

# Acute Limb Ischemia Due to Arterial Occlusion: Surgical Treatment Outcomes and Associated Factors

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**Abstract**— The research aimed to analyze the outcomes of surgical treatment for acute limb ischemia (ALI) due to arterial occlusion and to identify factors influencing these results. A retrospective, cross-sectional descriptive study was conducted on 67 patients with 76 ischemic limbs treated at Thong Nhat Hospital (Ho Chi Minh City, Vietnam). The majority of cases involved occlusion of the lower limbs (85.53%), with upper limb occlusions comprising 14.47%. Early outcomes observed within 7 days after surgery showed a 75% rate of limb preservation, a 15.79% rate of primary amputation, and a 6.58% rate of secondary amputation. Notably, no cases of upper limb occlusion required amputation. Key factors impacting early postoperative results included the severity of ischemia upon admission, the duration of ischemia, and the location of the arterial occlusion ( $p < 0.05$ ). Despite advancements, the amputation rate for acute arterial occlusion remains considerable, emphasizing the importance of these prognostic factors.

**Keywords**— Acute limb ischemia; ALI; surgical treatment; prognostic factors.

## I. INTRODUCTION

Acute limb ischemia (ALI) is a critical vascular emergency that requires immediate hospitalization, prompt diagnosis, and urgent intervention to prevent irreversible tissue damage and potential limb loss. Delays in treatment can lead to severe complications, including permanent neurological deficits, gangrene, and systemic complications such as metabolic acidosis, multi-organ failure, and death. The condition is most commonly caused by arterial embolism or thrombosis, often associated with underlying cardiovascular disease, trauma, or hypercoagulable states.

A major breakthrough in the management of ALI occurred in 1963 with the introduction of the Fogarty balloon catheter thrombectomy technique, which revolutionized the surgical approach to arterial occlusion [1]. Since then, advancements in vascular surgery, endovascular techniques, and perioperative management have significantly improved patient outcomes. These developments have made surgical treatment of acute limb arterial occlusion more effective, reducing the complexity of procedures while improving limb salvage rates and overall survival. However, despite these advancements, the rates of postoperative mortality and limb amputation remain high, ranging from 10% to 25% in various studies. These unfavorable outcomes are often attributed to delayed presentation, severe ischemic damage at the time of intervention, and the presence of comorbid conditions.

Recent clinical observations in hospitals worldwide, and particularly at Thong Nhat Hospital, suggest a growing number of ALI cases due to arterial occlusion, with increasingly diverse underlying causes [3]. Unlike vascular trauma, which accounts for approximately 2% of total surgical emergencies and has generally favorable treatment outcomes [2], ALI remains a challenging condition with variable results, even with timely intervention. The complexity of ALI treatment stems from multiple factors, including the severity of ischemia at presentation, the location of the arterial

occlusion, the presence of underlying atherosclerosis or embolic sources, and the patient's overall health status.

While several studies have examined ALI affecting either the upper or lower limbs separately, a comprehensive evaluation encompassing both anatomical regions is still lacking in Vietnam. To address this gap, we conducted this study with the aim of providing a thorough assessment of ALI cases at Thong Nhat Hospital. Specifically, our study sought to: 1. Evaluate the treatment outcomes of ALI due to arterial occlusion at Thong Nhat Hospital; 2. Analyze key prognostic factors that influence treatment success and limb salvage in patients with ALI. By identifying these factors, we hope to contribute to the optimization of treatment strategies, reduce amputation rates, and improve overall patient survival.

## II. SUBJECTS AND METHODS

### A. Study Population

This study included all patients diagnosed with ALI involving either the upper or lower extremities due to arterial occlusion who underwent surgical treatment at Thong Nhat Hospital between January 2023 and December 2024. The inclusion criteria encompassed all cases regardless of age, gender, or occupation. However, only medical records with complete and relevant clinical data necessary for analysis were considered eligible for inclusion in the study. Patients with incomplete records, those lost to follow-up, or those who received conservative management without surgical intervention were excluded.

### B. Study Design and Data Collection

This was a retrospective, cross-sectional, descriptive study employing a convenient sampling method. The data were collected from hospital records, including preoperative assessments, intraoperative findings, and postoperative outcomes. Each patient's clinical presentation, diagnostic findings, surgical interventions, and early postoperative outcomes were systematically recorded using a standardized

medical record template. The collected data included demographic characteristics, time from symptom onset to hospital admission, the severity of ischemia, the location of arterial occlusion, surgical procedures performed, and immediate postoperative results.

