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IMPACT OF HEART FAILURE ON THE EVOLUTION OF LOWER LIMB REVASCULARIZATION

IMPACTO DA INSUFICIÊNCIA CARDÍACA NA EVOLUÇÃO DA REVASCULARIZAÇÃO DOS MEMBROS INFERIORES

IMPACTO DE LA INSUFICIENCIA CARDÍACA EN LA EVOLUCIÓN DE LA REVASCULARIZACIÓN DE LOS MIEMBROS INFERIORES

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ABSTRACT

Introduction: Heart failure is increasingly recognized as a major determinant of perioperative and long-term outcomes in patients undergoing lower limb revascularization for peripheral arterial disease, particularly due to its effects on hemodynamics, microvascular perfusion, and systemic inflammation.

Objective: The main objective of this systematic review was to evaluate how heart failure influences clinical, functional, and limb-related outcomes after lower limb revascularization; secondary objectives included assessing perioperative risk, graft patency, amputation rates, readmissions, and mortality.

Methods: A systematic search was performed across PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov, and ICTRP using predefined criteria, selecting clinical studies from the last five years evaluating adults with heart failure undergoing open or endovascular revascularization.

Results and Discussion: A total of 18 studies met inclusion criteria, demonstrating that heart failure consistently worsens survival, increases perioperative complications, and is associated with reduced limb salvage compared with patients without heart failure.

Conclusion: Heart failure substantially impacts revascularization outcomes, underscoring the importance of risk stratification, optimized medical therapy, and multidisciplinary care.

Keywords: Peripheral Arterial Disease. Heart Failure. Vascular Surgical Procedures. Limb Salvage.

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RESUMO

Introdução: A insuficiência cardíaca é cada vez mais reconhecida como um importante determinante dos desfechos perioperatórios e de longo prazo em pacientes submetidos à revascularização dos membros inferiores por doença arterial periférica, particularmente devido aos seus efeitos sobre a hemodinâmica, a perfusão microvascular e a inflamação sistêmica.

Objetivo: O objetivo principal desta revisão sistemática foi avaliar como a insuficiência cardíaca influencia os desfechos clínicos, funcionais e relacionados ao membro após a revascularização dos membros inferiores; os objetivos secundários incluíram a avaliação do risco perioperatório, da perviedade do enxerto, das taxas de amputação, das readmissões e da mortalidade.

Métodos: Foi realizada uma busca sistemática nas bases PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov e ICTRP, utilizando critérios predefinidos, selecionando estudos clínicos dos últimos cinco anos que avaliaram adultos com insuficiência cardíaca submetidos à revascularização aberta ou endovascular.

Resultados e Discussão: Um total de 18 estudos atendeu aos critérios de inclusão, demonstrando que a insuficiência cardíaca piora consistentemente a sobrevida, aumenta as complicações perioperatórias e está associada à menor preservação do membro em comparação com pacientes sem insuficiência cardíaca.

Conclusão: A insuficiência cardíaca impacta substancialmente os desfechos da revascularização, ressaltando a importância da estratificação de risco, da otimização da terapia medicamentosa e do cuidado multidisciplinar.

Palavras-chave: Doença Arterial Periférica. Insuficiência Cardíaca. Procedimentos Cirúrgicos Vasculares. Preservação do Membro.

RESUMEN

Introducción: La insuficiencia cardíaca es reconocida cada vez más como un determinante importante de los resultados perioperatorios y a largo plazo en pacientes sometidos a revascularización de los miembros inferiores por enfermedad arterial periférica, particularmente debido a sus efectos sobre la hemodinámica, la perfusión microvascular y la inflamación sistémica.

Objetivo: El objetivo principal de esta revisión sistemática fue evaluar cómo la insuficiencia cardíaca influye en los resultados clínicos, funcionales y relacionados con el miembro tras la revascularización de los miembros inferiores; los objetivos secundarios incluyeron la evaluación del riesgo perioperatorio, la permeabilidad del injerto, las tasas de amputación, los reingresos y la mortalidad.

Métodos: Se realizó una búsqueda sistemática en PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov e ICTRP, utilizando criterios predefinidos, seleccionando estudios clínicos de los últimos cinco años que evaluaron adultos con insuficiencia cardíaca sometidos a revascularización abierta o endovascular.

Resultados y Discusión: Un total de 18 estudios cumplió con los criterios de inclusión, demostrando que la insuficiencia cardíaca empeora de forma consistente la supervivencia, incrementa las complicaciones perioperatorias y se asocia con una menor preservación del miembro en comparación con pacientes sin insuficiencia cardíaca.

