Acute lower limb ischaemia

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Salvage of the acutely ischaemic lower limb represents a large proportion of the emergency workload for the vascular surgeon. A successful outcome is dependent upon a careful clinical assessment and a prompt multidisciplinary approach to revascularization.

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The clinical presentation of acute arterial occlusion has been recognized for several hundred years, and it was the surgical pioneer John Hunter who first proposed the concept of embolectomy in the 18th century. The Frenchman Ernest Mosny reported the first successful surgical embolectomy in 1911, but treatment remained rudimentary until the development of anticoagulants and the balloon embolectomy catheter (Fogarty, 1963) (*Figure 1*). In recent decades advances in endovascular techniques and pharmacological thrombolysis have expanded the available therapeutic options. Nevertheless, acute limb ischaemia continues to pose a major therapeutic challenge to the vascular surgeon and interventional radiologist. In this article the aetiology, investigation and treatment of acute limb ischaemia is discussed. It must be appreciated that the eventual therapeutic measures adopted in each individual case depend upon the aetiology, severity of ischaemia and associated co-morbidity. The mortality and limb loss associated with acute lower limb ischaemia remains significant.

AETIOLOGY

Acute limb ischaemia has been defined by the Transatlantic Inter-Society Consensus (2000) as 'any sudden decrease or worsening in limb perfusion causing a potential threat to extremity viability'. It is a relatively common surgical emergency and estimates suggest that 30–40 cases will present annually to the average district general hospital. There are numerous causes but the three most frequent are arterial thrombosis, embolism and thrombosis of an arterial bypass graft (*Table 1*). Arterial thrombosis accounts for around 60% of cases and usually complicates pre-existing atherosclerosis, although rarely a thrombus may form spontaneously in a normal vessel in the presence of malignant disease or another hypercoagulable state. Embolic occlusion is responsible for 30% of cases and the vast majority of these occur as a result of atrial fibrillation. Emboli most frequently lodge at the femoral bifurcation but may occlude the distal aorta (saddle embolus) or cause more distal obstruction in the popliteal artery. In each patient the precise cause of acute limb ischaemia should be sought aggressively as a successful outcome is dependent upon specific intervention that addresses the underlying aetiology.

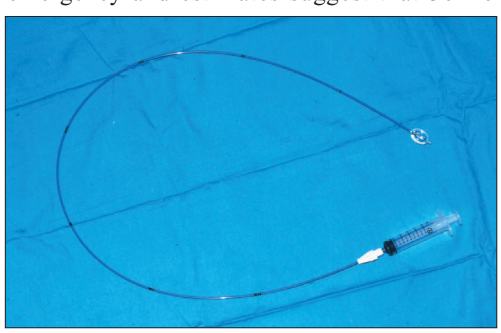

Figure 1. Fogarty embolectomy catheter.

CLINICAL PRESENTATION AND ASSESSMENT

The classical presentation of acute embolus is sudden pain, pallor, paraesthesia, paralysis,

TABLE 1.
Causes of acute limb ischaemia

Thrombosis
Embolus (usually atrial fibrillation or cardiac source)
Aortic dissection
Trauma
Iatrogenic injury
Thrombosed aneurysm (popliteal)
Thrombosed bypass graft
Injury caused by extreme cold
Intra-arterial drug administration
Venous gangrene
Prothrombotic states

pulselessness and perishing cold in the affected extremity. In cases of arterial thrombosis the symptoms and signs are often more subtle and less severe, as a result of established collateral vessels. Nevertheless, the diagnosis can usually be made without difficulty. Impalpable pedal pulses in association with either absent Doppler signals, or an ankle:brachial pressure index less than 0.5 will confirm the diagnosis. The patient who develops an acutely ischaemic limb is typically elderly with significant co-morbidity, and therefore a careful history and detailed clinical examination is paramount.

HISTORY

Important aspects of the history include previous claudication, cardiac or cerebrovascular disease, a prior vascular procedure, or associated medical problems such as diabetes, hypertension and renal disease. A history of severe back pain may indicate an aortic dissection. The general fitness of the patient and the previous functional status of the limb should be determined.

EXAMINATION

Particular emphasis should be placed on the general condition of the patient and cardiovascular system (heart rate, rhythm and presence of murmurs). Abdominal palpation is performed to detect an aortic aneurysm. Careful examination of the peripheral pulses should be performed to exclude a popliteal aneurysm and detect pre-existing atherosclerosis. A full complement of pulses in the unaffected limb suggests an embolic cause.

SEVERITY OF ISCHAEMIA

The degree of ischaemia will dictate the urgency and nature of intervention, and has been conveniently classified into three grades based upon a careful clinical examination (*Table 2*). Grade I is a viable limb and grade III represents irreversible ischaemia.

