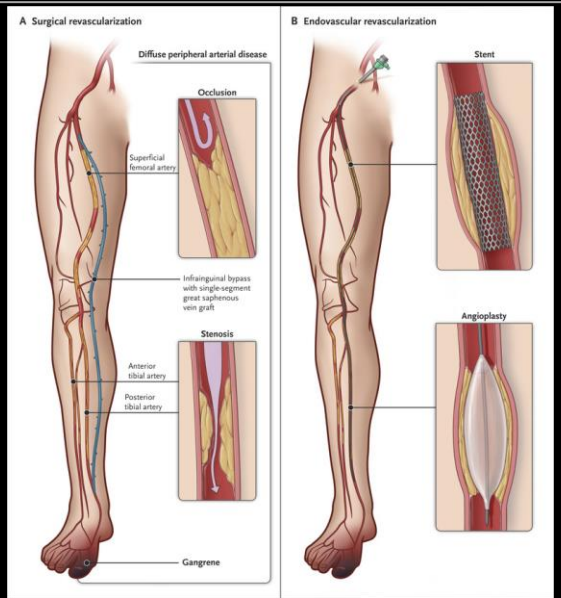
TREATMENT OF ALI

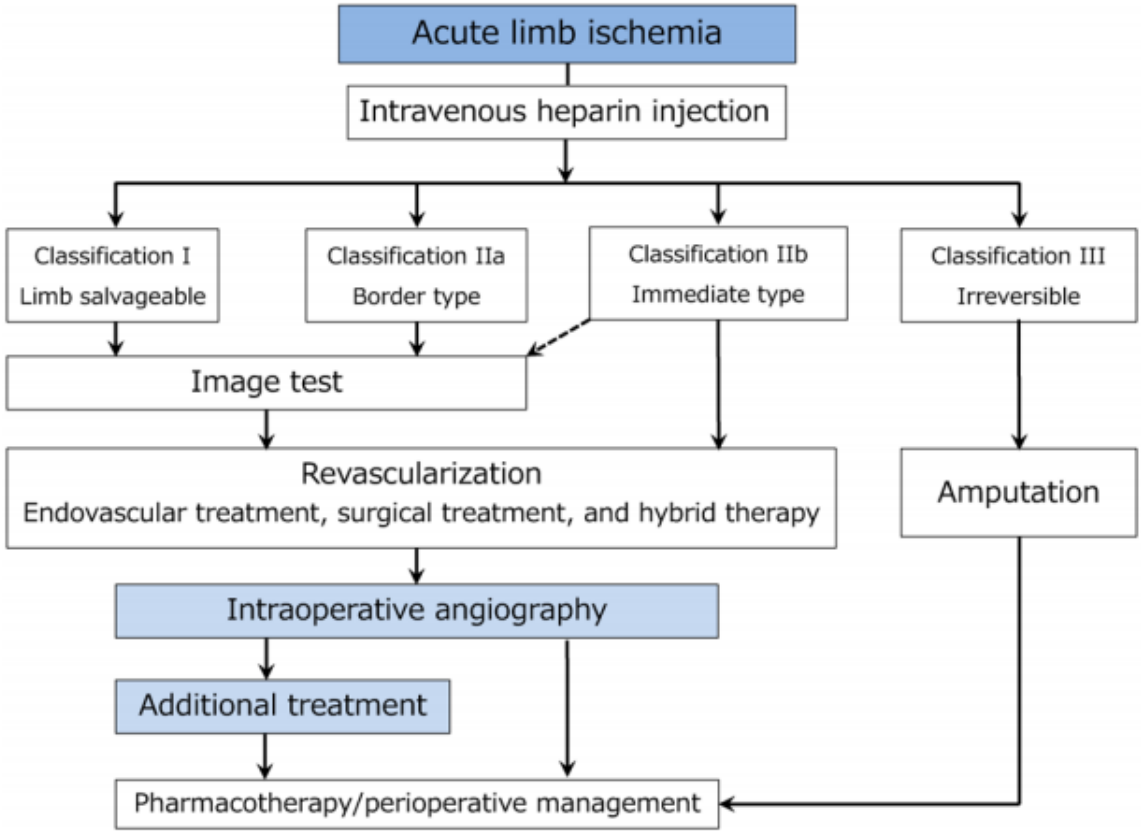
- **urgent intravenous injection of unfractionated heparin (50–100 units/kg), analgesia**
  - prevention of proximal and distal progression of secondary thrombosis in the site of occlusion.
- **severity and treatment plan must be determined :**
  - **IIb (neurological deficiency) – immediate revascularization)**
  - **I and IIa -**