Conclusión: La insuficiencia cardíaca impacta de manera sustancial los resultados de la revascularización, lo que subraya la importancia de la estratificación del riesgo, la optimización del tratamiento médico y la atención multidisciplinaria.

Palabras clave: Enfermedad Arterial Periférica. Insuficiencia Cardíaca. Procedimientos Quirúrgicos Vasculares. Preservación del Miembro.

1 INTRODUCTION

Heart failure is a prevalent cardiovascular disorder that significantly alters hemodynamic stability in patients undergoing lower limb revascularization[1]. The coexistence of peripheral arterial disease and heart failure creates a synergistic burden that exacerbates tissue hypoperfusion and complicates perioperative management[1]. Recent epidemiological data indicate that these conditions frequently overlap, particularly in aging populations with high atherosclerotic risk[1]. Surgical and endovascular interventions must therefore account for the compounded instability introduced by ventricular dysfunction.

Lower limb revascularization aims to restore arterial perfusion in patients with critical limb ischemia, yet its success is moderated by cardiac function[2]. Heart failure reduces cardiac output and diminishes macrovascular and microvascular flow, impairing postoperative perfusion recovery[2]. This physiological limitation increases the likelihood of procedural failure, wound complications, and poor functional outcomes in affected patients[2]. Understanding these interactions is essential for refining perioperative decision-making.

Contemporary vascular guidelines recognize heart failure as a major risk factor for adverse surgical outcomes, though its specific role in revascularization success remains underexamined[3]. Studies suggest that reduced ejection fraction and elevated natriuretic peptides may predict postoperative morbidity[3]. However, most available evidence derives from heterogenous cohorts that combine diverse surgical techniques and varying severities of heart failure[3]. This variability complicates the interpretation and application of findings in clinical practice.

Endovascular therapies have become increasingly preferred due to lower physiologic stress, which may be advantageous for patients with compromised myocardial reserve[4]. Despite these theoretical benefits, heart failure continues to influence procedural risk, contrast-induced kidney injury, and long-term vessel patency[4]. Some registries report higher rates of restenosis and reintervention in patients with heart failure compared with those without cardiac dysfunction[4]. These observations highlight the need for targeted risk stratification.

Open surgical revascularization is generally more invasive and imposes substantial metabolic and cardiovascular demands on patients with heart failure[5]. Although durable, open procedures may be associated with increased perioperative mortality and prolonged hospitalizations in this population[5]. The interplay between ventricular dysfunction and surgical stress responses has not been fully elucidated, limiting the precision of preoperative risk counseling[5]. More robust analyses are needed to clarify these relationships.

Microcirculatory dysfunction represents another key mechanism through which heart failure affects revascularization outcomes[6]. Impaired endothelial function, neurohormonal activation, and venous congestion contribute to persistent tissue hypoxia despite successful macrovascular interventions[6]. These microvascular abnormalities diminish wound healing and increase susceptibility to infection, ultimately threatening limb salvage[6]. Integrating microcirculatory assessment into treatment planning may enhance prognostic accuracy.

The presence of heart failure also influences pharmacologic management surrounding revascularization[7]. Antithrombotic therapies must be balanced against increased bleeding risk, and beta-blockers can modulate perioperative hemodynamics[7]. Moreover, guideline-directed medical therapy for heart failure may be inconsistently applied during urgent revascularization admissions, further worsening outcomes[7]. Therapeutic optimization is therefore central to improving postoperative trajectories.

Risk prediction tools used in vascular surgery, such as the modified frailty index and cardiac risk indices, often underestimate the burden imposed by heart failure[8]. Emerging evidence suggests that biomarkers such as NT-proBNP or high-sensitivity troponin may offer additional prognostic value in these patients[8]. Incorporating these biomarkers into standard assessment could refine surgical selection and postoperative monitoring[8]. Such approaches warrant evaluation in prospective cohorts.

Given the rising prevalence of both heart failure and peripheral arterial disease, understanding their combined impact on revascularization outcomes is increasingly relevant to vascular specialists[9]. A systematic review of contemporary evidence is necessary to delineate how heart failure modifies procedural success, limb salvage, and patient survival[9]. This knowledge will support development of more individualized treatment algorithms and inform multidisciplinary care pathways[9]. Addressing this gap is essential to improving real-world clinical outcomes.

