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Review Article

Revascularization Strategies and Outcomes in Critical Limb Ischemia: A Four-year Retrospective Study of 65 Patients in a Sub-Saharan Cardiovascular Surgery Center

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Abstract

Background: Critical limb ischemia (CLI) represents the most advanced stage of peripheral arterial disease (PAD) and remains associated with substantial morbidity and mortality. Data from Sub-Saharan Africa are scarce despite a rapidly increasing burden of disease. Objective: To evaluate the epidemiological characteristics, therapeutic strategies, and outcomes of patients treated for CLI in a tertiary cardiovascular surgery center. Methods: A retrospective study was conducted from January 2020 to December 2023, including 65 patients managed for CLI. Epidemiological, clinical, imaging, therapeutic, and outcome variables were analyzed. Results: Mean age was 65.3 years; 54% were male. Hypertension (58%), smoking (38%), and diabetes (34%) were the most common risk factors. Trophic lesions were present in 80% of cases. Endovascular therapy was performed in 70.7% of patients, bypass surgery in 15.4%, and thrombo-endarterectomy in 13.8%. Perioperative complications occurred in 37%. Mortality reached 14%. A total of 56 amputations were performed (25 minor, 31 major). Diabetes was significantly associated with minor amputation, while diabetes, hypertension, and smoking predicted major amputation. Primary patency was 61.5% at 1 month and 52.3% at 1 year. Conclusion: CLI remains a severe condition with high rates of complications, amputation, and mortality. Endovascular therapy was the predominant strategy with acceptable early patency. Earlier diagnosis and improved cardiovascular risk management are essential to improve outcomes in Sub-Saharan Africa.

Keywords

Critical Limb Ischemia, Peripheral Arterial Disease, Endovascular Therapy, Bypass Surgery, Limb Salvage, Amputation Predictors, Sub-Saharan Africa

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1. Introduction

Peripheral arterial disease (PAD) affects more than 230 million individuals worldwide, with a marked increase in low- and middle-income countries over the past decade [1]. Critical limb ischemia (CLI), the most advanced stage of PAD, is associated with ischemic rest pain, ulceration, or gangrene, and carries a 1-year mortality approaching 25% and a major amputation rate of nearly 30% [2, 3].

The Global Burden of Disease 2021 analysis reported a significant rise in PAD prevalence in Sub-Saharan Africa, driven by uncontrolled diabetes, hypertension, and smoking [4]. Despite this growing burden, access to vascular specialists, diagnostic imaging, and revascularization remains limited in many African countries, resulting in delayed diagnosis and high amputation rates [5, 6].

Revascularization-either endovascular or surgical-remains the cornerstone of limb salvage. The Global Vascular Guidelines (GVG) recommend an endovascular-first approach for most patients [3]. However, recent randomized trials, including BEST-CLI and BASIL-2, have renewed the debate by demonstrating the superiority of autologous vein bypass in selected patients [7, 8]. The 2023 ESC and ESVS guidelines further emphasize individualized treatment based on anatomy, comorbidities, and resource availability [9, 10].

In Sub-Saharan Africa, therapeutic choices are influenced not only by anatomical considerations but also by resource constraints, limited availability of equipment, and operator expertise [5, 6]. Understanding real-world outcomes in such settings is essential to guide national strategies.

This study aimed to describe the epidemiological profile, therapeutic strategies, and outcomes of patients treated for CLI in a Sub-Saharan cardiovascular surgery center, and to compare these findings with contemporary international evidence.

2. Methods

A retrospective descriptive study was conducted from January 2020 to December 2023 in a national referral cardiovascular surgery center. Sixty-five patients aged ≥18 years with CLI (rest pain and/or tissue loss) and complete clinical and imaging data were included. Patients with acute limb ischemia or non-atherosclerotic arterial disease were excluded.

Data collected included epidemiological characteristics, clinical presentation, imaging findings, therapeutic interventions, and outcomes. Statistical associations between risk factors and amputation were assessed using chi-square tests.

Statistical Analysis

Quantitative variables were presented as means with standard deviations, while qualitative variables were expressed as percentages. Most graphs were generated using Microsoft Excel 2016. Data were analyzed using SPSS (Statistical Package for the Social Sciences) Statistics version 25. Statistical significance was set at a p-value < 0.05 (Chi-square test). The Shapiro–Wilk test was used to assess the normality of variable distributions. Pearson's correlation coefficient was applied to determine the strength of associations.

3. Results

3.1. Epidemiological Characteristics

The mean age was 65.3 ± 15.8 years (range 33-92). Males represented 54%. Hypertension (58%), smoking (38%), and diabetes (34%) were the most prevalent risk factors.

Table 1. Epidemiological characteristics.