Revascularization – viable limb:

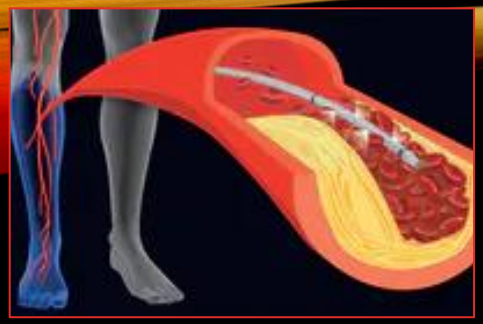
- catheter-directed thrombolysis (sistemic is not effective),
- ~~percutaneous thrombus aspiration,~~
- stent placement,
- thromboembolectomy
- bypass surgery

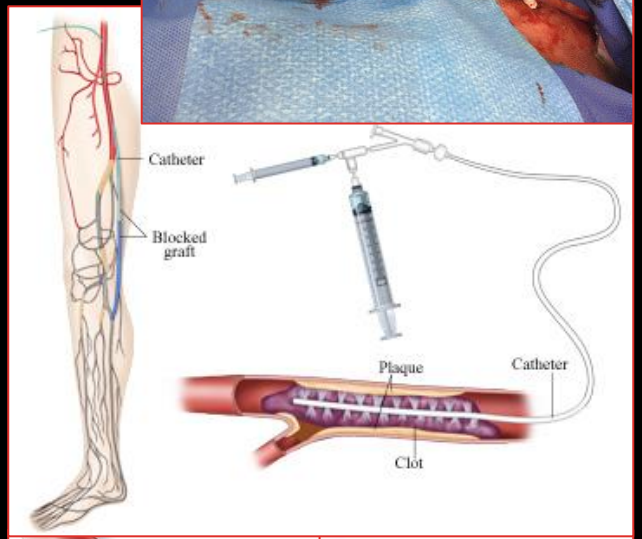
Amputation - irreversible tissues changes