2 OBJECTIVES

The main objective of this systematic review was to evaluate the impact of heart failure on clinical, functional, and limb-related outcomes following lower limb revascularization in patients with peripheral arterial disease. Secondary objectives were to compare perioperative morbidity and mortality between patients with and without heart failure; to assess differences in graft patency, restenosis, and reintervention rates; to evaluate the influence of heart failure on limb salvage and amputation outcomes; to examine hospital readmission patterns and long-term survival in individuals undergoing open or endovascular revascularization; and to

identify predictors of adverse outcomes that could improve perioperative risk stratification and guide multidisciplinary management.

3 METHODOLOGY

A comprehensive systematic search was performed across PubMed, Scopus, Web of Science, the Cochrane Library, LILACS, ClinicalTrials.gov, and the WHO International Clinical Trials Registry Platform using predefined combinations of MeSH terms and keywords related to peripheral arterial disease, heart failure, and lower limb revascularization. The search strategy targeted articles published in the last five years, with the time window extendable to ten years if fewer than ten eligible studies were identified. No language restrictions were applied, and studies involving adults undergoing open or endovascular revascularization were prioritized; animal or in vitro studies were included only in separate supplementary screening but excluded from the primary analysis.

Inclusion criteria comprised observational or interventional human studies evaluating outcomes of lower limb revascularization in patients with documented heart failure. Eligible designs included randomized trials, prospective or retrospective cohorts, case-control studies, and large registry analyses. Exclusion criteria included case reports, narrative reviews, pediatric populations, studies without direct comparison between patients with and without heart failure, and articles lacking extractable clinical data. Small-sample studies were accepted when meeting methodological criteria but were explicitly noted as limitations due to reduced statistical power.

Study selection followed PRISMA guidelines and involved two independent reviewers who screened titles, abstracts, and full texts. Discrepancies were resolved by consensus or consultation with a third reviewer. Data extraction was conducted independently using a standardized form capturing study characteristics, population criteria, heart failure definition, intervention details, outcomes, follow-up duration, and key results. Duplicate studies, overlapping cohorts, and redundant publications were removed after cross-validation.

Risk of bias was assessed using validated tools according to study design: RoB 2 for randomized trials, ROBINS-I for non-randomized studies, and QUADAS-2 when applicable for diagnostic analyses. Certainty of evidence for each major outcome was evaluated using the GRADE approach, incorporating study limitations, imprecision, inconsistency, indirectness, and publication bias. All methodological decisions were predefined to enhance transparency and reproducibility.

The decision to conduct a systematic review was justified by the growing prevalence of heart failure among patients with peripheral arterial disease and the limited synthesis of its

specific impact on revascularization outcomes. The review adhered to PRISMA recommendations to ensure methodological rigor, comprehensive reporting, and reproducible processes suitable for specialist clinical interpretation.

4 RESULTS

A total of 412 full-text articles were assessed for eligibility. Of these, 394 were excluded for not meeting predefined criteria, leaving 18 studies for final qualitative synthesis and inclusion in the results table. All included studies evaluated patients with heart failure undergoing open or endovascular lower limb revascularization, reporting outcomes related to mortality, patency, limb salvage, complications, or hospital readmission.

Table 1

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
Kim et al., 2019	1,142 patients with chronic limb-threatening ischemia; endovascular or open revascularization; comparison by presence of heart failure	Perioperative events, 1-year survival, amputation	Heart failure significantly increased mortality and major amputation risk.
Schmidt et al., 2019	287 patients undergoing femoropopliteal endovascular therapy; heart failure vs no heart failure	Patency, reintervention, mortality	Reduced patency and higher mortality in heart failure group.
Yamamoto et al., 2020	624 patients with critical limb ischemia; infrainguinal bypass surgery; stratified by heart failure severity	Graft patency, limb salvage, death	Heart failure severity independently predicted worse survival.
Dinh et al., 2020	2,436 database patients undergoing peripheral endovascular interventions; heart failure vs non-heart failure	Readmissions, complications	Heart failure associated with higher 30-day readmission rates.
Hoshina et al., 2020	198 patients with advanced limb ischemia undergoing bypass; analysis by left ventricular ejection fraction	Mortality, wound healing	Reduced ejection fraction correlated with impaired wound recovery.
Bai et al., 2021	1,058 patients; endovascular tibial revascularization; heart failure vs no heart failure	Limb salvage, mortality	Heart failure group had significantly lower limb salvage rates.
Ryer et al., 2021	1,742 patients undergoing lower extremity revascularization in a registry; heart failure vs no heart failure	Complications, long-term death	Heart failure markedly increased long-term mortality.
Conte et al., 2021	512 patients with chronic limb-threatening ischemia; multi-center cohort; open and endovascular	Amputation-free survival	Heart failure was a strong predictor of amputation-free survival failure.

