The ABCs of Acute Limb Ischemia

> **Acute limb ischemia (ALI) is a vascular emergency associated with a high risk for limb loss and death.**

Aetiology& Pathophysiology

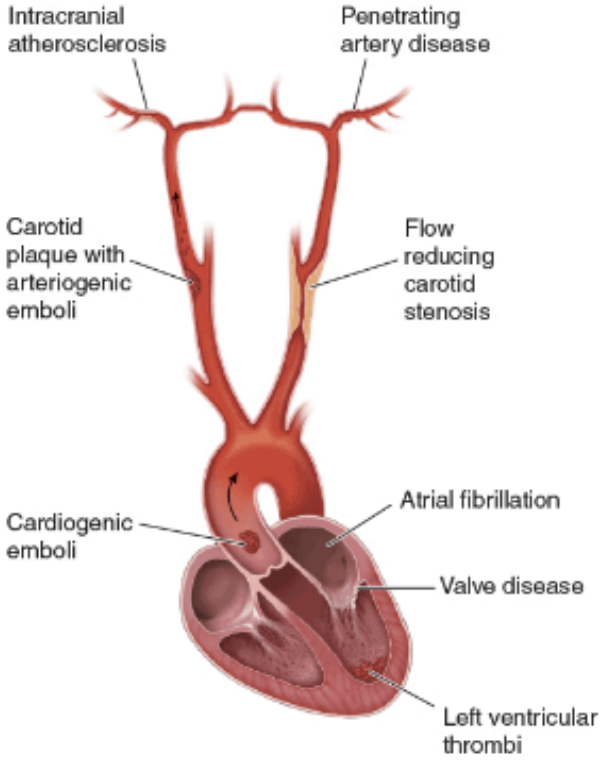
The **2 main causes** of ALI (excluding trauma):

- Embolism
- Thrombosis

**In the 2012 annual report of the Japanese Society for Vascular Surgery based on enrolments in the National Clinical Database, the number of patients with embolism and thrombosis accounted for approximately half of the total patients enrolled in the database.

Most cases of embolism are **cardiogenic embolism**, eg:

- atrial fibrillation
- valvular diseases, including post-valve replacement
- left ventricular wall thrombosis following myocardial infarction
- cardiac/ aortic tumour
- paradoxical embolism



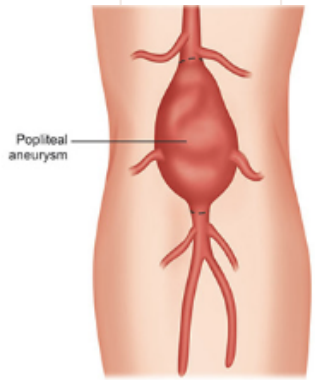
The most **common site** of embolism is **the femoral artery.**

Vascular embolism can be caused by atheroma of the aortic wall, such as:

- In shaggy aorta
- Penetrating atherosclerotic ulcer
- Aneurysm associated with mural thrombus
- Iatrogenic embolism can arise from catheter manipulations

ALI due to **peripheral embolism**:

- Popliteal artery aneurysm



- Thrombotic occlusion of an actual aneurysm

Thrombosis occurs when chronic stenotic lesions in occlusive atherosclerosis cause **acute obstruction** resulting from:

- Plaque breakdown
- Circulatory failure
- Hypercoagulable state
- Thrombotic occlusion of stents and bypass grafts

Clinical features

The classical description of patients with acute limb ischemia is represented by the:

"6Ps"

Pain
Pallor
Paralysis
Pulse deficit
Paresthesia
Poikilothermia

Blackish discoloration of his right leg with a line of demarcation just below the knee joint

- The signs of acute ischemia most often **develop rapidly.** The **sudden and dramatic development** of ischemic symptoms in a previously asymptomatic patient is most consistent with an embolus.
- Patients with an extremity embolism can frequently **pinpoint the exact time** that symptoms began.
- **History of intermittent claudication, previous leg bypass or other vascular procedures, and history suggestive of embolic sources, such as cardiac arrhythmias and aortic aneurysms.**
- General cardiac risk factors (smoking, hypertension, diabetes, hyperlipidemia, amputations, other vascular procedures, family history of cardiac or vascular events, age of parents at time of death) should also be recorded, as these can be predictors of periprocedural mortality.
- **Typical presentation**: **"blue toe syndrome",** that is characterised by embolic occlusion of digital arteries that causes acute pain, hypothermia and cyanosis of toe

Diagnosis

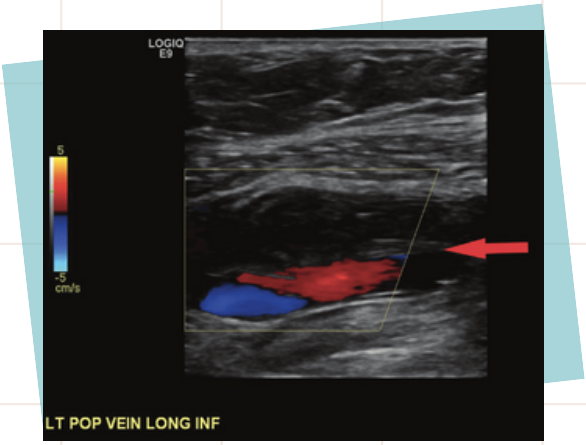
ALI is diagnosed on the basis of **medical history, visual examination, palpation**, and **Doppler examination** of the peripheral arterial pulse using vascular ultrasonography and contrast-enhanced computed tomography (CT) as imaging tests.