Variable	Value
Mean age (years)	65.3 ± 15.8
Male sex	35 (54%)
Hypertension	38 (58%)
Smoking	25 (38%)
Diabetes	22 (34%)

3.2. Clinical Presentation

Symptoms had been present for an average of 20.7 days. Trophic lesions were observed in 80% of patients, including ulcers (45%) and gangrene (35%). Popliteal pulse was absent in 73% and distal pulses in all patients. ABI values confirmed severe ischemia.

3.3. Imaging Findings

CT angiography revealed multilevel arterial disease in more than 80% of patients, predominantly affecting tibial vessels. Doppler ultrasound confirmed tibial occlusions or subocclusions. Cardiac evaluation showed left ventricular hypertrophy (21.5%), moderate LV dysfunction (13.8%), and atrial fibrillation (10.7%).

Table 2. Clinical presentation.

Clinical feature	n (%)
Trophic lesions	52 (80%)
Ulcers	29 (45%)
Gangrene	23 (35%)
Absent popliteal pulse	47 (73%)

Clinical feature	n (%)
Absent distal pulses	65 (100%)

3.4. Therapeutic Management

Revascularization procedures included endovascular therapy in 46 patients (70.7%), bypass surgery in 10 patients (15.4%), and thrombo-endarterectomy in 9 patients (13.8%).

Endovascular therapy consisted primarily of balloon angioplasty (45 cases), with stent placement performed in a single case. The most frequently treated arterial segments were the anterior tibial artery (55%), the tibioperoneal trunk (50.7%), and the fibular artery (57%).

Bypass surgery involved the use of prosthetic grafts in 80% of cases, and anatomical bypasses accounted for 60% of procedures. The types of bypass performed included femoro-popliteal (n=5), femoro-femoral (n=4), and aorto-bifemoral (n=1) reconstructions.

Table 3. Summary of Revascularization Procedures.

Procedure type	n (%)	Details
Endovascular therapy	46 (70.7%)	Balloon angioplasty (45), stent (1)
Bypass surgery	10 (15.4%)	Prosthetic grafts (80%), anatomical bypass (60%)
Thromboendarterectomy	9 (13.8%)	-

3.5. Outcomes

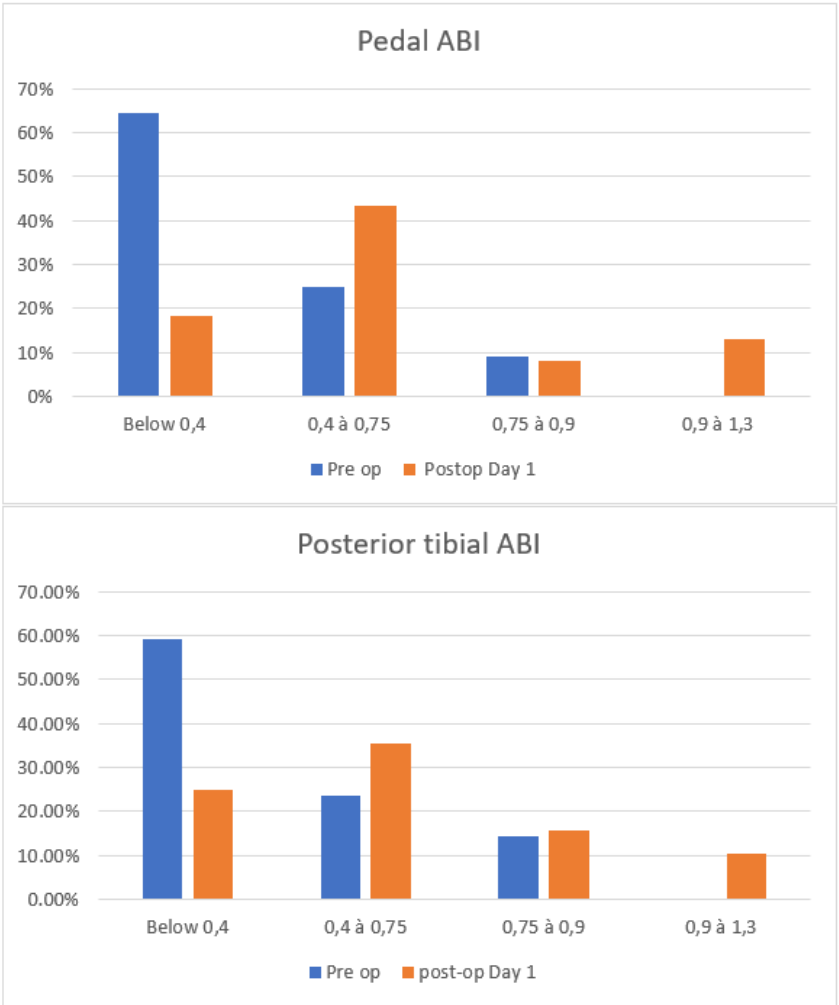

Figure 1. Comparison of preoperative and postoperative Day-1 ABI values.