INVESTIGATIONS

In this frail group of patients baseline blood tests, an electrocardiogram and chest radiograph are mandatory. Unless the limb is immediately threatened a preoperative anteriogram should be performed. Duplex scanning is becoming an increasingly useful adjunct to arteriography. It can detect aneurysmal disease, identify the site of occlusion and may demonstrate the distal run-off.

INITIAL MANAGEMENT

Early referral should be made to a vascular surgeon as prompt revascularization offers the only hope of limb salvage in many cases. Associated medical conditions such as dehydration, cardiac failure and arrhythmias are corrected and adequate analgesia given. Providing there are no contraindications a bolus of intravenous heparin (5000 iu) should be given to prevent propagation of clot and to protect any collateral circulation. A heparin infusion should be commenced to maintain an activated partial thromboplastin ratio of 2–2.5.

SUBSEQUENT MANAGEMENT

This will depend upon the degree of ischaemia and the frailty of the patient. Angiography should be performed if the limb is not immediately threatened (grade I and IIa). If the limb is threatened then surgical intervention should proceed without delay (grade IIb). A non-viable limb should be amputated without delay (grade III). Attempted revascularization may well be fatal as a result of the systemic release of toxic metabolites.

THERAPEUTIC INTERVENTION

Intervention may proceed by the endovascular route at the time of angiography or by open surgery.

THROMBOLYSIS

Catheter-directed thrombolysis may be performed when the limb is not in immediate danger (De Maioribus et al, 1993; Faggioli and Ricotta, 1993). The preferred agent is tissue plasminogen activator (TPA) which is given as an infusion via a catheter inserted into the thrombus. The condition of the limb should be closely monitored preferably on a high dependency facility and frequent angiography is performed to monitor lysis.

Thrombolysis has been advocated for use in acute embolism, native vessel thrombosis, graft thrombosis and thrombosis of a popliteal aneurysm. In thrombotic occlusions clot lysis usually reveals an underlying lesion which will require angioplasty, stent placement or surgical correction. Lysis of a thrombosed popliteal aneurysm will alleviate the acute ischaemia and

TABLE 2.
Classification system for acute limb ischaemia

Grade	Symptoms
I	Viable: not immediately threatened. No sensory loss or muscle weakness. Audible Doppler signal
IIa	Marginally threatened: salvageable if promptly treated. Minimal sensory loss with no muscle weakness. Arterial Doppler signal often inaudible
IIb	Immediately threatened: salvageable with immediate revascularization. Sensory loss with rest pain in more than the toes. Moderate muscle weakness. Arterial Doppler signal usually inaudible
III	Irreversible: major tissue loss or permanent nerve damage. Profound limb anaesthesia and paralysis. Arterial and venous Doppler signal inaudible

define the distal outflow, before performing a vein bypass to exclude the aneurysm. Thrombolytic agents are also a useful adjunct to surgery. They may be used intraoperatively to lyse distal clot that remains following balloon catheter embolectomy, or before surgical bypass to define the site for the distal anastomosis.

Successful lysis is reported to occur in about 70% of cases but many patients require further intervention to maintain vessel patency. Thrombolysis carries a significant risk of complications which include bleeding, stroke, renal failure and distal embolization. The latter results in deterioration of the limb and surgical salvage may be particularly difficult. Absolute contraindications to thrombolysis include active bleeding, coagulopathy, recent surgery (within 10 days) or intracranial malignancy. A recent consecutive series from a large American centre reported 30-day mortality, morbidity and major amputation rates of 4%, 30% and 9% respectively (Korn et al, 2001).

OTHER ENDOVASCULAR TECHNIQUES

Percutaneous aspiration thrombectomy and percutaneous mechanical thrombectomy are adjunctive techniques which have been used in isolation or with thrombolysis. These are not widely utilized and their role in the treatment of acute limb ischaemia has not been defined.

SURGERY

Immediate limb-threatening ischaemia requires surgical intervention. The surgical approach depends on the likely diagnosis.

Emboli

In suspected femoral emboli a balloon catheter embolectomy is performed via a groin incision. This procedure may be performed adequately under local anaesthesia in the frail elderly patient. An arteriotomy is made at the femoral bifurcation and the balloon catheter is passed proximally and distally. The embolus should be sent for histology to exclude an atrial myxoma. If brisk inflow and back bleeding occur following retrieval of clot the arteriotomy is closed. Reactive hyperaemia and restoration of the peripheral pulses confirm a successful outcome. If the foot does not improve then this suggests residual distal thrombus, and on-table angiography is performed to determine the site of occlusion. The arteriogram is performed with the inflow occluded using an umbilical feeding catheter (6F) inserted into the superficial femoral or profunda femoris artery. Thrombolytic agents may be given and are often successful in clearing distal thrombus that cannot be removed by further passage of the balloon catheter. If the tibial vessels are occluded, then exposure of the below-knee popliteal artery will allow selective embolectomy or intraoperative thrombolysis of each tibial artery. An image intensifier is essential to obtain good images and to assess the results of further intervention (Beard et al, 1993).