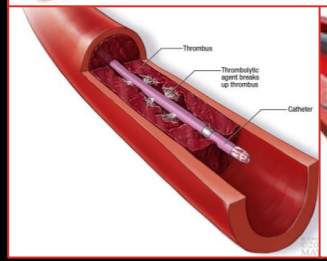


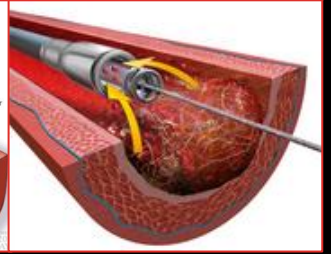


CATHETER-DIRECTED THROMBOLYSIS





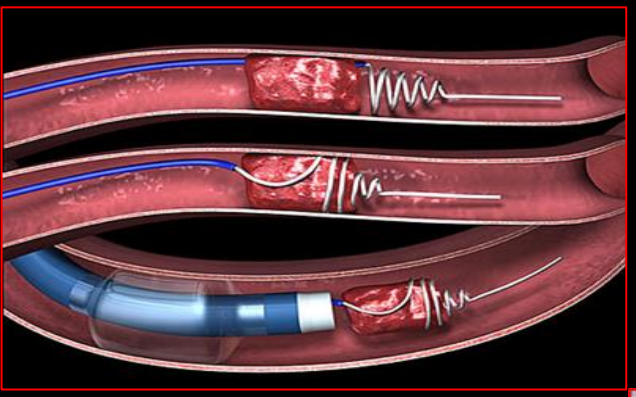




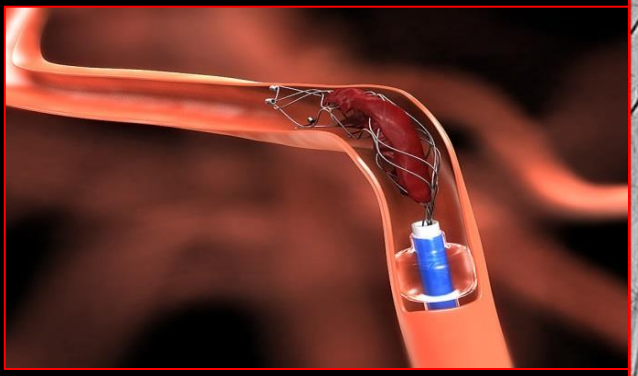
- Target lesions - femoral artery and arteries distal to the femoro-popliteal arteries.
  - requires more time than surgery,
  - I and IIa patients are candidates,
    - reperfusion syndrome rates are lower.

- 4Fr multihole catheter is positioned in the thrombus,
- 240,000–480,000 units of urokinase are directly delivered within the thrombus at once under fluoroscopic guidance
- a catheter is placed and CDT is performed over several days
  - Actilyse®, Streptokinase, Urokinase

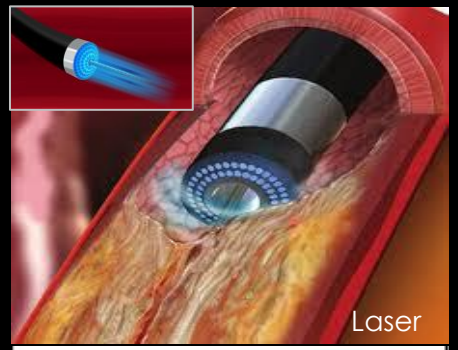
OTHER ENDOVASCULAR OPTIONS

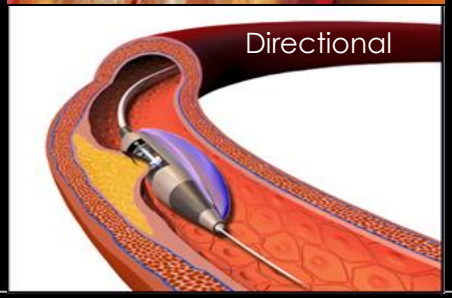


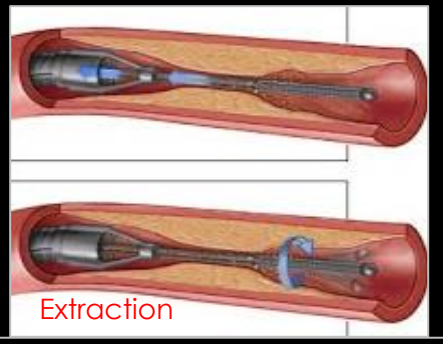
- Percutaneous thrombembolectomy
  - Minimal vessel diameter is more than 3 mm
  - Mechanical,
  - Laser-assisted,
  - Rheolityc.
- Atherectomy

