

# Surgical Interventions for Acute Limb Ischaemia (ALI)

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## ABSTRACT

**Objective:** To evaluate presentations, aetiologies, interventions, and outcomes of patients presenting with acute limb ischaemia (ALI).

**Study Design:** An observational study.

**Place and Duration of the Study:** Department of Surgery, The Aga Khan University Hospital, Karachi, Pakistan, from January 2000 to December 2020.

**Methodology:** Record of 104 patients who underwent surgical interventions for ALI was retrospectively evaluated. The diagnosis was confirmed on imaging (ultrasound / CTA / conventional angiography). Demographic characteristics, co-morbidities, aetiologies, and outcomes were analysed using descriptive statistics and logistic regression.

**Results:** The cohort's mean age was  $58.89 \pm 12.6$  years, with (54.8%,  $n = 57$ ) females and (45.2%,  $n = 47$ ) males. Hypertension (54.8%,  $n = 57$ ), diabetes (46.2%,  $n = 48$ ), and atrial fibrillation (34.6%,  $n = 36$ ) were common comorbidities. Thromboembolism (67.3%,  $n = 70$ ) and thrombotic occlusion (32.7%,  $n = 34$ ) were primary aetiologies, predominantly affecting the lower limb (66.3%,  $n = 58$ ) and femoral artery (51.9%,  $n = 54$ ). The majority of cases were classified as Rutherford classification 2A (53.8%; 56 cases) and 2B (44.2%; 46 cases); 58 (55.8%) patients were classified as ASA Class III, while 36 (34.6%) patients were categorised as ASA Class IV. Embolectomy (80.8%,  $n = 84$ ) was the prevailing intervention, with an amputation rate (17.3%,  $n = 18$ ) and a mortality rate (5.8%,  $n = 6$ ).

**Conclusion:** Most patients with ALI presented with Rutherford Class II and had thromboembolism aetiology. Embolectomy was the most commonly performed procedure with a high amputation rate and mortality.

**Key Words:** Acute limb ischaemia, Embolectomy, Amputation, Thromboembolism.

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## INTRODUCTION

Acute limb ischaemia (ALI) constitutes a vascular emergency characterised by a sudden decrease in blood supply to a limb, demanding prompt intervention to salvage tissue viability and mitigate the risk of amputation.<sup>1</sup> Reported mortality at 1 year is 9-12% and the risk of major amputation is 12.7-30% in various studies.<sup>2</sup> Patients with ALI can present with a diverse range of symptoms, which depend on factors such as the underlying aetiology, involved vessels, collateral circulation, and co-existing medical conditions.<sup>3</sup> The Rutherford classification system provides a framework to categorise patients into subgroups based on the severity of their ischaemic limb status, guiding treatment decisions and predicting the outcomes.<sup>4</sup>

While several studies have explored the aetiologies, presentations, interventions, and outcomes of ALI in various healthcare settings, the literature remains limited, particularly within the context of low-to-middle-income countries (LMICs).<sup>5,6</sup>

For instance, Siddique *et al.* conducted a study focusing on the embolectomy's effectiveness. They only included patients presenting with acute limb ischemia due to embolic source and excluded patients with ALI due to *in situ* thrombosis.<sup>7</sup> Similarly, Khan *et al.* reviewed ALI cases but included a heterogeneous patient group, potentially diluting the specific outcomes of interest.<sup>8</sup> Furthermore, insights from LMICs are scarce, and these regions face challenges as lack of standard referral system, expertise to deal with emergency situation and limited resources that influence ALI management and outcomes.<sup>5</sup>

To bridge this knowledge gap, the authors conducted a review of records of the surgical intervention performed for ALI in a tertiary care centre located in Karachi, Pakistan. The objective was to evaluate the presentations, aetiologies, interventions, and outcomes of patients presenting with ALI who underwent surgical treatment.

## METHODOLOGY

This study was conducted at the Department of Surgery, The Aga Khan University Hospital, Karachi, Pakistan, from January 2000 to the December 2020. Medical records of 256 patients were reviewed after obtaining an exemption from Ethical Review Committee (ERC number 2022-7631-22764). Inclusion criteria encompassed adult patients (>18 years) who underwent surgical interventions for ALI. Patients with ALI due to traumatic

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injuries and incomplete medical records were excluded. The diagnosis was confirmed on imaging (ultrasound / CTA / conventional angiography). Demographic characteristics, comorbidities, aetiologies, and outcomes were analysed.

Data were analysed using IBM SPSS Statistics version 27.0. Continuous variables were expressed as mean with standard deviation, and percentages by categories. Univariate and multivariate logistic regression were applied to assess risk factors for amputation within the cohort, with reported 95% confidence intervals of beta coefficients. A p-value of less than 0.05 was considered significant. Time to amputation after onset of symptoms was calculated through the Kaplan-Meier method and stratified according to the aetiology.

