Emergency Bulletin
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An old lady who presented with unilateral leg weakness

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A 90-year-old lady presented to our emergency department for an acute onset of numbness and weakness of the right lower limb for 1 hour, with no involvement of the right upper limb. She had no facial asymmetry, dysarthria or headache. She had no chest pain or abdominal pain. She was able to walk with a stick before the index admission. She had a past medical history of paroxysmal atrial fibrillation, prediabetes, hypertension, hyperlipidemia, ischemic heart disease and osteoporosis. She was regarded as a case of stroke by the triage nurse and was transferred to the resuscitation room for management of acute stroke. The stroke nurse was also informed.

Her blood pressure was 178/87 mmHg, with a pulse rate of 89/min. She was afebrile. The oxygen saturation was 98% on room air. The Glasgow Coma Scale was full. She was unable to plantarflex or dorsiflex her right ankle. However, muscle power of right hip flexion and right knee extension was full. The muscle power of bilateral upper limbs and left lower limb was full. The plantar reflexes on both sides were equivocal.

It was not until plantar reflex examination was performed that the doctor noticed obvious pallor and prolonged capillary refill over right foot. (Fig.1) Lower limb ischemia was therefore suspected. The patient also admitted that apart from weakness and numbness, she also had pain over the right lower limb. Physical examination revealed that bilateral femoral pulses were strong, but right popliteal pulse, posterior tibial pulse and dorsalis pedis pulse were not palpable.

A chest X-ray has been done, and it was unremarkable. Her ECG showed atrial fibrillation at a rate of 91/min. Bedside Doppler ultrasound showed presence of Doppler signals over left dorsalis pedis pulse, and absence of flow in right dorsalis pedis pulse.

Her blood glucose (by point-of-care testing glucometer) was 10.5 mmol/L. Her hemoglobin (by point-of-care testing hemoglobinometer) was 14 g/dL.

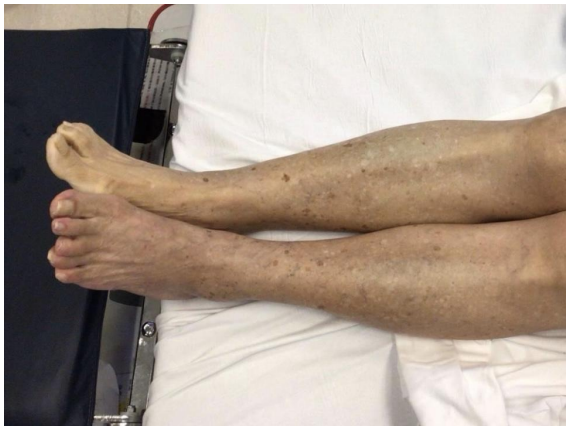

Fig.1 Photo showing the lower limbs of the patient

What are the differential diagnoses of limb weakness and numbness?

The differential diagnoses of limb weakness and numbness depends on the pattern of involvement. One sided weakness and numbness favours the diagnosis of acute stroke or transient ischemic attack; other symptoms such as facial asymmetry, drooling of saliva and dysarthria may also be present in stroke. However, weakness and numbness involving only one of the limbs may be the presentation of acute limb ischemia, cervical or lumbar radiculopathy. Spinal cord pathology, such as cord compression and transverse myelitis, needs to be ruled out if the weakness and numbness involves both lower limbs.

Distal weakness and sensory loss can be symptoms of peripheral neuropathy, electrolyte disturbance including hypokalemia, hyperkalemia and hypocalcemia, or metabolic causes such as hypothyroidism, diabetic or alcoholic neuropathy.

Progress of the patient

The clinical picture was compatible with acute limb ischemia with pre-existing atrial fibrillation.

She was admitted to the surgical ward. The patient's preoperative blood results revealed unremarkable complete blood count, liver and renal function, random glucose and creatinine kinase. Computed tomography angiography was not done as emergency femoral embolectomy was arranged for suspected acute limb ischemia. Moderate amount of blood clots was retrieved from the external femoral artery, superficial femoral artery and profunda artery. Right femoral, popliteal and posterior tibial pulses were palpable after embolectomy, right foot returned pink, capillary refill was around 2 seconds.

