

## ROLE OF SMALL VESSEL THROMBO-EMBOLECTOMY IN LOWER LIMB SALVAGE AND ITS CLINICO PATHOLOGICAL SPECTRUM IN ACUTE LIMB ISCHEMIA

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(Received, 27<sup>th</sup> June 2024, Revised 10<sup>th</sup> October 2024, Published 31<sup>st</sup> October 2024)

**Abstract:** Acute limb ischemia (ALI) is a vascular emergency where prompt intervention is crucial to salvage the limb. The standard treatment window is within 6 hours; beyond this period, the limb is presumed to suffer irreversible ischemic damage. However, surgical interventions like retrograde thrombo-embolctomy offer hope for limb salvage even in delayed presentations. This study investigates the efficacy of retrograde thrombo-embolctomy in small distal vessel occlusions due to thrombus or embolus in patients presenting after the 12-hour mark. **Objective:** To report the patients who presented to us beyond the 6-hours mark, beyond which the limb is presumed to have developed irreversible ischemic changes. The efficacy of retrograde thrombo-embolctomy in distal small vessel occlusion secondary to thrombus or embolus in delayed presentation of ALI was also evaluated. **Methods:** Thirty-five cases presented with acute limb ischemia for more than 12 hours. All Rutherford Grade IIa, IIb were included in the study. A prospective cross-sectional study was conducted and intra-operative findings, outcomes, post-operative complications were noted. All selected patients were operated by open surgery approach consisting of CFA thrombectomy and retrograde PTA/ATA Thrombo-embolctomy at ankle depending on thrombus site. **Results:** The study demonstrated a 97.1% success rate in limb salvage and functionality over 6 months follow-up. One patient had a major complication of re-thrombosis for which a repeat procedure was done. Four patients developed minor complications such as wound infection, ray amputation, needing wound debridement. **Conclusion:** Surgical intervention is possible for acute ischemic limb with delayed presentation (>12 hour). An open surgical approach is a safe and reliable option in such patients. However, further research is needed with a wider study population to actually see benefits of surgical intervention in delayed ALI presentation.

**Keywords:** Acute limb ischemia, Embolctomy, Surgery, Thrombus.

### Introduction

Acute limb ischemia (ALI) is a frequent complication of vascular surgery occurring 14 patients in every 100,000 patients annually with a high mortality rate of 10-25%. (1) The prognosis is poor even when diagnosed early with a death rate of up to 66% in the first month. (2) ALI is clinically diagnosis and can present as pain, pallor, paresthesia, paralysis and pulselessness in the limb. It can be treated based upon radiography, physical assessment and Rutherford grading. (3)

Unfortunately, the prognosis for ALI from thromboembolism remains poor even with early intervention; the 30-day mortality rate reaches 0%–66%. Surgical management of ALI includes thrombo-embolctomy, bypass surgery, patch angioplasty and intraoperative thrombolytic therapy. (4) Poor outcomes of ALI result due to delayed diagnosis and incomplete restoration of arterial perfusion as it is difficult to remove thrombi completely due to surgical approach or instruments. (5) Apart from delayed diagnosis and treatment, reason for a poor outcome is the incomplete restoration of perfusion in arteries below the knee due to propagation of the thrombi, which are difficult to remove via an antegrade approach from the common femoral artery (CFA). (4) It is difficult to completely remove the thrombus present within the tibial artery, mostly anterior tibial artery (ATA), because of the difficulty of passage of the embolctomy catheter or guidewire into the tibial artery. Hence, distal pedal access and retrograde passage is under-

utilized and effective option to overcome this disadvantage. The retrograde approach can also be used in upper limb via radial and ulnar arteries. (5) In our set up patients usually present after 1 week or later after initial symptoms, they were usually on simple analgesia and anti-platelets. To summarize, there were two problems that needed to be addressed in our center; the delayed presentation of ALI and incomplete restoration of perfusion in below-the-knee (BTK) arteries mostly induced by propagation of the thrombi, which are difficult to remove via an antegrade approach from the transfemoral (CFA).

The aim of this study to report the patients who presented to us beyond the 6-hours mark, beyond which the limb is presumed to have developed irreversible ischemic changes. The efficacy of retrograde thrombo-embolctomy in distal vessel occlusion secondary to thrombus or embolus in delayed presentation of ALI was also evaluated.