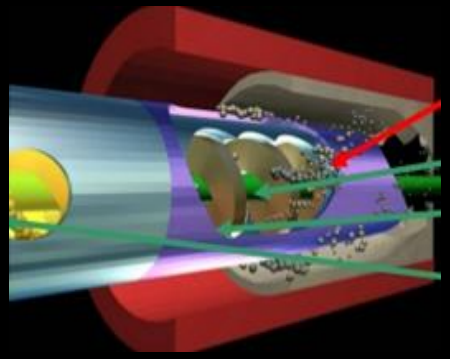


- Endovascular atherectomy

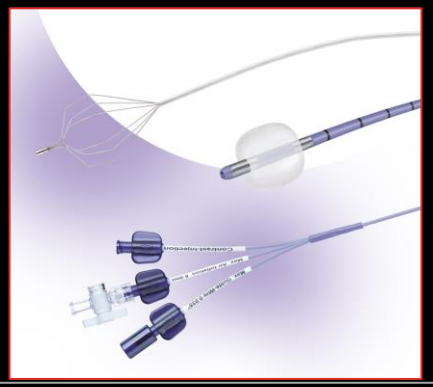




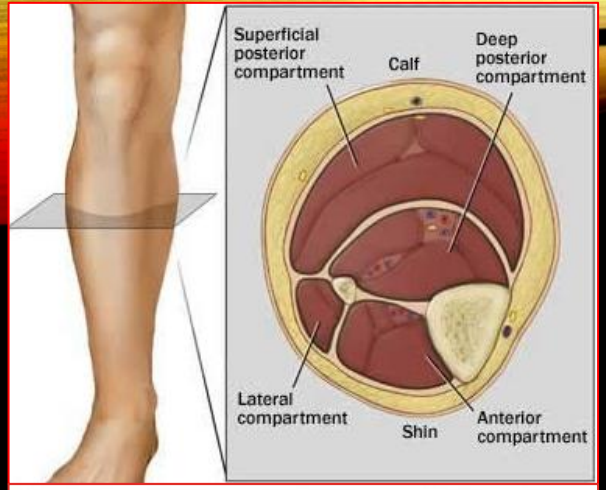


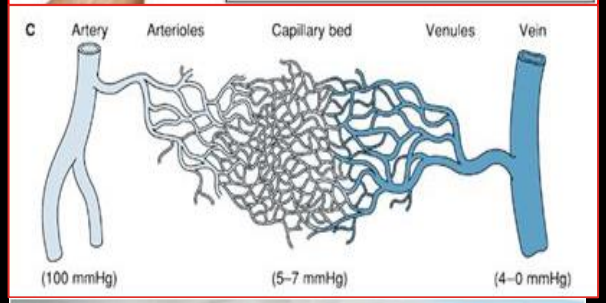


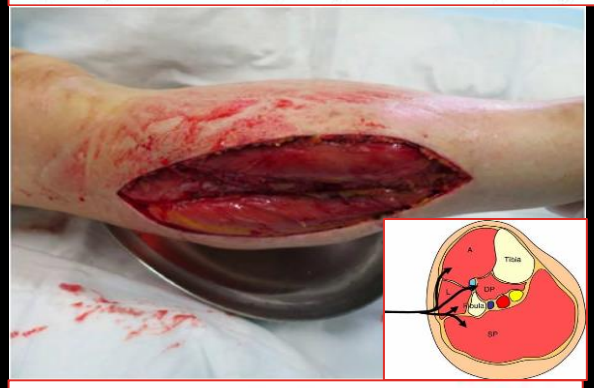
SURGICAL REVASCULARIZATION

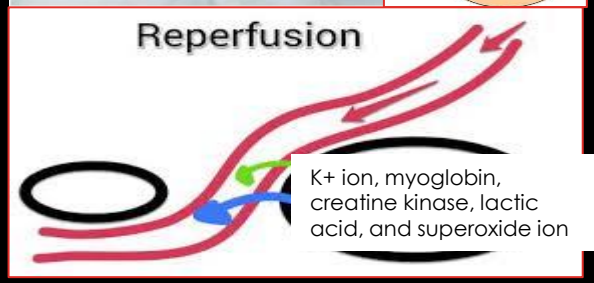


- Thromboembolectomy with a balloon catheter (Thomas Fogarty 1963) – standard for 60 years
- Hybrid treatments :
  - over-the-wire type Fogarty catheter - intraoperative selective fluoroscopically assisted thromboembolectomy;
  - thromboembolectomy + subsequent balloon dilatation/stent placement
- Bypass surgery/patch plastics of the anastomotic site :
  - limb salvage if endovascular treatment fails/impossible.









SPECIFIC COMPLICATIONS

Compartment syndrome:

- increased capillary permeability at the time of ischemic reperfusion causes localized edema and increased intramuscular compartmental pressure:
  - circulatory disturbance
  - neuromuscular dysfunction
  - irreversible nerve and muscle necrosis occurs if pressure exceeds 30 mmHg
  - 4 (four) muscular compartments in lower limb
  - Risk of amputation even after successful revascularization
- Treated with fasciotomy.

Myonephropathic metabolic syndrome (MNMS)

Prolonged ischemia causes muscle necrosis and K+ ion, myoglobin, creatine kinase, lactic acid, and superoxide accumulation.