She was admitted to the intensive care unit for post-operative observation. Bedside ultrasound of bilateral lower limbs showed compressible bilateral popliteal vein with no obvious thrombus. Post-operative laboratory studies showed elevated troponin I peaked at 363 ng/L and creatine kinase peaked at 9113 U/L, and positive urine myoglobin. Intravenous fluid replacement, analgesics and subcutaneous enoxaparin were given. She was transferred to the general surgical ward on post-op day 2.

Medical colleagues were consulted for the plan of anticoagulation. Apixaban was initiated. Echocardiogram was done, showing dilated biatria with normal-sized left and right ventricles. The left ventricular systolic function was normal with left ventricular ejection fraction of 56%, there was no regional wall motion abnormality. The right ventricular systolic function was mildly impaired. There was moderate mitral valve regurgitation, mild aortic valve regurgitation and moderate tricuspid valve regurgitation. There was no pericardial effusion or thrombus.

The patient's condition gradually improved. She was then transferred to the rehabilitation ward for further rehabilitation.

Acute limb ischemia due to embolisation

Background

The working definition of acute limb ischemia is based on the 2007 Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II), which describes acute limb ischemia as "a quickly developing or sudden decrease in limb perfusion, usually producing new or worsening symptoms or signs, and often threatening limb viability".[1] The duration of symptoms that distinguishes acute from chronic limb ischemia is defined as less than 2 weeks.[2]

Pathogenesis

The causes of acute arterial occlusion include thrombosis, embolism and vascular trauma.

Heart is the most common source of lower extremity emboli.[3] Emboli can arise from intracardiac thrombus in the left atrium associated with atrial fibrillation, in the left ventricle in severe cardiomyopathy and post-myocardial infarction or rarely, from cardiac tumors, such as myxoma.[4] The aortic or mitral valves can also be the sources of emboli to the lower extremities, including debris on diseased native or prosthetic valves, vegetative growths from bacterial endocarditis, or non-bacterial vegetations in Libman-Sacks endocarditis.[6]

Emboli can also be sourced from a diseased aortic wall with complex atherosclerotic plaque. Following the rupture of the fibrous cap overlying an atherosclerotic plaque, luminal irregularities and ulcerations result in a surface that is thrombogenic. Asymptomatic atherosclerotic disease of the aorta can lead to macrovascular or microvascular embolization.[7] This can occur in the ascending aorta, aortic arch, descending thoracic aorta, or abdominal aorta. Mural thrombus which is nearly free-floating with attachment at one end to the wall of the aorta can be another source of emboli from the aorta.[8] Altered blood flow within thoracic or abdominal aortic aneurysms enhances the formation of mural thrombus within the aneurysm sac. Although mural thrombus in an aortic aneurysm is common, dislodgement of aortic thrombus is an uncommon source of embolization to the lower extremities.[9]

Venous thrombus can occasionally cause embolization in systemic circulation. A paradoxical embolus results from venous thrombus embolizing to the right heart and then crossing into the arterial circulation through an intracardiac septal defect (e.g., patent foramen ovale, atrial septal defect), or a right-to-left shunt in the pulmonary circulation.

Catheter-based or surgical cardiac or peripheral interventions can be sources of lower extremity embolization. A variety of arterial closure devices (suture-mediated closure, metal clip-mediated closure, collagen or other soluble plugs) can be used at the end of endovascular procedures. Although the incidence is low, it is a potential etiology when evaluating an embolic event. Therefore, careful manipulation of wires, catheters and treatment devices during endovascular interventions is important to minimize damage from the intervention.