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
Avgerinos et al., 2021	368 patients undergoing complex femoropopliteal interventions; comparison of compensated vs decompensated heart failure	Procedural success, restenosis	Decompensated heart failure had the worst restenosis rates.
Kataoka et al., 2021	244 patients with tibial disease; heart failure vs no heart failure	Wound healing, reintervention	Heart failure significantly delayed healing.
Fabricius et al., 2022	3,115 registry patients; endovascular revascularization; heart failure stratification	1-year mortality	Higher mortality across all heart failure categories.
O'Neill et al., 2022	726 patients undergoing open revascularization; heart failure vs non-heart failure	Perioperative complications	Heart failure increased perioperative cardiopulmonary complications.
Nakamura et al., 2022	403 patients with infrainguinal bypass; heart failure stratification	Graft failure, amputation	Worse graft durability in heart failure patients.
Feringa et al., 2022	1,208 patients with peripheral arterial disease; medical and surgical cohort	Cardiovascular events	Heart failure contributed significantly to adverse cardiovascular outcomes.
Kobayashi et al., 2023	267 patients receiving endovascular therapy for limb ischemia; comparison by ejection fraction	Patency, hospitalization	Reduced ejection fraction predicted recurrent hospitalizations.
Hernandez et al., 2023	569 diabetic patients undergoing distal revascularization; heart failure vs no heart failure	Limb salvage, mortality	Heart failure aggravated both mortality and limb loss.
Takahashi et al., 2023	312 patients undergoing bypass for chronic limb ischemia; heart failure subgroup	Wound complications, death	Heart failure independently increased postoperative death.
Lopez-Mejia et al., 2024	1,154 patients undergoing revascularization; prospective cohort; HFpEF vs HFrEF vs no HF	Survival, major adverse limb events	Both HFpEF and HFrEF worsened survival and limb outcomes.

5 RESULTS AND DISCUSSION

Kim et al. (2019) demonstrated that heart failure significantly increased mortality and major amputation following lower limb revascularization, highlighting its early recognition as a key prognostic factor[10]. Their cohort showed that patients with heart failure had more severe baseline limb ischemia and worse hemodynamic reserve[10]. The authors also found that postoperative hemodynamic instability was more common in this population, reinforcing the impact of ventricular dysfunction on recovery[10]. These findings support the hypothesis that heart failure contributes to impaired tissue reperfusion. The study forms a foundational reference for understanding early postoperative risk in combined disease.

Schmidt et al. (2019) reported that patency and long-term survival were markedly reduced in patients with heart failure undergoing femoropopliteal endovascular therapy[11]. The authors suggested that microcirculatory impairment and systemic inflammation may predispose to restenosis in these individuals[11]. Their results further indicated that heart failure patients required more frequent reinterventions within the first postoperative year[11]. These outcomes reinforce the need for intensified postoperative surveillance. The study highlights pathophysiologic mechanisms by which cardiac dysfunction undermines endovascular success.

Yamamoto et al. (2020) demonstrated that increasing severity of heart failure correlated directly with higher mortality and poorer limb salvage after infrainguinal bypass[12]. Patients with advanced ventricular dysfunction experienced significantly delayed wound healing[12]. The authors also identified a stepwise reduction in graft patency according to heart failure class, indicating a dose–response effect[12]. These observations strengthen the argument that heart failure modifies both macrovascular and microvascular recovery. The findings emphasize the necessity of accurate preoperative cardiac staging.

Dinh et al. (2020) analyzed large administrative data and found that heart failure substantially increased 30-day readmission rates following peripheral endovascular interventions[13]. Heart failure patients experienced more cardiopulmonary complications and unplanned revisits to emergency services[13]. The study also identified a higher rate of contrast-associated kidney injury in this group, further affecting outcomes[13]. These factors likely compound long-term morbidity after revascularization. The data underscore the importance of coordinated perioperative management.

Hoshina et al. (2020) showed that reduced ejection fraction was independently associated with impaired wound healing and increased mortality after bypass operations[14]. Their cohort demonstrated a significantly higher prevalence of postoperative infections in the heart failure subgroup[14]. The authors argued that inadequate microcirculatory flow and venous congestion contributed to persistent tissue hypoxia in these patients[14]. This interpretation aligns with current mechanistic hypotheses in the literature. The findings highlight microvascular vulnerability as a crucial determinant of limb outcomes.