### Methodology

A prospective, cross-sectional study conducted at the Department of Vascular Surgery, Doctors Hospital and Medical Center, Lahore, from September 01, 2022 to August 31, 2023. This study targeted patients who underwent antegrade thromboembolctomy at CFA and retrograde thrombectomy/embolctomy of the lower extremities ATA/PTA at ankle level. Non-probability, convenience sampling was used to select the patients according to defined inclusion and exclusion criteria. All

[Citation: Nasir, M., Sadiq, I., Mushtaq, A., (2024). Role of small vessel thrombo-embolctomy in lower limb salvage and its clinico pathological spectrum in acute limb ischemia. *Biol. Clin. Sci. Res. J.*, 2024: 1187. doi: <https://doi.org/10.54112/bcsrj.v2024i1.1187>]



patients, irrespective of age suffering from acute limb ischemia of lower limb for more than 12 hours; patients satisfying Rutherford class IIa and IIb were included in study. Thrombus in posterior tibial/anterior tibial artery on CT angiogram Patients who required amputation and Patients with Rutherford class I and III, trauma/iatrogenic injury and patients with chronic limb ischemia were excluded from study. All patients provided their consent to be included in the study. Ethical board of the hospital approved the study.

Patient's data including comorbidities, age, gender, presenting signs and symptoms like pain, coolness, sensory and motor deficit and color change were recorded. After history/examination and CT angiography of both lower limbs, the patients were shifted to theater and surgery was performed under spinal/general anesthesia.

Patients were first explored from groin vertical incision and femoral thrombectomy was performed. ATA and PTA were explored at the ankle region and retrograde thrombo-embolectomy was performed (Figure I & II). The patients were operated by the same surgical team consisting of two vascular surgeons, one operation theater staff, one operation theater assistant. 2, 3, 4 Fr Fogarty Catheter was used to revascularize. On table completion angiography was done. Calf and foot were examined immediately after revascularization to assess the need for fasciotomy. A hand-

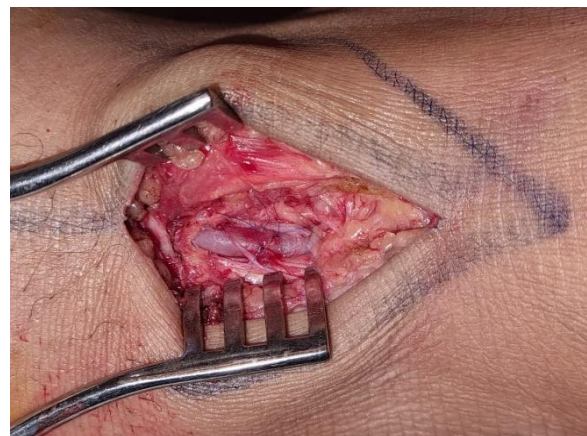
held doppler was used to confirm the restored blood supply. If the calf gave a tense and turgid feel, the surgeon proceeded with standard four compartment fasciotomy. Bypass was considered in the cases of failed negotiation of Fogarty catheter and failed establishment of blood flow on either proximal or distal side of arteriotomy during embolectomy.

Postoperatively the circulation of distal limb was assessed by palpation of distal pulses, capillary refill and with hand held Doppler. Post operatively, all the patients were closely monitored regarding the state of circulation of distal limb (presence of distal pulses, capillary refill and the temperature) wound hematoma, compartment syndrome, signs of secondary hemorrhage and reperfusion injury. Injection enoxaparin subcutaneously continued postoperatively for 3 to 4 days followed by oral anticoagulant therapy with rivaroxaban for 3 months or more depending upon the cause of ALI.

Data regarding patient's demographics, presenting features, pre-operative investigations, peri-operative findings, post-operative complications was collected via Google Forms (Google Inc., USA). Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, Version 24, USA) was used to analyze the data in terms of measures of central tendency, percentage and frequency and charts were generated for comparison.



**Figure I:** PTA exploration at ankle



**Figure II:** ATA exploration at ankle

## Results

Among the 35 respondents, 54.28% (19) were male and 45.72% (16) were female (Figure III). The mean age was 51.8 years, with patients ranging from 25 to 79 years (Table I). Various co-morbidities were observed prior to surgery, with diabetes mellitus and hypertension being the most prevalent at 29.51% each, followed by ischemic heart disease at 16.39%. Limb involvement was predominantly left-sided in 57.1% of cases, right-sided in 40%, and bilateral in 2.9% (Table II).