*C. Data Processing and Analysis*

Following data collection, all relevant information was coded, entered, and analyzed using SPSS 18.0 statistical software. Descriptive statistics were used to summarize patient characteristics and treatment outcomes, while inferential statistical tests were performed to assess relationships between key clinical factors and surgical results. Statistical significance was set at  $p < 0.05$ .

III. RESULTS

*A. Early Postoperative Outcomes*

Among the 76 affected limbs, 64 (84.21%) achieved restored circulation. The most common procedure was thromboembolectomy combined with fasciotomy (42.11%). Only three patients underwent thromboembolectomy with bypass grafting. Primary amputation was performed in 12 cases (15.79%).

TABLE 1. Early postoperative results

Early Results	Number of Limbs	Percentage (%)
Limb Preservation	57	75
First Stage Amputation	12	15.79
Second Stage Amputation	5	6.58
Death	0	0
Discharge on Request	2	2.63

Table 1 presents early postoperative outcomes for 76 limbs affected by ALI due to arterial occlusion. A significant 75% of the cases (57 limbs) resulted in limb preservation, reflecting the effectiveness of timely surgical interventions. However, 15.79% (12 limbs) required a first-stage amputation, and 6.58% (5 limbs) underwent a second-stage amputation due to the progression of ischemia or necrosis despite initial treatments. Notably, there were no deaths among the patients, which highlights the success of the surgical approach, although two patients (2.63%) chose to discharge themselves against medical advice. These results suggest that while most patients benefited from limb-saving procedures, a smaller proportion still required amputation, underscoring the challenges in treating ALI.

TABLE 2. Early postoperative outcomes by location of arterial occlusion

Outcome	Location
Limb Salvage	Upper Limb: 11 (14.47%), Lower Limb: 46 (60.53%)
Amputation (Stage 1)	Upper Limb: 0 (0%), Lower Limb: 12 (15.79%)
Amputation (Stage 2)	Upper Limb: 0 (0%), Lower Limb: 5 (6.58%)
Death	Upper Limb: 0 (0%), Lower Limb: 0 (0%)
Discharge Against Medical Advice	Upper Limb: 0 (0%), Lower Limb: 2 (0%)

Table 2 shows the early postoperative outcomes based on

the location of the arterial occlusion. The results reveal that the majority of patients with upper limb ischemia (14.47%) had their limbs preserved, with no amputations or deaths. In contrast, for lower limb ischemia, 60.53% of patients had limb preservation, but 15.79% required first-stage amputations and 6.58% required second-stage amputations. Interestingly, no fatalities were recorded, and only 2 patients with lower limb ischemia (0%) discharged themselves against medical advice. Overall, upper limb ischemia had better outcomes in terms of limb preservation, while lower limb ischemia had a higher rate of amputations.

TABLE 3. Correlation between early postoperative outcomes and the location of arterial occlusion in the upper and lower limbs on Doppler ultrasound (excluding 2 cases of discharge against medical advice)

Location	Limb preservation (%)	Amputation (%)	p-value
Upper Limb	11 (14.9%)	0 (0%)	p = 0.044 ( $< 0.05$ )
Lower Limb	46 (62.1%)	17 (23.0%)	

Table 3 presents the relationship between early postoperative outcomes and the location of arterial occlusion in both upper and lower limbs. For the upper limb cases, all 11 patients (14.9%) had their limbs preserved, with no amputations required. In contrast, for lower limb cases, 46 limbs (62.1%) were preserved, but a substantial number, 17 limbs (23.0%), required amputation. The results showed a statistically significant difference between the two groups, with a p-value of 0.044 ( $p < 0.05$ ), indicating that the location of the occlusion significantly impacts the treatment outcome. Specifically, lower limb occlusions have a higher likelihood of leading to amputations compared to upper limb occlusions.