Clinical evaluation

The classical clinical presentation of 6Ps in acute limb ischemia is as follows:

1) **Pain** (sudden and dramatic pain is consistent with acute embolism while gradual onset is more consistent with chronic ischemia)
2) **Pallor** (level of arterial obstruction is usually one joint above the line of demarcation)
3) **Poikilothermia** ("perishingly cold")
4) **Pulselessness** (presence of a strong pulse in the contralateral extremity indicates an acute arterial occlusion)
5) **Paresthesia** (sensory deficits over the foot dorsum is usually the earliest neurologic sign as the anterior compartment of the leg is most sensitive to ischemia)
6) **Paralysis** (weakness of toes is usually the first motor deficit, indicating advanced ischemia)

The clinical presentation of acute lower extremity ischemia varies depending upon the source of the thrombus, the size of the embolic debris, and the ability of the extremity to compensate for reduced flow related to the obstruction. Symptoms of acute lower extremity ischemia are sudden and rapidly progressive. A thorough evaluation for signs of acute and chronic limb ischemia is crucial in diagnosis of lower extremity ischemia. Physical examination involves evaluation of femoral, popliteal, posterior tibial and dorsalis pedis pulses. The pulses should be documented in the

form of intensity grading from 0 to 4+:

0: no palpable pulse
1+: faint but detectable pulse
2+: diminished pulse
3+: normal pulse
4+: bounding pulse

The presence of pallor, paresthesia, poikilothermia, pulse deficit and prolonged capillary refill should also be evaluated. The severity of the initial presentation corresponds to the degree of urgency needed for treatment.[10]

In patients with an absent pulse on palpation, a hand-held Doppler ultrasound device can also be used for confirmation. The device is placed over the pulse areas to detect the presence or absence of blood flow. If the Doppler signal is present, the ankle-brachial index (ABI), calculated by dividing the blood pressure in an artery of the ankle by the blood pressure in an artery of the arm, can also be checked. However, the ABI is not a sensitive tool for diagnosing peripheral arterial disease, and is not a useful diagnostic tool in the emergency department. One study showed that up to 43% of symptomatic patients with peripheral arterial diseases with more than 50% stenosis on ultrasound examination had either normal or inconclusive resting ABI.[16]

Emergency physicians should also be aware of blue toe syndrome, a variation of acute limb ischemia, which can occur if the embolic material is small enough to travel into the end arteries. This results in digital ischemia with intact large vessel circulation.[11] The patient will often have intact pedal pulses, but inadequate circulation to the individual toe(s).

In addition, the clinical presentation may also be atypical for repeated embolisation to the lower extremities which can result in a stepwise deterioration of distal arterial flow from individual embolic events. Patients may have no or mild symptoms. Such subclinical progression to chronic ischemia results in disruption of the lower extremity outflow circulation and causes rest pain or tissue loss.[12]

Investigations

Laboratory studies are frequently conducted to evaluate treatment risks and establish a baseline for future comparisons. In nearly all patients with acute limb ischemia, anticoagulation is typically started, and there is a strong possibility that iodinated contrast will be administered for catheter-based arteriography or computed tomographic (CT) angiography at some stage during diagnosis and treatment. Therefore, complete blood count,

	Viable (I)	Marginally threatened (IIa)	Immediately threatened (IIb)	Nonviable (III)
Pain	Mild	Moderate	Severe	Variable
Capillary refill	Intact	Delayed	Delayed	Absent
Motor deficit	None	None	Partial	Complete paralysis
Sensory deficit	None	None or minimal (toes)	More than toes	Complete anaesthetic
Doppler (arterial)	Audible	Inaudible	Inaudible	Inaudible
Dopper (venous)	Audible	Audible	Audible	Inaudible
Treatment	Urgent evaluation	Urgent revascularization	Emergency revascularisation	Amputation

Table 1. Rutherford classification of acute limb ischemia

liver and renal function tests and clotting profile are required. A baseline electrocardiogram and chest X-ray should be obtained before emergency revascularization.

The use of diagnostic imaging for work-up should be guided by the Rutherford criteria as shown in Table 1. Patients with stage I or grade IIa may undergo diagnostic imaging before definitive treatments. Patients with stage IIb (e.g., even a minor motor deficit) should receive immediate revascularisation without any additional diagnostic imaging studies. For those with stage III, irreversible damage is already present, and amputation may be required. There are several imaging study modalities, including digital subtraction angiography (DSA), CT angiography (CTA), duplex ultrasonography (DUS) and magnetic resonance angiography (MRA). The advantage of DSA is that treatment can be provided at the same stage. CTA is more readily available and is useful for cases with equivocal examination findings. DUS is an alternative choice for patients allergic to contrast or high risk of contrast nephropathy.

