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# Microtibial Embolectomy

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***Background:*** *microtibial embolectomy is an important technique in cases of limb threatening acute arterial occlusion affecting native crural and pedal vessels. It is particularly useful when thrombolysis is contraindicated or ineffective as in "trash foot".*
***Methods:*** *in order to evaluate the efficacy of this technique, a retrospective case note review was carried out for patients undergoing microtibial embolectomy from 1990 to 1999. Data collected included the causes and degree of ischaemia, additional procedures required, vessel patency, limb salvage and complications encountered.*
***Results:*** *twenty-two limbs underwent exploration of the crural/pedal vessels with ankle level arteriotomies under local anaesthetic in 12 cases, general anaesthetic in nine and epidural in one. The causes of ischaemia were cardiac emboli (8), "trash foot" (7), emboli from aortic and popliteal aneurysms (3) and thrombotic occlusion of crural vessels (4). The vessel patency rate was 69% and limb salvage rate 62% (13/21) up to 5-years follow-up. Six of the seven cases with "trash foot" were salvaged while one required an amputation at 3-months post-operatively. The 30-day mortality was 22% (5/22).*
***Conclusions:*** *microtibial embolectomy is effective in acute occlusion of the crural/pedal arteries including cases of "trash foot", offering limb salvage to a worthwhile proportion of cases.*

*Key Words: Microtibial embolectomy; Acute lower limb ischaemia.*

## Introduction

The optimal management of acute arterial occlusion of the crural and pedal vessels is not clear. Surgical thromboembolectomy, bypass reconstruction and percutaneous intra-arterial thrombolysis have been the mainstay of treatment with surgery being the procedure of choice in the severely ischaemic limb when immediate revascularisation is required or thrombolysis contraindicated.[1–4] Significant amounts of residual clot may remain in the crural vessels after transfemoral embolectomy in up to 30% of cases.[5] Blind selection of the anterior and posterior tibial arteries is notoriously difficult and the route of the Fogarty catheter tends to favour the peroneal artery in 89% of cases.[6,7] Methods for improving the removal of distal thrombus include popliteal trifurcation embolectomy and intra-operative thrombolysis, delivered either from the transfemoral, popliteal or ankle routes.[8–12] Both techniques, however, have potential drawbacks. The embolectomy catheter may not pass easily from the popliteal artery down the crural vessels. Thrombolysis may not be effective in the presence of old, well organised clot or athero-emboli originating from ruptured vessel wall plaque ("trash") and is contraindicated in certain situations. When these measures are excluded, embolectomy of the crural and pedal vessels via arteriotomy at ankle level may successfully retrieve clot in the crural or pedal vessels that is otherwise inaccessible. Although previously described, this technique has not been widely adopted or promoted. The present article describes our experience with "microtibial embolectomy".

## Methods

In order to evaluate the efficacy of this technique, we undertook a retrospective study of all patients

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undergoing exploration of the tibial vessels at the level of the ankle for acute ischaemia due to thromboembolism of the crural and pedal arteries between 1990 and 1999. Data was collected from patient case notes and included patient demographics, cause of ischaemia, procedural details (anaesthetic technique, vessels explored, method of closure of arteriotomy, concurrent bypass or proximal embolectomy) and use of adjuvant intra-arterial thrombolysis. Outcome measures were patency of the crural and pedal vessels, limb salvage and patient survival.

### *Surgical technique*

The anterior tibial, posterior tibial or both arteries were exposed by small separate ankle incisions and opened either transversely or longitudinally, using optical loupe magnification and a micro-knife. After forceps extraction of local thrombus, proximal and distal embolectomy was performed using a Size 2 balloon catheter, directed proximally to the popliteal trunk and distally into and if possible, around the pedal arch. Care was taken to partially deflate the balloon as it emerged from the arteriotomy in order to avoid splitting. Upon apparent completion of embolectomy (achieving back and down bleeding and signs of improved perfusion to the foot) the arteries were flushed with heparinised Hartmann's solution (10 units/ml), whilst papaverine solution (30 mg in 2 ml) was used as an intra-luminal and topical vasodilator. Adjunctive thrombolysis was indicated in cases of incomplete embolectomy, allowing microembolectomy to be repeated. This involved the local intra-arterial infusion of 30 000 units of streptokinase in 20 ml of saline proximally and distally. Streptokinase was used due to its availability in the operating department and lower costs as compared to tissue plasminogen activator. Other lytic agents may be used if there are contraindications to streptkoinase. Because of the small and delicate nature of crural and pedal arteries, increased care is required with the use of the balloon catheter to avoid overdistension and intimal injury. Rupture of these arteries is an avoidable complication. All operations were carried out under antibiotic cover and with a heparin infusion (1000 units/h), continuing peri-operatively. Longitudinal arteriotomy incisons were closed with small vein patches secured with running 6-0 or 7-0 polypropylene sutures and transverse arteriotomies were closed with interrupted 8-0 sutures. On de-clamping 30 mg of papaverine was injected distally to encourage vasodilatation and flow as assessed by insonation with an 8 MHz Doppler probe and by observing the colour of the foot.