Thrombosis and graft thrombosis

In most cases of acute thrombosis the limb is not immediately threatened and there is usually time for angiography to fully assess the vascularity. If urgent surgery is required then on-table angiography is used to identify a suitable distal vessel for surgical bypass. In the absence of a femoral pulse it is often necessary to use the contralateral femoral or axillary artery as the inflow for an arterial graft. In cases of acute graft thrombosis it is often possible clear the occluded graft with a balloon catheter. An on-table angiogram is then performed to assess the distal anastomosis and graft run-off. Graft occlusion occurs as a result of progressive atherosclerosis proximal or distal to the graft, or as a result of intimal hyperplasia at the anastomoses. The cause of the graft occlusion must be corrected to restore and maintain patency.

REPERFUSION INJURY

Fasciotomy

Relief of prolonged severe ischaemia is frequently complicated by a reperfusion injury which is manifest as limb hyperaemia and oedema. Significant calf muscle oedema may result in the development of a compartment syndrome, which if unrelieved will lead to muscle necrosis and permanent nerve damage. Following revascularization the limb should be closely monitored, and if the calf muscles become tense, swollen and tender an immediate fasciotomy should be performed. Full-length medial and lateral incisions are made to decompress all four muscle compartments.

Systemic effects of reperfusion

Revascularization is followed by the systemic release of hydrogen ions, potassium ions, oxygen free radicals, inflammatory mediators and myoglobin. Acidosis and hyperkalaemia may result in cardiac arrhythmias, and therefore serum potassium and pH should be closely monitored, and if necessary corrected following reperfusion. The release of free radicals and inflammatory mediators may rarely precipitate non-cardiogenic pulmonary oedema and therefore the oxygen saturation should be measured regularly in the post-operative period. Myoglobin released from

ischaemic muscle may infrequently precipitate in urine leading to acute renal failure. Myoglobin will produce a red/brown discolouration of the urine and its presence can be confirmed by a laboratory assay. In the presence of myoglobinuria a forced alkaline diuresis should be maintained (>200 ml urine/hour) until all the myoglobin has be excreted.

OUTCOME

The overall mortality and limb loss following acute limb ischaemia is in the region of 15% which reflects the age and co-morbidity of this group of patients. Recent improvements in outcome have occurred primarily as a result of advances in medical management of critically ill patients, although better anaesthesia and improved surgical techniques have contributed. It is the authors' impression that cases of acute lower limb ischaemia are becoming less frequent and occurring in an increasingly elderly population. Although aggressive limb salvage should be attempted, many patients are in such a poor medical condition that a successful outcome is unlikely. The more liberal use of anticoagulants in patients with atrial fibrillation and the aggressive correction of atherosclerotic risk factors are likely to lead to a further future decline in the incidence of acute limb ischaemia. HM

Conflict of interest: none.

Beard JD, Nyamekye I, Earnshaw JJ, Scott DJA, Thompson JF (1993) Intraoperative streptokinase: a useful adjunct to balloon–catheter embolectomy. *Br J Surg* **80:** 21–4

De Maioribus CA, Mills JL, Fujitani RM at al (1993) A re-evaluation of intraarterial thrombolytic therapy for acute lower extremity ischaemia. *J Vasc Surg* **17:** 888–95

Faggioli GL, Ricotta JJ (1993) Thrombolytic therapy for lower extremity arterial occlusion *Ann Vasc Surg* **7:** 297–302

Fogarty TT (1963) Catheter technique for arterial emboli and thrombi. *Surg Gynecol Obstet* **116:** 241–4

Korn P, Khilnani NM, Fellers JC et al (2001)Thrombolysis for native arterial occlusions of the lower extremities: clinical outcome and cost. *J Vasc Surg* **33**(6): 1148–57

Transatlantic Inter-Society Consensus (2000) Management of peripheral vascular disease. *J Vasc Surg* **31:** 135–67

KEY POINTS

- Acute lower limb ischaemia remains a common vascular surgical emergency.
- It provides a major therapeutic challenge to the vascular surgeon and radiologist.
- Prompt diagnosis and treatment is critical for a successful outcome.
- Despite technical advances, the morbidity and mortality remain high as a result of co-existing disease.