### RESULTS

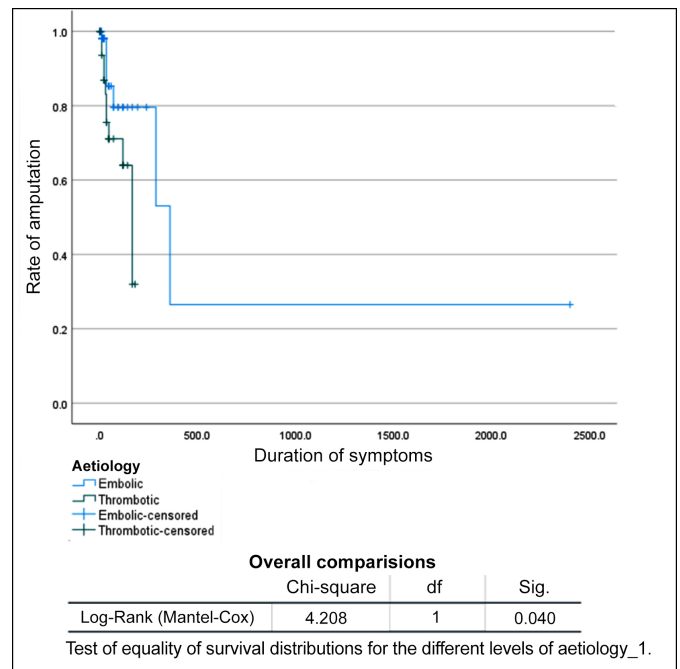
A total of 104 patients, including 57 females (54.8%) and 47 males (45.2%), underwent surgical interventions. The mean age was 58.89 ± 12.6 years. Prevalent comorbidities included hypertension in 57 patients (54.8%), followed by diabetes in 48 patients (46.2%), ischaemic heart disease in 40 patients (38.5%), and atrial fibrillation in 36 patients (34.6%). Other comorbidities e.g. history of cerebrovascular attack (CVA), valvular heart disease, smoking, end-stage renal disease, and malignancy were analysed. Symptom duration averaged 75 ± 240.8 hours. Thromboembolism constituted of ALI 70 cases (67.3%), with embolectomy emerging as the predominant successful intervention, accounting for 84 cases (80.8%). The majority of cases were classified as Rutherford classification 2A (53.8%; 56 cases) and 2B (44.2%; 46 cases); 58 patients (55.8%) were classified as ASA Class III, while 36 patients (34.6%) were categorised as ASA Class IV. The lower limb was the predominant site of involvement, affecting 69 patients (66.3%), with the femoral artery representing the primary occluded vessel in 54 cases (51.9%). Amputation was performed in 18 patients (17.3% of the total), with 5 undergoing minor amputations and 13 undergoing major amputations. Notably, the limb salvage rate was 83.6% (87 patients), while the mortality rate stood at 5.8% (6 patients) (Table I). Furthermore, postoperative wound infections were observed in 11 patients (10.5%), and 7 patients (6.7%) experienced acute kidney injury (AKI). Fasciotomy was performed in 7 patients (6.7%) despite of average presentation of 75 hours (SD 240.8) as few patients were noticed needing fasciotomy due to severe ischaemia as decision was made on clinical assessment and individual practice.

On univariate logistic regression, cerebrovascular accident (OR: 1.27, p = 0.03) and thrombotic aetiology (OR: 1.46, p = 0.01) were significant predictors for amputation. However, on multivariate analysis, only thrombotic aetiology (OR: 2.05, p = 0.01) was an independent predictor. Other variables, age, gender, ASA class, Rutherford class, extremity affected, mode of intervention, and comorbidities e.g. diabetes mellitus, ischaemic heart disease, atrial fibrillation, valvular heart disease, smoking, end-stage renal disease, and malignancy were analysed and were statistically insignificant (Table II).

Time-to-event analysis (Figure 1) shows patients presenting with ALI due to thrombotic aetiologies had a significantly shorter time to requiring amputation (p = 0.04).

**Table I: Demographics, clinical presentations, intervention, and outcomes of the patients.**

Variable	Value
Patients	104
Mean age (years) (SD)	58.89 (12.6)
Gender	
Female	57 (54.8%)
Male	47 (45.2%)
Comorbidities	
HTN*	57 (54.8%)
DM**	48 (46.2%)
IHD***	40 (38.5%)
AF****	36 (34.6%)
<b>Extremity affected</b>	
Right-lower limb	38 (36.5%)
Left-lower limb	31 (29.8%)
Left-upper limb	20 (19.2%)
Right-upper limbs	15 (14.4%)
<b>Site of occlusion</b>	
Femoral artery	54 (51.9%)
Brachial artery	21 (20.2%)
Popliteal trifurcation	19 (18.3%)
<b>Aetiology</b>	
Embolic	70 (67.3%)
Thrombotic	34 (32.7%)
<b>Intervention</b>	
Embolectomy	84 (80.8%)
Bypass grafting	3 (2.9%)
Thromboembolectomy with bypass grafting	17 (16.3%)
<b>Grades of ischaemia</b>	
Rutherford 1	1 (1%)
Rutherford 2A	56 (53.8%)
Rutherford 2B	46 (44.2%)
Rutherford 3	1 (1%)
<b>Amputation</b>	
Major amputation	13 (12.5%)
Minor amputation	5 (4.8%)
Limb salvage	87 (83.6%)
Mortality	6 (5.8%)