Completion angiography was not routinely used; clinical estimation of the completeness of thrombus retrieval was judged by the adequacy of down and back bleeding and the restoration of colour of the foot. Imaging was only employed when it would influence surgical strategy.

### *Post-operative surveillance*

Regular clinical observation of the foot was the main determinant of success or failure. In addition, immediate post-operative assessment of vessel patency was carried out by palpation of foot pulses supplemented by hand held Doppler examination. In the majority, duplex ultrasound was used for vessel surveillance at regular intervals post-operatively. In one case, vessel patency was evaluated by measurement of ABPI earlier in the series, a drop of more than 0.1 prompting angiography for confirmation of patency.

## Results

Of 233 patients presenting as emergencies with acute ischaemia of the lower limb, twenty-two limbs (38 arteries) in 22 patients (median age 68 years, range 45–83) underwent micro-tibial embolectomy. Fourteen patients were male, 15 were smokers, 12 were being treated for hypertension, eight had ischaemic heart disease and one was being treated for cardiac arrythmias. The median time to presentation was 32 h (range 1 h–7 days). Ten patients presented with motor weakness and sensory loss (Rutherford Grade IIb) while the remaining 12 presented with sensory loss and rest pain alone (Grade IIa). Immediate surgery was carried out for 19 patients due to the need for urgent revascularisation or because they were judged unsuitable for percutaneous intra-arterial thrombolysis (trashfoot or specific contraindications) with the remaining three requiring surgery after failure to progress after initial treatment with thrombolysis.

### *Causes of acute ischaemia*

The heart was the commonest source for emboli (8), followed by "trash foot" complicating aorto-iliac reconstructive surgery in 7 cases (Table 1). Diagnosis was made in three cases on pre-operative angiography and following completion angiography after proximal thromboemboletomy in nine. In the seven cases of

**Table 1. Cause of acute ischaemia.**

| Cause | ($n = 22$) |
|---|---|
| Embolism | |
| Cardiac | 8 |
| Aorto-iliac surgery ("trash foot") | 7 |
| Abdominal aortic aneurysm | 2 |
| Popliteal aneurysm | 1 |
| Thrombosis | |
| Atherosclerosis | 4 |

**Table 2. Concurrent surgical procedures.**

| Procedure | $n$ |
|---|---|
| Embolectomy | |
| Femoral | 2 |
| Trifurcation | 5 |
| Femoral and trifurcation | 6 |
| Bypass | |
| Femoro-popliteal | 1 |
| Femoral-to-posterior tibial | 1 |
| Popliteal-to-pedal | 1 |
| Popliteal-to-posterior tibial | 1 |
| Posterior tibial-to-plantar | 1 |
| Others | |
| Common iliac angioplasty | 1 |
| Fasciotomy | 7 |

trash foot complicating aorto-iliac reconstruction and in the remaining three cases, the decision to explore the tibial arteries was made on clinical grounds.

*Procedural details*

Microtibial embolectomy was carried out under local anaesthetic in 12 cases, general anaesthetic in nine cases and epidural in one. Nine patients had microtibial embolectomy as the primary procedure. Concurrent procedures are listed in Table 2. The distal anastomosis for these were at the level of the popliteal artery in one, posterior tibial in two and pedal vessels in two (Table 2).

The anterior and posterior tibial vessels were explored in 16 cases and a single vessel in six cases (posterior tibial five; anterior tibial one). A transverse arteriotomy was used in 31 cases with a vein patch used to close a longitudinal arteriotomy in seven others. Adjunctive thrombolysis was used in 8 cases including one after "trash foot". Seven of the 22 patients required a fasciotomy to prevent compartment syndrome.