A marked improvement in functional outcomes was observed postoperatively. Most patients experienced a substantial reduction in pain, accompanied by a significant enhancement in ankle–brachial index (ABI) measurements, indicating improved limb perfusion (Figure 1).

Complications occurred in 37% of patients. Overall mortality reached 14%, including 8% early deaths and 6% late deaths. A total of 56 amputations were performed, consisting of 25 minor and 31 major procedures. Postoperative morbidity was documented in 24 patients, representing 37% of the operated cohort. Metabolic complications were the most frequent (15%), mainly related to inadequate glycemic control among diabetic patients. Infectious complications were also reported (13%), contributing substantially to postoperative morbidit (table).

Table 4. *Complications, Mortality, and Amputations.*

Complication type	**n (%)**
Metabolic	10 (15%)
Infectious	9 (14%)
Cerebral	2 (3%)
Cardiac	2 (3%)
Outcome	Value
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Total mortality	9 (14%)
Minor amputations	25
Major amputations	31

Predictors of amputation:

Diabetes was significantly associated with an increased risk of minor amputation (p = 0.002). Regarding major amputations, several predictive factors were identified. Diabetes (p = 0.026), hypertension (p = 0.001), and smoking (p = 0.025) were all significantly correlated with a higher risk of major limb loss.

Table 5. *Association Between Cardiovascular Risk Factors and Limb Amputation (Minor and Major).*

Risk factor	**Amputation type**	**No**	**Yes**	**Total**	**P value**
Hypertension (HTN)	Minor	28 (73.6%)	10 (23.4%)	38	0.087
	Major	35 (92%)	3 (8%)	38	0.001
Diabetes	Minor	10 (45%)	12 (55%)	22	0.002
	Major	18 (81.8%)	4 (18.2%)	22	0.026
Smoking	Minor	22 (88%)	3 (12%)	25	0.774
	Major	18 (72%)	7 (28%)	25	0.025

Primary patency:

Primary patency progressively declined over the follow up period. It was estimated at 81.5% at 1 month, decreased to 71.3% at 6 months, and reached 62.3% at 12 months. This pattern reflects a gradual loss of patency during the first year, with the most pronounced reduction occurring between the first and sixth month. The Kaplan–Meier curve illustrates this downward trend and provides a clear visualization of the temporal evolution of primary patency. (Figure 2).

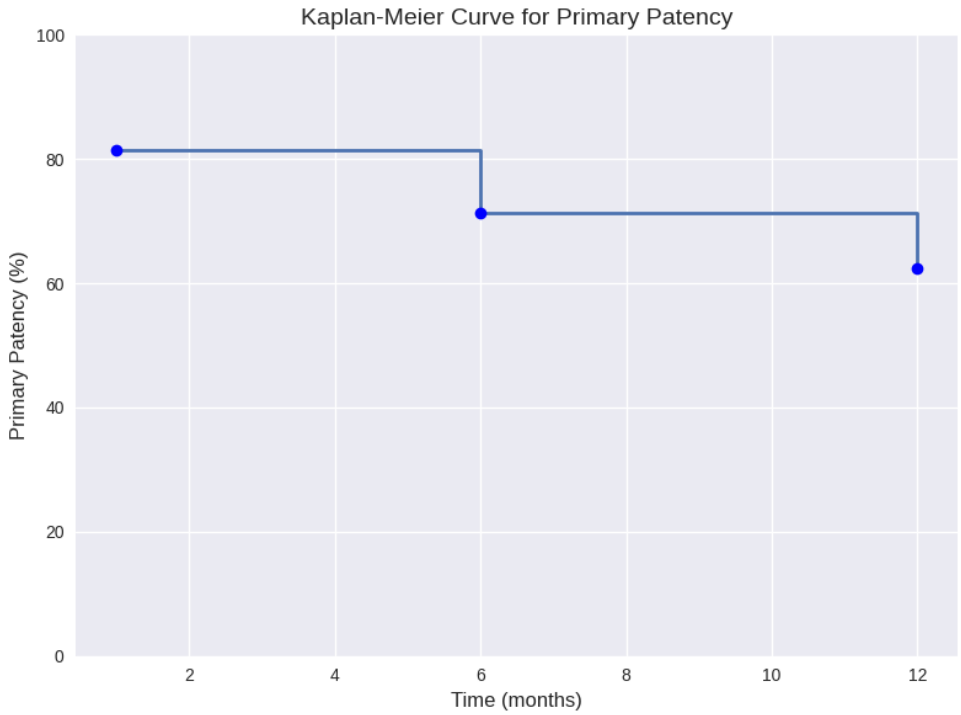

Figure 2. *Primary patency trends.*

4. Discussion

This study provides one of the most detailed contemporary analyses of CLI management in a Sub-Saharan cardiovascular surgery center. The findings highlight the severity of presentation, the predominance of tibial disease, and the challenges in achieving durable limb salvage in low-resource settings.