Revascularization leads to perfusion of these substances through the body:

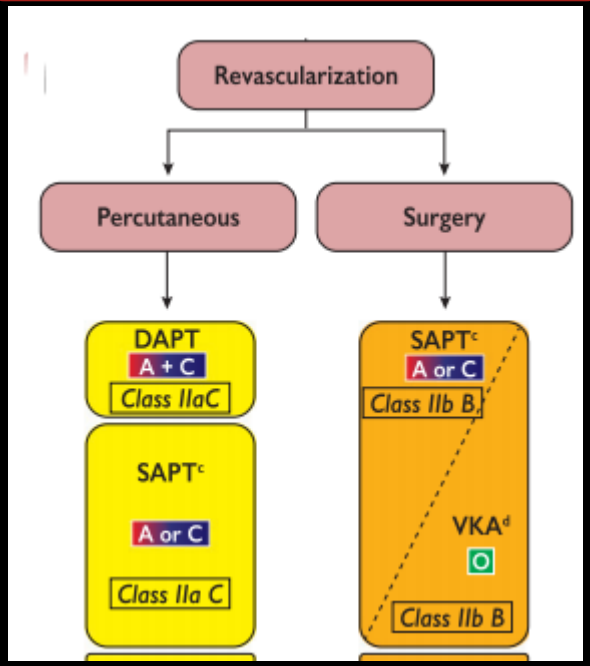
- hyperkalemia, arrhythmia (heart failure);
- pulmonary edema
- metabolic acidosis
- myoglobinuria (renal failure)

- No established specific prevention and treatment methods of MNMS yet.
- Forced diuresis and hemodialysis are used now.

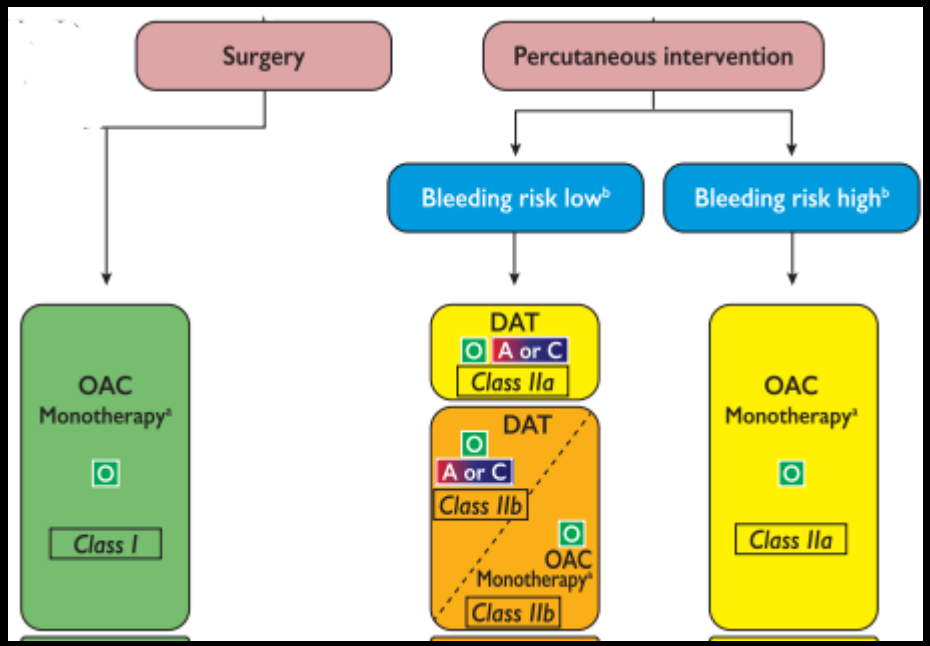
POSTOPERATIVE MANAGEMENT

- **Heparin – in early postoperation period.**
- **Long-term period – depends on risk of complications:**
  - **long-term VKA or OAC**
  - **DAT + antiocoagulants**

Patient does NOT require anticoagulation



Patient requires anticoagulation



C Clopidogrel 75 mg/day A Aspirin 75–100 mg/day O Oral Anticoagulation (VKA or NOACs)

Antithrombotic therapy in patients with LEAD requiring oral anticoagulation. ACS = acute coronary syndrome; CAD = coronary artery disease; CLTI: chronic limb-threatening ischaemia; DAT = dual antithrombotic therapy; LEAD = lower extremity artery disease; NOACs = non-vitamin K oral anticoagulants; OAC = oral anticoagulation; VKA = vitamin K antagonist.