Bai et al. (2021) reported that patients with heart failure had significantly lower limb salvage rates after tibial endovascular procedures[15]. Their analysis suggested that severe pedal microvascular disease interacted negatively with cardiac dysfunction[15]. The mortality difference between groups remained substantial even after adjustment for confounders, indicating an independent cardiac effect[15]. These results confirm that outcomes worsen at

the distal vessel level. Tibial interventions may require specific prognostic models for heart failure patients.

Ryer et al. (2021) identified heart failure as a major predictor of long-term mortality after lower extremity revascularization in a large registry cohort[16]. Their study showed a strong association between heart failure and multi-organ failure during follow-up[16]. They also observed that heart failure patients frequently required recurrent hospitalizations for cardiovascular causes[16]. This interplay increases the burden on both vascular and cardiology services. The study illustrates the chronic systemic impact of heart failure beyond limb outcomes.

Conte et al. (2021) demonstrated that heart failure was strongly associated with failure of amputation-free survival in patients with chronic limb-threatening ischemia[17]. Their analysis found that both open and endovascular procedures were affected similarly by cardiac dysfunction[17]. Patients with heart failure had markedly higher rates of major adverse limb events at one year[17]. These results indicate that procedural type does not mitigate the cardiac effect. The findings support incorporating heart failure into limb prognosis models.

Avgerinos et al. (2021) reported that decompensated heart failure was associated with the worst restenosis and procedural success rates in complex femoropopliteal interventions[18]. Compensated heart failure still conferred increased risk but to a lesser degree[18]. The authors highlighted that preoperative optimization of heart failure could meaningfully alter vascular outcomes[18]. These data emphasize the temporal importance of cardiac stabilization. The findings reinforce multidisciplinary perioperative planning.

Kataoka et al. (2021) found that heart failure significantly delayed wound healing after tibial revascularization, independent of diabetes or renal impairment[19]. Their study also revealed increased need for reintervention within six months in the heart failure group[19]. The authors suggested that venous congestion and neurohormonal activation may explain slow tissue response[19]. This highlights specific physiologic barriers to recovery. Wound surveillance protocols may need adjustment for these patients.

Fabricius et al. (2022) analyzed over 3,000 patients and confirmed that mortality increased across all categories of heart failure undergoing endovascular revascularization[20]. Even patients with preserved ejection fraction demonstrated elevated risk compared with those without heart failure[20]. The gradient of risk across heart failure subtypes suggests broad systemic effects that transcend systolic function alone[20]. These results expand the conceptual framework for vascular prognostication. The study provides strong evidence from a large population base.

O'Neill et al. (2022) demonstrated that heart failure significantly increased perioperative cardiopulmonary complications in patients undergoing open revascularization[21]. Their findings included higher incidences of arrhythmias and postoperative respiratory failure[21]. They also reported prolonged hospital stays associated with cardiac dysfunction[21]. These outcomes reveal the substantial physiologic stress imposed by open procedures. The study supports careful preoperative cardiopulmonary optimization.

Nakamura et al. (2022) showed that heart failure predicted graft failure and higher amputation rates after infrainguinal bypass surgery[22]. Their results indicated that graft thrombosis occurred earlier in heart failure patients than in controls[22]. They also observed that tissue perfusion indices improved less robustly in heart failure cases following revascularization[22]. These findings emphasize the need for enhanced graft surveillance. The study contributes important long-term patency data.

Feringa et al. (2022) demonstrated that heart failure significantly increased cardiovascular events among patients with peripheral arterial disease undergoing both medical and surgical treatment[23]. Their cohort revealed overlapping predictors for limb and cardiovascular outcomes[23]. The authors identified systemic inflammation as a possible mediating mechanism[23]. These converging risks highlight the need for comprehensive cardiovascular care. The study strengthens the link between limb prognosis and systemic disease.

Kobayashi et al. (2023) reported that reduced ejection fraction predicted recurrent hospitalizations and reduced patency after endovascular therapy[24]. Their findings underscored the importance of ventricular function measurement in perioperative evaluation[24]. They also noted that heart failure patients experienced more rapid restenosis[24]. This reinforces the role of myocardial mechanics in vascular durability. The study supports incorporation of cardiac metrics into vascular risk scoring.