Management

The management of acute limb ischemia in the emergency department starts with early consultation with a vascular surgeon for consideration of further management. Revascularization should be performed within 6 hours to achieve good outcomes, and intervention beyond 6 hours is associated with much higher need of amputation. The definitive management should be determined by the surgeon, while the emergency physician should document the exact time of onset, physical findings of ischemia, as well as the Rutherford class of the patient clearly in the record.

The initial medical management should also include pain control and anticoagulation. Systemic anticoagulation, for example, low molecular-weight heparin, should be initiated as soon as the clinical diagnosis of acute limb ischemia is made, ideally before subsequent imaging.[12] Anticoagulation prevents further propagation of thrombus and inhibits thrombosis distally in the arterial and venous systems due to low flow and stasis.

Majority of patients with lower extremity embolism have underlying cardiovascular disease. The severity of any underlying cardiac condition(s) may increase the risk of treatment and limit the options available for restoring blood flow to the ischemic extremity. When time allows, preoperative cardiac evaluation should be included in the management to assess surgical risk.

The definitive management strongly depends on the clinical presentation, especially the severity of limb ischemia at presentation and duration of symptoms.[2] Other factors, including presumed etiology, lesion location and length, duration of symptoms, suitability of the patient for surgery and availability of autologous vein for bypass grafting, may also affect the management of acute lower limb ischemia. Revascularisation is achieved by two treatment modalities:

1) Endovascular intervention (intra-arterial thrombolysis or percutaneous thrombectomy)
2) Surgery (open thrombectomy or bypass surgery)

Intra-arterial thrombolysis may be an effective alternative to surgery for appropriately selected patients with no significant difference in limb salvage or death at 30 days, six months or one year.[13] However, failure of thrombolysis can lead to progression of ischemia to a higher degree of limb threat that may necessitate conversion to immediate surgical revascularization to reduce the risk of limb loss.

For patients with an immediately threatened extremity, emergency surgical revascularization is the most appropriate initial management. Although pharmacologic thrombolysis may

successfully dissolve the embolus, the time required is usually too long for it to be an acceptable alternative to surgery. Progression to an unsalvageable limb can occur in as little as four to six hours if prompt revascularization is not performed.

For patients with a nonviable extremity, prompt amputation should be performed. Vascular imaging prior to surgery is usually not necessary since the level of amputation is determined by clinical findings and by the viability of tissues at the time of surgery. Surgeons should make every effort in preserving as many joints as possible to improve the likelihood for successful rehabilitation. Delayed amputation of a nonviable limb can result in multiple complications such as infection, myoglobinuria, acute renal failure, and hyperkalemia. However, preoperative therapeutic anticoagulation can be considered if no complication is developed with a nonviable limb. By anticoagulating and allowing for collateral flow to develop, a longer residual limb may result which improves postamputation function.

After the management of an acute ischemic limb, further evaluation and treatment focuses on preventing recurrent embolic events. The subsequent diagnostic evaluation, including echocardiography and vascular imaging, helps identify the suspected embolic source. Adjunctive medical therapies or additional intervention can be adopted to remove or exclude the source from the circulation once the source of emboli is known.

Prognosis

Prognosis of patients with acute embolism highly depends on the severity and duration of ischemia. However, despite optimal treatment, acute embolism is associated with high rates of morbidity and mortality.[14] Limb loss rates as high as 30 percent and hospital mortality as high as 20 percent have been quoted in surgical series.[15] For patients with blue toe syndrome, the clinical course after the acute insult varies. Sometimes there is complete resolution; other times, there may be chronic pain or nerve damage, but the toe is preserved. In other cases, there can be progression to gangrene, necessitating toe amputation.

Lesson to learn

- For acute limb ischemia, early diagnosis and rapid treatment are essential.
- Elderly patients may have an atypical presentation, and pain may not be the predominant clinical feature.
- Patients with acute limb ischemia may have a clinical presentation that mimics stroke, so adequate exposure for peripheral vascular examination is essential for those who present with weakness or numbness over only one limb.
- Rutherford classification is a valuable tool for guiding the plan of management.
- For patients who present early, prompt surgical consultation or rapid transfer for surgical evaluation would be limb saving.

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