**Figure 1: Kaplan-Meier estimate for time to amputation according to aetiology (Log-rank = 0.04).**

**Table II: Univariate and multivariate logistic regression model for predicting amputation after ALI within the cohort.**

Variable	Univariate regression			Multivariate regression		
	Odds ratio	p-value	95% CI	Odds ratio	p-value	95% CI
Thrombotic	1.46	0.01	0.40	2.52	0.01	0.57
CVA	1.27	0.03	0.16	1.05	0.19	2.63

## DISCUSSION

ALI not only affect limb salvage but also causes other damaging outcomes e.g., metabolic derangement, renal injury, and uncontrolled blood glucose levels.<sup>9</sup> Different studies reported delay of more than 6 hours associated with increased risk of amputation.<sup>10,11</sup> Delayed referral to a vascular surgeon is also a cause of limb loss in a low-middle-income country.<sup>12</sup> Kempe *et al.* conducted a retrospective study involving 170 patients with ALI. They reported a 15% amputation rate and an 18% mortality rate at 30 days.<sup>13</sup> Atrial fibrillation was identified as a significant risk factor for poor outcomes.<sup>13</sup> This study's findings are comparable to the present study's amputation rate of 17.3% and mortality rate of 5.8%.<sup>13</sup> Both studies highlight the importance of identifying and managing risk factors such as atrial fibrillation in ALI patients.

In a retrospective comparison of endovascular *versus* surgical treatment for ALI, Grip *et al.* found that endovascular treatment resulted in higher patency rates and lower mortality rates compared to open surgery.<sup>14</sup> While this study focused on surgical interventions, the findings from Grip *et al.*'s study support the broader trend towards endovascular approaches in the management of ALI.

Dubouis *et al.* conducted a monocentric retrospective study involving 83 patients with ALI. They reported a 9.1% major amputation rate and a high mortality rate of 22.9% at 30 days.<sup>15</sup> The study highlighted that higher age, cerebrovascular disease, and cardiac failure were associated with poor outcomes.<sup>15</sup> In comparison, the current study reported a slightly higher amputation rate (12.5%) but a lower mortality rate (5.8%). This variation in mortality rates might be due to differences in patient characteristics and comorbidities between the two studies.

Umetsu *et al.* conducted a retrospective study involving 93 patients with ALI. They reported a 9.3% major amputation rate and a 12.1% mortality rate.<sup>16</sup> Notably, their study included a significant proportion of patients from the Rutherford Class IIb.<sup>16</sup> In comparison, this study had a more balanced distribution across Rutherford classifications, mainly Class IIb. This highlights the importance of categorising patients based on severity when interpreting outcomes.

Dilawari *et al.* conducted a recent retrospective analysis of 173 ALI patients. They reported a 17.1% amputation rate and a notably low mortality rate of 2%.<sup>17</sup> The findings of this study highlight potential differences in ALI outcomes in the

Pakistani population compared to the international data.<sup>17</sup> The reasons for these differences could be multifactorial, including variations in patient demographics, healthcare access, and treatment approaches.<sup>17</sup> They had included the patients with ALI due to trauma.

The amputation and mortality rates reported in this study are within the range reported by other studies. The identified risk factors for poor outcomes, such as thrombotic aetiology and delayed presentation, are consistent with previous researches. Additionally, the discussion on the preference for endovascular interventions aligns with the growing trend towards minimally invasive approaches in ALI management.<sup>18-20</sup>

While there are variations in some outcomes and risk factors across studies, these differences can often be attributed to variations in patient demographics, sample sizes, study designs, and healthcare systems. The diversity of findings across different studies underscores the importance of context and the need for further research to better understand the nuances of ALI management in different populations.

Limitations of this study include its retrospective nature, single-centred focus, and potential variations in patient characteristics. Early intervention and management play a pivotal role in improving outcomes. While this study contributes valuable insights, more prospective, multicentric studies are recommended to further establish these findings in diverse populations.

## CONCLUSION

The majority of ALI patients are presented with Rutherford Class II, predominantly due to thromboembolism aetiology. Embolectomy was the most frequently performed procedure with an amputation rate of 17.3%, and a mortality rate of 5.8%. Patients with a thrombotic aetiology and with delayed presentation exhibited an elevated risk of amputation.

### ETHICAL APPROVAL:

Exemption was obtained from the Institutional Ethical Review Committee (ERC No: 2022-7631-22764).

### PATIENTS' CONSENT:

Not applicable.

### COMPETING INTEREST:

The authors declared no conflict of interest.

### AUTHORS' CONTRIBUTION:

ZUR: Concept, literature search, ethical approval, conduction of the study, data analysis, and manuscript writing and editing.

FS: Conduction of the study, data analysis, and manuscript writing.

MHB: Data analysis and manuscript editing.

All authors approved the final version of the manuscript to be published.

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