4.1. Epidemiology and Risk Factors

The mean age of 65 years is slightly lower than that reported in Western cohorts, where CLI typically affects older populations [11]. This difference likely reflects earlier exposure to uncontrolled cardiovascular risk factors in Sub-Saharan Africa. Hypertension, diabetes, and smoking were the most prevalent comorbidities, consistent with recent African and global studies [4, 12-14]. These risk factors are known to accelerate atherosclerosis and worsen distal arterial disease [15, 16]. Moreover, the WIfI classification [17] emphasizes the prognostic impact of these risk factors, particularly in patients presenting with advanced tissue loss.

4.2. Severe Clinical Presentation

The high prevalence of trophic lesions (80%) and multilevel tibial disease reflects late presentation, a pattern frequently reported in low-resource settings [5, 18]. Limited access to PAD screening, delayed referral pathways, and lack of public awareness contribute to advanced disease at diagnosis.

4.3. Imaging and Anatomical Complexity

More than 80% of patients presented with multilevel disease, predominantly affecting tibial arteries. This pattern is typical of diabetic arteriopathy and is associated with poorer patency and higher amputation rates [15, 16]. Such anatomical complexity often limits the durability of endovascular interventions.

4.4. Endovascular Therapy as the Predominant Strategy

Endovascular therapy was used in more than two-thirds of patients, consistent with global recommendations favoring minimally invasive approaches [3, 9]. However, tibial angioplasty is known to have limited long-term patency, particularly in diabetic patients [14, 18, 19]. The 1-year primary patency of 52% observed in this study aligns with contemporary international series [18, 19].

4.5. Limited Use of Bypass Surgery

Bypass surgery was performed in only 15% of patients, largely due to the scarcity of suitable autologous veins and the frequent need for prosthetic grafts. Prosthetic conduits are associated with lower patency and higher infection risk, especially in CLI [20]. Recent trials have demonstrated the superiority of autologous vein bypass in selected patients [7, 8], but such strategies remain difficult to implement in resource-

limited settings.

4.6. High Amputation and Mortality Rates

The high number of amputations and the 14% mortality rate reflect the systemic nature of PAD and the severity of disease at presentation. Similar outcomes have been reported in other African cohorts [5, 6]. CLI is increasingly recognized as a marker of advanced cardiovascular disease, with mortality comparable to many cancers [12, 21].

4.7. Implications for Practice

The findings underscore several priorities:

1) Earlier detection through PAD screening programs targeting diabetics and smokers.
2) Strengthening endovascular capacity, including training and equipment acquisition.
3) Developing multidisciplinary diabetic foot teams, shown to reduce amputation rates [16].
4) Improving postoperative surveillance to enhance patency and reduce restenosis.
5) Establishing national PAD registries to guide policy and resource allocation [22].

4.8. Future Directions

Future research should explore:

1) Cost-effectiveness of endovascular vs surgical strategies in African settings.
2) Hybrid revascularization approaches.
3) The role of drug-coated balloons and drug-eluting stents in improving tibial patency [23, 24].
4) Long-term survival and quality-of-life outcomes [25].

5. Conclusion

CLI remains a severe condition with high morbidity and mortality in Sub-Saharan Africa. Endovascular therapy was the predominant revascularization strategy, offering acceptable early patency but limited long-term durability. Improving outcomes requires earlier diagnosis, aggressive risk factor control, expansion of vascular care infrastructure, and development of multidisciplinary limb-salvage programs.

Abbreviations

ABI	Ankle–Brachial Index
CLI	Critical Limb Ischemia
CT	Computed Tomography
ESC	European Society of Cardiology
ESVS	European Society for Vascular Surgery
GVG	Global Vascular Guidelines
HTN	Hypertension
LV	Left Ventricular
PAD	Peripheral Arterial Disease
SPSS	Statistical Package for the Social Sciences
WIfI	Wound, Ischemia, and Foot Infection Classification

Author Contributions

Abdoul Aziz Thiaw: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Writing – original draft, Writing – review & editing

Ndeye Fatou Sow: Funding acquisition, Project administration, Resources, Supervision, Validation

Abdou Lahat Mbengue: Methodology, Software, Validation, Visualization

Papa Adama Dieng: Formal Analysis, Validation, Visualization

Conflicts of Interest

The authors declare no conflicts of interest.

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