The severity of ALI is classified using the **TASC II and Rutherford classifications.**

Stage	Description and Prognosis	Findings		Doppler Signal	
		Sensory loss	Muscle Weakness	Arterial	Venous
I	Limb viable, not immediately threatened	None	None	Audible	Audible
II	Limb threatened				
IIa	Marginally threatened, salvageable if promptly treated	Minimal (toes) or none	None	Often inaudible	Audible
IIb	Immediately threatened, salvageable with immediate revascularisation	More than toes, associated with pain at rest	Mild or moderate	Usually inaudible	Audible
III	Limb irreversibly damaged, major tissue loss or permanent nerve damage inevitable	Profound, anaesthetic	Profound, paralysis (rigour)	Inaudible	Inaudible

Investigation

1. Duplex ultrasound (first-choice imaging modality)
- Identifies the level, severity (incomplete vs. complete occlusion), and chronicity of occlusion (loss of echogenicity and continuous systolic/diastolic downstream flow are noted in older lesions with collaterals)
- Provides clues to underlying aetiology



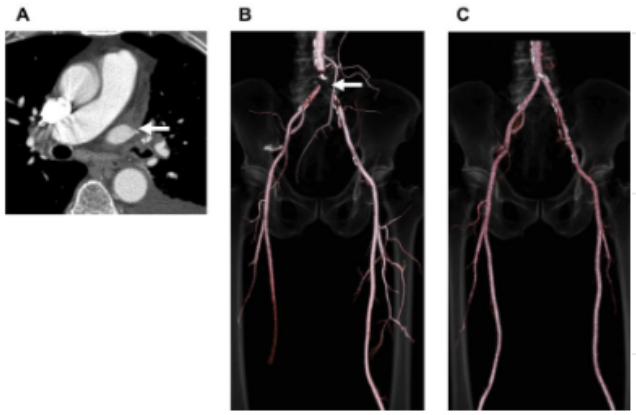
2. Contrast-enhanced CT of lower limbs, as well as of the head, thoracoabdominal and pelvic area:

- To determine the range of the occluded site,
- Close examination of the underlying disease and source of the embolus,
- To distinguish among multiple embolisms

OR

Simple CT (if contrast-enhanced examination cannot be performed)

- Provide important information regarding aneurysms and arterial calcification



3. Magnetic resonance angiography (MRA)

4. Digital subtraction angiography (DSA)

- Invasive and requires operators with vascular expertise,
- Considered as the "gold standard" modality
- Offers the advantage of simultaneous revascularization in the form of thrombolysis or angioplasty

Other test:

- Electrocardiography,
- Thoracoabdominal radiography,
- Full blood count,
- Biochemistry,
- Coagulation system testing (including protein C and S, anticardiolipin antibodies, and antithrombin III, etc for thrombophilia screening),
- Urine analysis,
- Blood gas analysis, and
- Echocardiography

** To determine the severity of ischemia and to predict the onset of ischemia-reperfusion injury, check for:
blood and urinary myoglobin,
blood creatine kinase (CK),
lactate dehydrogenase (LDH),
potassium (K),
lactic acid (on blood gas analysis) levels and the presence or absence of acidosis

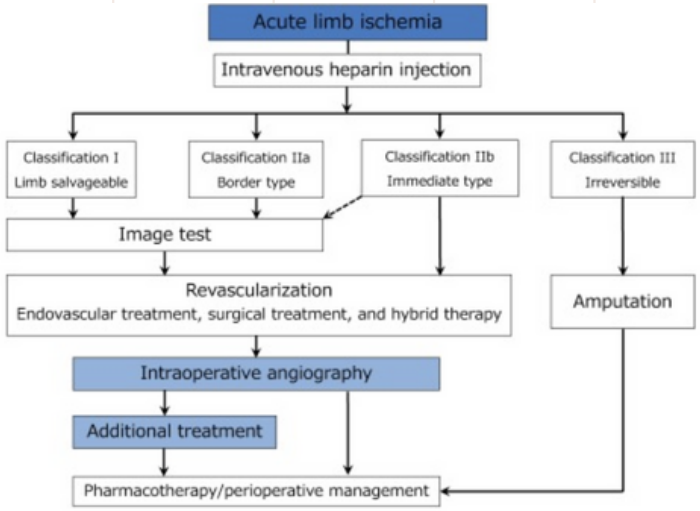
Treatment

Upon the diagnosis of ALI:

1. IV injection of unfractionated heparin

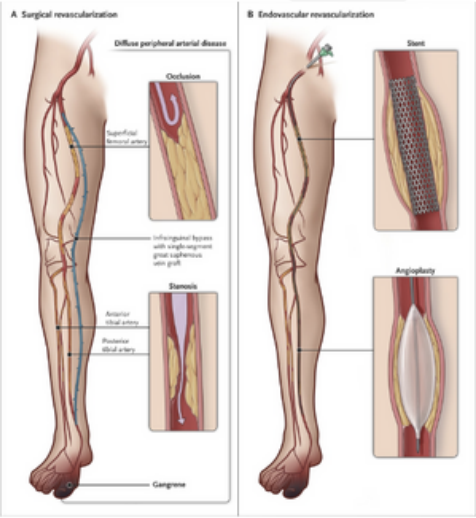
- prevent the proximal and distal progression of secondary thrombosis to the site of occlusion

2. Determine the severity and the subsequent treatment plan



Treatment methods:

- **Surgical treatment** (such as thromboembolectomy and bypass surgery),
- **Endovascular treatment** (such as catheter-directed thrombolysis [CDT], percutaneous thrombus aspiration, and stent placement),
- **Hybrid treatment** that combines both therapies.

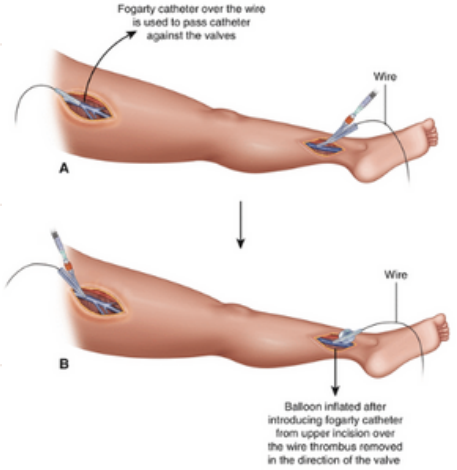


** A meta-analysis of five randomised controlled trials investigating whether surgical or endovascular treatment (thrombolytic therapy) should be performed as the first line of treatment for ALI was reported in 2013. While there was no significant difference between the two groups in terms of limb salvage and mortality rates, the endovascular treatment group showed a significantly higher incidence of severe complications, such as stroke and bleeding, within 30 days of treatment.

1. Surgical Revascularization

- Thromboembolectomy using a balloon catheter by arterial cut-down approach,

** The availability of over-the-wire type Fogarty catheter has enabling intraoperative selective fluoroscopically assisted thromboembolectomy, which has led to the



rapid popularisation of hybrid treatments, such as thromboembolectomy combined with subsequent balloon dilatation or stent placement using a guidewire passed through the lesion.

- bypass surgery,
- thromboendarterectomy,
- patch plasty, and
- intraoperative thrombolysis.

2. Catheter-directed thrombolysis (CDT)

CDT requires more time than does surgical treatment.

should be considered when there is time, such as in severity classifications I and IIa.

Reperfusion after CDT is slower than with surgical thromboembolectomy and can, therefore, reduce the risk of ischemia-reperfusion injury.

3. Percutaneous thrombus aspiration

rarely indicated in the iliac artery area containing several thrombi.

The concurrent use of CDT is recommended and is expected to shorten the duration of ischemia more compared with that by CDT alone.

Complications

1. Myonephropathic metabolic syndrome (MNMS)

- Prolonged ischemia can cause muscle cell liquefactive necrosis and K+ ion, myoglobin, creatine kinase, lactic acid, and superoxide accumulation in the affected limb.
- These metabolites perfuse throughout the body upon revascularization and cause **hyperkalemia, arrhythmia, pulmonary edema, metabolic acidosis, and myoglobinuria, and in severe cases, it can cause sudden death from heart and renal failure.**
- The so-called ischemia-reperfusion injury is a severe complication that determines prognosis after the revascularization of ALI.

2. Compartment Syndrome

- Increased capillary permeability at the time of ischemic reperfusion causes localised edema and increased intramuscular compartment (compartmental) pressure, which leads to circulatory disturbance and neuromuscular dysfunction.
- Can cause irreversible nerve and muscle necrosis, and in some instances, lower limb amputation is necessary even if revascularization is successful.

Lateral fasciotomy of right lower leg was performed in an 86-year-old male who developed compartment syndrome after the arterial reconstruction for acute limb ischemia.

Patients with acute limb ischaemia are at increased risk of a**mputation, stroke, and death.**

**** Some data to support:**

Amputation:

The rate of amputation of the upper limbs after thromboembolectomy has been reported to be 0–6.6% in many studies.

Stroke:

In the largest population-based study on nearly 1400 patients who underwent thromboembolectomy for upper limb thromboembolism, the rate of stroke was reported to be 19.1%, with a higher incidence in women compared to men.

Credits
Content – Eva Teo ; Design – Hoo Zhi Ai (SIGMUM Committee of 2022/2023)