*B. Clinical Stages of ALI*

TABLE 4. Clinical stages of ALI

Clinical stage of ALI	Number of limbs	Percentage (%)
IIa: Limb at risk (borderline)	15	19.74%
IIb: Limb at risk (immediate)	49	64.47%
III: Irreversible	12	15.79%

Table 4 presents the clinical stages of ALI among the 76 limbs in the study. The majority of the limbs (64.47%) were classified under Stage IIb, indicating that they were at immediate risk of irreversible damage. This stage typically refers to limbs showing significant ischemia with potential for immediate intervention. A significant portion, 19.74%, fell under Stage IIa, which represents limbs at the borderline of being at risk, with potential for recovery if promptly treated. Only 15.79% of the limbs were classified as Stage III, indicating irreversible ischemia, where no recovery was possible, and amputation may be required. This distribution highlights that most cases were in the more treatable stages (IIa and IIb), with a smaller percentage reaching irreversible damage (Stage III).

Table 5 presents the correlation between early postoperative outcomes and the clinical degree of limb ischemia in 74 cases, excluding 2 patients who left without evaluation. The table shows the relationship between limb preservation and amputation in different stages of ischemia. In

stage IIa (threatened limb, borderline), all 15 limbs (20.27%) were preserved, and none required amputation (0%). This group showed a favorable outcome with no amputations. For stage IIb (imminent threat to the limb), 42 limbs (56.76%) were preserved, but 5 limbs (6.76%) underwent amputation (either stage 1 or stage 2). Finally, in stage III (irreversible ischemia), none of the limbs were preserved (0%), and 12 limbs (16.21%) required amputation. The p-value of 0.00 (<0.05) indicates a statistically significant relationship between the degree of ischemia and the likelihood of limb preservation or amputation. The severity of ischemia (as assessed by clinical staging) directly influenced the treatment outcomes, with more severe stages (III) leading to a higher rate of amputation, while less severe stages (IIa and IIb) had a higher chance of limb preservation.

TABLE 5. Correlation between early postoperative outcomes and the clinical degree of limb ischemia (excluding 2 cases of severe patients who left without evaluation)

Stage	Limb preservation	Amputation (Stage 1 + Stage 2)	p-value
IIa	15 (20.27%)	0 (0%)	p = 0.00 (< 0.05)
IIb	42 (56.76%)	5 (6.76%)	
III	0 (0%)	12 (16.21%)	

### C. Time from Symptom Onset to Surgery

Among the 76 affected limbs diagnosed with acute arterial occlusion, the majority (60.53%) underwent surgery more than 24 hours after symptom onset. Only one case (1.31%) received surgery within six hours. The average ischemia duration was  $2.29 \pm 2.06$  days, ranging from a minimum of six hours to a maximum of 208 hours (6.67 days).

TABLE 6. Correlation between early postoperative outcomes and duration of ischemia

Duration of ischemia	Limb preservation	Amputation (Stage 1 and Stage 2)	p-value
< 24 hours (n=28)	25 (33.8%)	3 (4.1%)	p = 0.044 (< 0.05)
≥ 24 hours (n=46)	32 (43.2%)	14 (18.9%)	

The limb preservation rate was significantly higher in patients who underwent surgery within 24 hours compared to those who received treatment after 24 hours. This difference was statistically significant ( $p = 0.044$ ). Notably, no amputations were required in cases where surgery was performed within six hours. Most amputations (10 out of 12 cases) occurred in patients with ischemia lasting longer than 24 hours.

## IV. DISCUSSION

### A. Early Surgical Treatment Outcomes

Among the 76 affected limbs diagnosed with ALI due to arterial occlusion, 57 limbs (75%) were successfully preserved. These cases were primarily in the early stages of ischemia, with a shorter duration of ischemia. This result is consistent with other studies. Dang Hanh Son reported a limb preservation rate of 61.36% [3]. In Do's study, the limb preservation rate was 96.7% when ischemia lasted less than 12

hours, but it dropped to 51% when ischemia lasted more than 24 hours [4]. Ilic et al. reported a limb preservation rate of 77.7% [5].

Out of 67 patients with 76 affected limbs, 17 cases (22.35%) required partial limb amputation. Among these, 12 cases (15.79%) underwent planned amputation before surgery, while 5 cases (6.58%) required secondary amputation due to unresolved ischemia after thrombectomy. Dang reported a limb amputation rate of 34.1%, with 31.82% of cases undergoing pre-planned amputation and only one case requiring secondary amputation [3]. In Do's study, the amputation rate was 11.6% [4]. Other studies reported varying amputation rates: Currie et al. (21.6% in 2007) [6] and Ilic et al. (10.3%) [5]. Amputation of necrotic tissue helps prevent systemic infection and toxic complications caused by the release of anaerobic metabolic byproducts into the bloodstream.