The most frequently affected vessels were the posterior tibial artery (32.6%), femoral artery (30.2%), and anterior tibial artery (24.4%). Native arterial thrombosis was the most common cause of acute ischemia, affecting 85.7% of patients, while 14.3% had arterial embolism secondary to thrombosis elsewhere. Acute limb ischemia was nearly

equally distributed between Grade 2A (51.4%) and Grade 2B (48.6%). In terms of surgical interventions, 48.5% (17 patients) underwent combined thromboembolectomy of the common femoral artery (CFA) and posterior tibial artery (PTA), 40% (14 patients) had thromboembolectomy of the CFA, anterior tibial artery (ATA), and PTA, and 11.4% (4 patients) underwent thromboembolectomy of the CFA and ATA (Table III).

Re-thrombosis or occlusion of the superficial femoral artery (SFA) occurred in 2.85% (1 patient), necessitating a repeat procedure. Postoperative minor complications, such as wound infections, were observed in 11.42% (4 patients), while 5.7% (2 patients) required wound debridement. Unfortunately, one patient (2.85%) ultimately required a below-knee amputation

To summarize, the study demonstrated a 97.1% success rate in limb salvage and functionality over 6 months follow-up. One patient had major complication of re-thrombosis for

which repeat procedure was performed. Four patients developed minor complication such as wound infection, needing wound debridement.

### Gender of patients

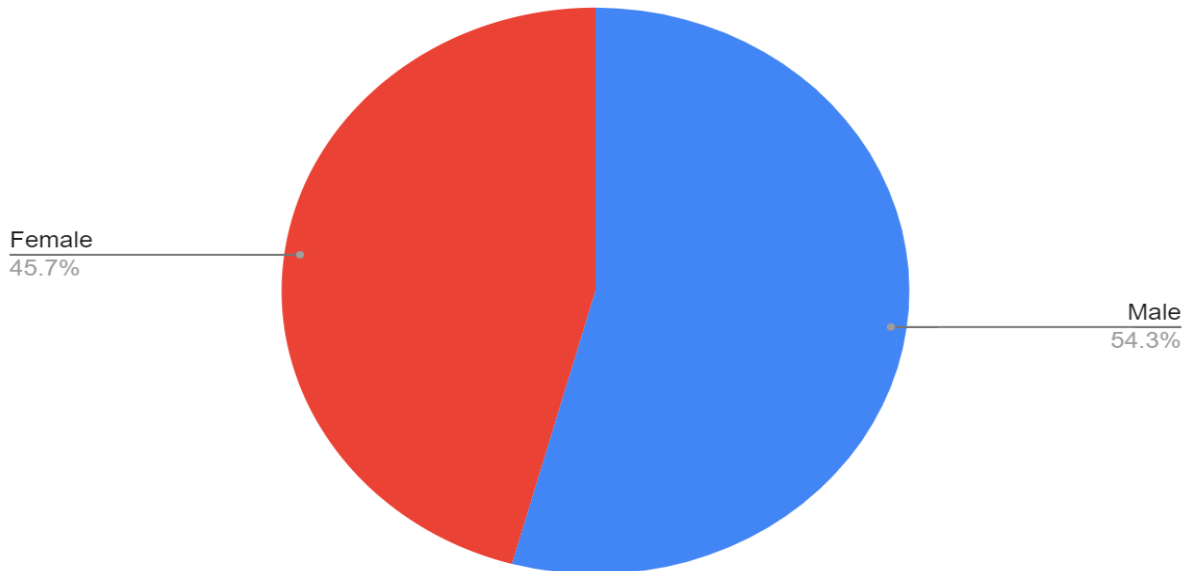


Figure III: The Gender distribution of the patients with percentage

Table I: The Mean age of adults with the standard deviation

SR	Adults	Mean	SD
1	Ages	51.81	15.96

Table II: The Co-morbidities of patients with the frequency and percentage.

SR.	Comorbidities	Frequency	Percentage
1	Diabetes Mellitus	18	29.51
2	Hypertension	18	29.51
3	Ischemic Heart Disease	10	16.39
4	Smoker	5	8.20
5	Heart Failure	3	4.92
6	Cerebrovascular Accidents	2	3.28
7	Atrial Fibrillation	1	1.64
8	Hepatitis C	1	1.64
9	Hyperlipidemia	1	1.64
10	Hyperuricemia	1	1.64
11	Ulcerative Colitis	1	1.64

Table III: The frequency of arterial involvement in patients

SR	Arteries Involved	Frequency	Percentage
1	Posterior Tibial	28	32.6 %
2	Femoral	26	30.2 %
3	Anterior Tibial	21	24.4 %
4	Popliteal	9	10.5 %
5	Brachial	1	1.16 %
6	Radial	1	1.16 %
	Total	86	100 %