*Outcome*

A total of 38 vessels were explored at the level of the ankle joint (Fig. 1). Two of these were solid, due to occlusive atheroma, one requiring a bypass from the anterior tibial artery to the plantar artery. The other did not require further treatment since there was clinical improvement of perfusion of the foot upon successful embolectomy of the other tibial artery.

Twenty-three vessels remained patent after embolectomy in 13 limbs, all being salvaged with 1 patient dying from multi-organ failure 4 days post-operatively. Adjuvant intra-arterial thrombolysis was used in four of these 13 limbs. Six of the seven patients with "trash foot" following aorto-iliac surgery had their limbs successfully salvaged with one patient developing rest pain associated with a popliteal stenosis 3 months after the original procedure. Despite angioplasty, the vasculature was not reconstructable and amputation was required. One patient who had presented with compartment syndrome developed foot-drop despite fasciotomy, which resolved over 12 months. All other patients remained asymptomatic at follow-up.

There were 11 vessel re-occlusions in seven limbs that underwent microtibial embolectomy. Intra-arterial thrombolysis had been used in three of these limbs. All were not salvageable, requiring below-knee amputation. Two of these patients died before amputation and two others after the procedure, three deaths being due to cardiac causes and one from multi-organ failure. One limb remained non-viable despite successful embolectomy and patent dorsalis pedis post-operatively.

At a median follow-up of 6 months (range 6 weeks–5 years), the overall patency rate was 69% (25/36), limb salvage 62% (13/21) and 30-day mortality rate 22% (5/22). There were four minor wound infections requiring antibiotics. There was no significant post-operative bleeding.

## Discussion

Primary thrombo-embolic occlusion of the crural vessels is rare and it usually arises in conjunction with proximal thrombo-embolic occlusion. Traditionally revascularisation has comprised proximal surgical embolectomy, resorting to bypass when this fails, usually due to underlying occlusive disease. If clearance of the crural vessels is not successful from the femoral route, options include trifurcation embolectomy, intra-arterial thrombolysis or a combination of both in an attempt to reduce the dosage of lytic agent.

Trifurcation embolectomy is a straightforward procedure. Following dissection of the popliteal artery below the knee, all three crural artery origins are exposed, each of which can be individually catheterised via a single popliteal arteriotomy overlying