[a]DAT may be considered in high ischaemic rick patients defined as prior stent thrombosis, acute limb ischaemia on OAC and concomitant CAD (recent ACS, stenting of the last patent coronary artery, multiple coronary vessel disease in diabetic patients with incomplete revascularization).

[b]Compared to the risk for stroke/CLTI due to stent/graft occlusion.

[c]Stands for as long as it is well tolerated.

TRAUMAS OF LIMBS' VESSELS

Signs and symptoms:

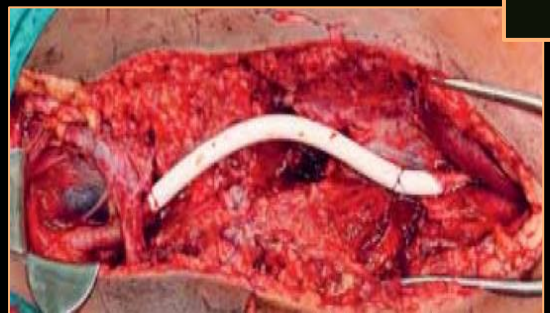
- Streaming/massive bleeding, even if it has already stopped.
- Increasing hematoma.
- Distal pulselessness after proper resuscitation.

- ***Hemostasis-resuscitation-reconstruction.***

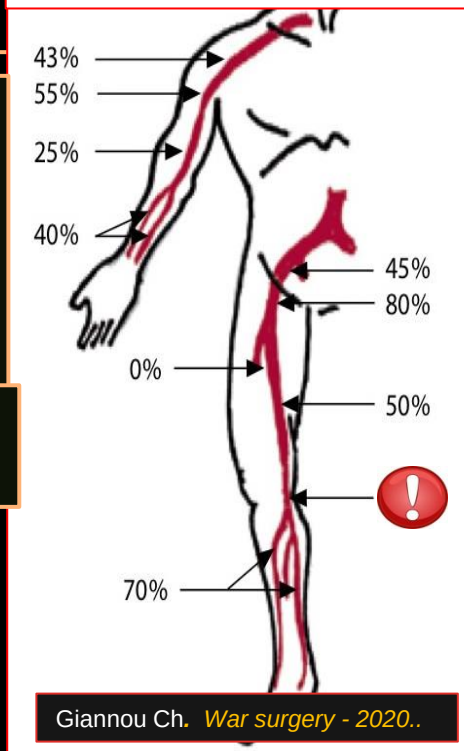
Surgical revision is obligatory: ***"It's always better to open and examine than just to wait and watch".***

- *Early artery reconstruction is the main issue:*
  - Approach – vessel projection line;
  - Temporary bypass if reconstruction is impossible:
    - 2-4 cm in each end of the vessel; thrombi evacuation; fixation.
  - Immobilization comes first; vessel plastic is second.
  - Veins – *"Don't waster blood during veins plastic, ligate". L.Riddez*

- ***Don't start reconstruction if the wound can not be closed with vial tissues.***



Arteries ligation vs ischemic gangrene



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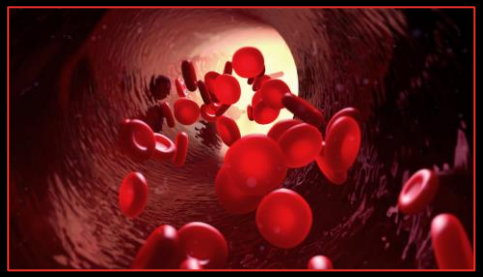
SECONDARY PROPHYLAXIS IN PATIENTS WITH LEADS



- General CV prevention is of the utmost importance and management should be multidisciplinar.
- Best medical therapy:
  - antihypertensive drugs (BP <140/90 mmHg);
  - lipid-lowering drugs (LDL Cholesterol below 70 mg/dL) ;
  - antithrombotic drugs (SART, DART+OAC);
  - optimal glucose level control in diabetic patients.
- Smoking cessation, healthy diet, weight loss and regular physical exercise.


THANKS FOR
YOUR ATTENTION