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## Discussion

ALI is a dire surgical emergency with impending loss of extremity unless timely intervention is done. The purpose of study was to address which patients are candidates of delayed intervention and is retrograde open surgical approach feasible in distal vascular occlusion. To date, only a handful of studies have been published in local and international journals regarding the success of this surgical technique.(6, 7)

As highlighted before, the golden period to treat ALI is 6-hour. Siddique et al. conducted a study in Combined Military Hospital, Rawalpindi in which 49 patients were included who underwent embolectomy in delayed ALI (between 6-72 hours). They demonstrated an 85.7% success in limb salvage.(8) A study conducted in Hungary showed that patients presenting at different times to hospital and undergoing embolectomy (between less than 24 hours to more than 1 week), a success rate of 88.1 % and 82.6% in upper and lower limb was demonstrated.(9) This is comparable to our study, although a lower sample size. Our study showed a 97.1% success rate with only one patient needing repeat surgery and one patient required amputation despite intervention. Although the evidence in previous literature is scanty, it is a promising study which proposes that intervention is still possible beyond the 6-hours mark.

The open surgical approach of retrograde embolectomy at ankle region for ATA/PTA is safe, reliable and ensure complete thrombus/ embolus removal which may not be possible via antegrade approach. A case series conducted in Chang Gung Memorial Hospital demonstrated a 100% success rate in limb salvage after retrograde embolectomy.(10) Cho et al. in his case report, combined both antegrade and distal retrograde access for complete removal of thrombus.(11) Korosoglou et al. described a hybrid operative thrombectomy technique combining endovascular and operative aspects to maximize thrombus resolution and comparing it with percutaneous techniques.(12) In our setting, patients presented with varying levels of arterial occlusive disease. However, both clinical and radiological assessments consistently revealed distal vascular involvement, prompting retrograde embolectomy/thrombectomy in every case. This highlights the importance of not only restoring patency in medium to large arteries but also addressing distal vasculature. The 100% success rate emphasizes the importance of ensuring distal vascular patency, with open retrograde surgical intervention proving to be the definitive treatment approach for these patients.

As with our study and previous emerging reports about delayed intervention in ALI, It is inevitable to mention the role of collateral circulation of the extremities. It is still an enigma as to why some affected limbs survive ischemic insults longer than others and how and why collateral develop more in some ischemic limbs or open up during period of ischemia. A study was conducted in which cadaveric limbs were dissected.(13) The study came to a conclusion that lower limbs collateral channels are extremely uncommon and with normal and abnormal anastomosis. Certain studies suggest the role of Nitric oxide in development of collateral circulation in mice.(14) Although similar effects are seen in human but no study is conducted to correlate the factors leading to development of collateral circulation and its effectiveness in ALI. In our

study, CT angiogram showed development of adequate collaterals which could be explained by ongoing chronic ischemia secondary to co-morbid conditions of patients. Why Posterior tibial (PT) and Anterior tibial (AT) arteries exposure at ankle? These areas of access are preferred cut down sites for Fogarty embolectomy in the setting of calf and foot thrombosis rather than the below-knee popliteal artery. Access of the distal AT and PT allow for passage of a 2 Fr Fogarty embolectomy balloon proximally to the popliteal artery, and distally through the pedal arch, with less risk of further embolization to the foot and avoids popliteal fossa hematoma in an anticoagulated patient. There are certain limitations of study that need to be discussed. Firstly, this is an experience of a single center. Secondly, the sample size is relatively low to provide a strong evidence of efficacy of study. Thirdly, the follow-up is limited upto 6 months. For long-term assessment, the patients should be followed at least 2 years post-operative. Lastly, majority of data in on lower extremity. It is difficult to interpret effectiveness of procedure on upper extremity.

## Conclusion

Surgical intervention is possible for acute ischemic limb with delayed presentation (>12 -hour). An open surgical approach is a safe and reliable option in such patients. However, further research is needed with a wider study population to actually see benefits of surgical intervention in delayed ALI presentation.

## Declarations

### Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

### Ethics approval and consent to participate.

Approved by the department Concerned. (IRB-DCHP-003/23)

### Consent for publication

Approved

### Funding

Not applicable

### Conflict of interest

The authors declared an absence of conflict of interest.

### Authors Contribution

**MUHAMMAD NASIR (Vascular fellow)**

*Final Approval of version & Data Analysis*

**ILYAS SADIQ (Professor of Vascular Surgery)**

*Revisiting Critically*

**ADEEL MUSHTAQ (Registrar Vascular Surgery)**

*Drafting, Concept & Design of Study*

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