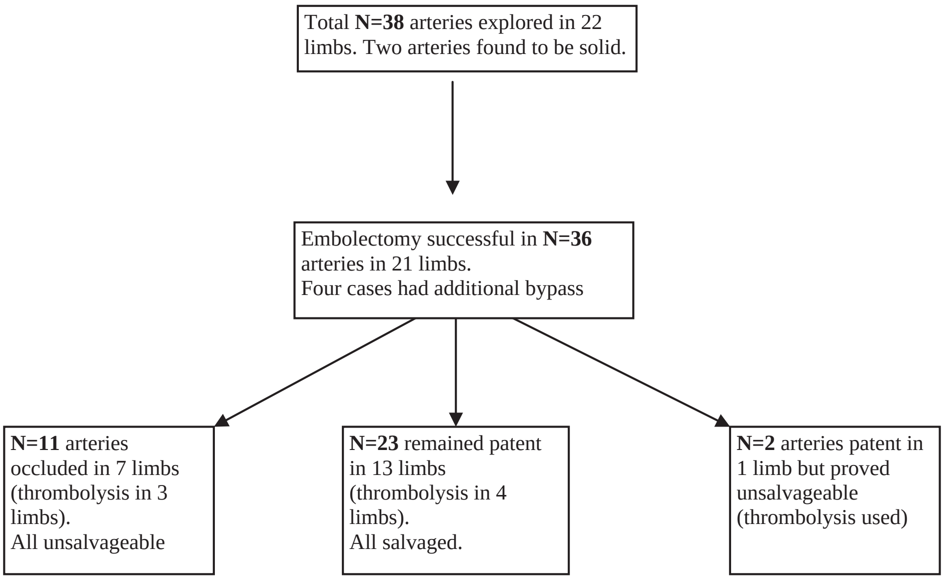


**Fig. 1.** Results of microtibial embolectomy.

the anterior-tibial origin. Vessel selection usually requires bending of the tip of the Fogarty catheter, then advancing and rotating it under vision. Whereas adequate peroneal thrombo-embolectomy is usually feasible from the popliteal trifurcation, it may prove difficult to advance the embolectomy catheter down the anterior or posterior tibial artery because of angulation or atherosclerotic disease. If this is the case and the limb remains ischaemic, microtibial embolectomy at the ankle should be considered. In cases of "trash foot", when popliteal and tibial pulses are palpable in the presence of a mottled, ischaemic foot, a direct approach to the ankle arteries is indicated. Early in this series we utilised a longitudinal tibial arteriotomy which had to be closed with a vein patch to preclude stenosis. We now prefer a transverse arteriotomy with interrupted closure, for its speed, simplicity and lack of complications. A small dose of adjunctive thrombolysis may be used after incomplete initial embolectomy, allowing successful embolectomy subsequently, with minimal risk of systemic bleeding.[9] Intra-operative lysis without embolectomy requires a higher dose of agent and hence carries a higher risk of bleeding. We did not experience any wound haematomas or systemic bleeding complications in the eight cases where local adjunctive lysis was employed.

Although percutaneous intra-arterial thrombolysis is an effective treatment for acute limb ischaemia, it cannot be considered as first-line treatment in all cases because of specific contraindications and patient co-morbidities. In an audit of the management of acute lower limb ischaemia by surgeons in the U.K. consisting of 539 cases, Campbell *et al*. reported a mortality rate of 19% after thrombolysis compared with a 6% mortality with surgical reconstruction.[13] Furthermore, Korn *et al*. reported a 30-day morbidity rate of 31%.[14] In addition, other studies have not shown an obvious economic benefit when comparing thrombolysis with surgery.[14,15] Primary thrombolysis was not considered in the majority of the cases in our series either because of the severity of the neurosensory deficit demanding rapid revascularisation or because of the risk of haemorrhage. In the causes of "trash foot" the embolic material consisted of atheromatous debris and organised thrombus that would have resisted lysis.

Beard *et al*.[10] described the use of adjunctive thrombolysis from the popliteal route after unsuccessful popliteal embolectomy in 14 tibial occlusions using 100 000 u of streptokinase. However, those with "trash foot" did poorly with this technique and the limb salvage rate quoted of 75% was the overall figure for the series of 31, which included 17 limbs with acute occlusion of the femoro-popliteal segment only. Knaus *et al*.[12] described delivery of 375 000 u of urokinase in to the crural vessels in combination with suction, from trifurcation arteriotomies after inflow (femoro-popliteal) embolectomy alone. In addition, two cases of "trash foot" underwent successful thrombolysis delivered from both ankle and trifurcation arteriotomies. Although the series of 25 included two with profunda artery occlusion only, the 2-month limb salvage rate was impressively 86%. Of note a high proportion required subsequent interventions (15 bypass, three angioplasty). Wyffels *et al*.[16] reported salvage of all 12 limbs who underwent ankle level embolectomy combined with intra-operative lysis (in those with a poor back bleed), which was continued in 10 cases post-operatively via a catheter introduced at the level of the ankle.

Novel endovascular techniques such as accelerated thrombolysis and aspiration embolectomy also show promise. Using the latter technique, Desgranges *et al*.[17] reported a limb salvage rate of 91% at 1-month in a series of 33 limbs of which 23 were tibial occlusions and six had a non-threatened limb (Rutherford grade I). The technical success rate for the procedure was 82% with 18% also requiring thrombolysis. Of note, there were five cases of groin haematoma and four of compartment syndrome. Sophisticated endovascular methods of thrombus retrieval demand a degree of radiological expertise and technical support that may not be available on a 24-h emergency basis. Much of the published experience with these techniques derives from thrombo-embolic episodes during planned interventions rather than in the emergency context.

As emphasised by one case in our series, despite successful clearance of crural vessels and pedal vessels with either embolectomy catheter or lytic agent, a severely ischaemic limb may at times remain ischaemic due to microvascular and arteriolar thrombosis (no re-flow). Law *et al*.[11] reported limb salvage in three out of four cases using continued post-operative thrombolysis in limbs with no re-flow following occlusion of crural bypass grafts. The catheter was introduced surgically from a side branch of the occluded vessel, distal to the anastomosis. However, a significant proportion had bleeding complications from the operated limb, requiring blood transfusion.

In conclusion, microtibial embolectomy remains an effective alternative to intra-operative thrombolysis for acute crural or pedal arterial occlusion, offering the potential for limb salvage to a worthwhile proportion of patients. It is a relatively, quick and simple procedure that can be performed in conjunction with proximal embolectomy or emergency bypass reconstruction, if necessary under local anaesthesia.[18] It remains the procedure of choice in cases of trash foot and when primary or intra-operative thrombolysis is contraindicated and we suggest it has a place within the armamentarium of all vascular surgeons.

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