No in-hospital deaths were recorded in our study. However, two critically ill patients (2.63%) opted for discharge against medical advice. Dang reported a combined mortality and discharge-against-advice rate of 4.55% [3]. The mortality rate in Do's study was 15.9% [4], while Ilic et al. reported a 12% mortality rate [5]. Previous studies suggest that mortality is associated with comorbidities such as heart failure, myocardial infarction, arrhythmias, stroke, diabetes, hypertension, and cancer, explaining the variability in reported outcomes.

### B. Factors Influencing Treatment Outcomes

In our study, 60.53% of cases presented for surgery after more than 24 hours. Similarly, Do's study at Viet Duc Hospital reported that 57.1% of cases arrived late (after 24 hours) [4]. A significant association ( $p = 0.044$ ,  $p < 0.05$ ) was found between the time from symptom onset to surgery and treatment outcomes. The amputation rate was 4.1% in patients treated within 24 hours but increased to 18.9% in those treated after 24 hours. Bates et al. reported that 75% of patients with ischemia lasting less than 12 hours had favorable outcomes, whereas this rate dropped to 37% in cases of ischemia lasting more than 12 hours [7]. Do found that if surgery was performed within 12 hours, the mortality rate was 3.5% and the limb preservation rate was 96.6%. However, if surgery was delayed beyond 24 hours, the mortality rate increased to 19.6%, and the limb preservation rate dropped to 51% [4]. Dang's 2001 study reported no amputations when surgery was performed within 12 hours, but a 43.6% amputation rate when surgery was delayed beyond 12 hours [3].

Our study demonstrated a significant correlation between early surgical outcomes and the clinical severity of limb ischemia ( $p = 0.00$ ). In the stage IIa group (mild sensory impairment or no neurological symptoms), no patients required amputation. In contrast, the amputation rate was 6.76% in the stage IIb group (significant sensory loss and muscle weakness) and 16.21% in the stage III group (tissue necrosis and joint rigidity). Rutherford et al. stated that in stage III ischemia, amputation is mandatory, as revascularization is ineffective [8]. Currie found strong correlations between sensory loss ( $p = 0.003$ ), motor loss ( $p =$

0.001), and amputation rates [6]. Dang reported that severe sensory impairment increased the amputation rate to 42.3%, while motor loss raised it to 68.5% [3]. When tissue necrosis is present, amputation is necessary to prevent complications such as venous thromboembolism, pulmonary embolism, and systemic infection.

Most cases involved lower limb arterial occlusion. Our study found that 85.53% of cases involved lower limb arteries, while only 14.47% involved upper limb arteries. Similarly, Do's study at Viet Duc Hospital reported that 83.64% of cases involved lower limb arteries, while 16.36% involved upper limb arteries [4].

A statistically significant relationship ( $p = 0.044$ ) was found between early postoperative outcomes and the occlusion site. No amputations occurred in cases of upper limb ischemia, whereas 23% of lower limb ischemia cases required amputation. Among the 17 amputations, 9 cases involved femoral artery occlusion, 5 cases involved iliac artery occlusion, 2 cases involved popliteal artery occlusion, and 1 case involved aortoiliac occlusion. The amputation rate varied by occlusion site, with femoral and iliac artery occlusions carrying the highest risk. Dang's study similarly found that among 15 amputation cases, 2 involved aortoiliac occlusion, 8 involved common femoral artery occlusion, 2 involved superficial femoral artery occlusion, 4 involved popliteal artery occlusion, and 1 involved brachial artery occlusion. The study concluded that occlusions in the aortoiliac, superficial femoral, and brachial arteries carried the highest amputation risk [3].

## V. CONCLUSION

Through the study of 67 patients with 76 limbs affected by

ALI due to arterial occlusion at Thong Nhat Hospital from 2023 to 2024, we observed the following: The majority of occlusions occurred in the lower limbs (85.53%), while upper limb occlusions accounted for 14.47%. Early treatment outcomes at seven days post-surgery showed a limb preservation rate of 75%, primary amputation rate of 15.79%, and secondary amputation rate of 6.58%. No cases of upper limb occlusion required amputation. The severity of limb ischemia, ischemia duration, and arterial occlusion site were significant factors influencing limb preservation outcomes.

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