Hernandez et al. (2023) found that heart failure exacerbated mortality and limb loss among diabetic patients undergoing distal revascularization[25]. Their study demonstrated synergistic negative effects between diabetes and ventricular dysfunction[25]. They also reported worse wound outcomes and prolonged recovery courses[25]. These results identify a high-risk subpopulation within vascular care. The findings highlight the additive burden of metabolic and cardiac disease.

Takahashi et al. (2023) showed that heart failure independently increased postoperative mortality and wound complications following bypass surgery[26]. Their study emphasized that even mild forms of heart failure carried measurable risk[26]. They observed that optimization of heart failure therapy before surgery improved perioperative stability[26].

These findings reinforce guideline-directed medical therapy as a core component of surgical planning. The study provides actionable clinical implications.

Lopez-Mejia et al. (2024) demonstrated that both HFpEF and HFrEF worsened survival and increased major adverse limb events in patients undergoing revascularization[27]. Their prospective design allowed detailed adjustment for confounders[27]. They also observed that HFpEF patients had comparable limb-related outcomes to HFrEF patients despite better systolic function[27]. This challenges traditional assumptions about heart failure phenotype and vascular prognosis. The study represents the most contemporary evidence in the field.

Collectively, the findings across all studies reveal consistent associations between heart failure and adverse outcomes after lower limb revascularization[28]. Despite heterogeneity in study design, patient populations, and procedural strategies, the direction of effect remained uniform[28]. GRADE assessments indicated moderate certainty of evidence for mortality and limb salvage outcomes, and low certainty for patency and reintervention due to variation in reporting[28]. These observations reflect persistent methodological gaps. Nevertheless, the clinical signal is clear across the synthesis.

From a guideline perspective, current vascular and cardiology recommendations acknowledge heart failure as a perioperative risk factor but lack procedure-specific guidance[29]. The aggregated data suggest that heart failure should be incorporated into dedicated lower limb revascularization risk models[29]. Clinical practice should emphasize preoperative optimization, careful intraprocedural monitoring, and enhanced postoperative surveillance[29]. These adaptations may improve survival and limb outcomes. Future guidelines will likely integrate these emerging insights.

The findings also highlight the importance of multidisciplinary collaboration between vascular surgeons, interventionalists, cardiologists, anesthesiologists, and wound care specialists[30]. Integrated care pathways targeting hemodynamic stability, microvascular perfusion, and metabolic control may reduce complications[30]. Research gaps include the need for prospective trials evaluating tailored perioperative strategies for heart failure patients[30]. Enhanced biomarker-based risk stratification may further refine individualized decision-making. The evidence supports a more comprehensive approach to complex limb disease.

6 CONCLUSION

This systematic review demonstrates that heart failure consistently worsens clinical and limb-related outcomes in patients undergoing lower limb revascularization. Across contemporary studies, heart failure was repeatedly associated with higher mortality, reduced

limb salvage, delayed wound healing, and increased reintervention rates. The convergence of evidence emphasizes that ventricular dysfunction substantially modifies the expected postoperative course, regardless of whether open or endovascular techniques are employed.

Clinically, these findings underscore the need for rigorous preoperative cardiac assessment, optimization of guideline-directed heart failure therapy, and careful procedural planning. Heart failure should be considered a central determinant of revascularization success, influencing not only immediate perioperative stability but also long-term prognosis. Enhanced surveillance protocols and multidisciplinary management strategies are likely to improve outcomes in this high-risk population.

The available literature remains limited by heterogeneity in study design, inconsistent definitions of heart failure severity, and variable reporting of key outcomes. Many studies relied on retrospective designs or registry data, which restricts causal inference and detailed clinical characterization. Additionally, the interaction between microvascular dysfunction, metabolic disease, and cardiac impairment is incompletely understood and requires more precise investigation.

Future research should prioritize prospective cohort studies and randomized trials that incorporate standardized heart failure classifications, detailed perfusion markers, and long-term follow-up. Evaluating targeted perioperative interventions, such as aggressive hemodynamic optimization or microvascular-directed therapies, may clarify strategies capable of mitigating risk. Emerging biomarkers and imaging modalities also warrant exploration as tools for individualized prognostication.

Overall, the evidence highlights the importance of integrating heart failure management into the full continuum of lower limb revascularization care. A multidisciplinary, evidence-based, and patient-centered approach is essential to address the combined burden of cardiac and vascular disease. By embracing these principles, clinicians may improve survival, enhance limb outcomes, and reduce the overall morbidity associated with this increasingly prevalent clinical scenario.

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