

The Impact of Revascularization on the Prognosis of Patients with Ischemic Heart Failure in the Contemporary Era: Viewpoint

Luhanda Leonora Cardoso Monti Sousa,¹  Luís Henrique Wolff Gowdak¹ 

Instituto do Coração do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo,¹ São Paulo, SP – Brazil

Introduction

The impact of myocardial revascularization on the prognosis of patients with heart failure (HF) and reduced left ventricular (LV) ejection fraction (EF) of ischemic etiology, especially those with $EF \leq 40\%$, remains one of the most debated topics in contemporary cardiology. Historically, this subgroup of patients with chronic coronary syndrome (CCS) was indicated for revascularization to reduce hard cardiovascular outcomes, according to guidelines, primarily through coronary artery bypass grafting (CABG). However, recent results and the evolution of optimized clinical treatment (OCT), which now includes medications and devices, have questioned the prognostic benefit of revascularization in this context.¹⁻⁴

The core of the controversy lies in the applicability and impact of the concept of myocardial viability. For a long time, the demonstration of viable hibernating myocardium was considered a prerequisite for indicating revascularization, based on the reasoning that functional recovery of the LV would lead to better long-term outcomes. More recent evidence, however, refutes this concept as a dichotomous criterion.^{4,5}

Discussion

Evidence in evolution

The first indication that revascularization could confer prognostic benefit in LV dysfunction came from the sub-analysis of patients with $EF \leq 50\%$ in the CASS study, in a pre-contemporary COT era. However, the major milestone was the STICH (Surgical Treatment for Ischemic Heart Failure) randomized clinical trial, which allocated multivessel disease patients with $EF \leq 35\%$ to receive COT alone or CABG + COT.^{6,7}

Although STICH did not achieve statistical significance for the primary outcome of all-cause mortality in the first five years, the extended follow-up of 9.8 years (STICHES) demonstrated a clear late benefit of CABG on TCO, for both overall and cardiovascular

mortality, with the curves diverging from three years onwards. This benefit occurred despite the absence of significant improvement in LVEF and, more importantly, independently of myocardial viability, as evidenced in the STICH Viability substudy.⁷⁻⁹

The contemporary REVIVED-BCIS2 (Revascularization for Ischemic Ventricular Dysfunction) study randomized 700 patients with CCS and a multi-vessel obstructive pattern and ejection fraction ($EF \leq 35\%$, with proven viability in at least four dysfunctional segments, to receive percutaneous coronary intervention (PCI) + COT versus COT alone. The study was neutral for the primary outcome of overall mortality or hospitalization for heart failure, raising debate about the most appropriate type of revascularization and, again, questioning the hibernating myocardium theory.¹⁰

However, differences between the STICH and REVIVED populations, as well as the distinct revascularization method, may justify divergent results. The use of resynchronization devices and cardioverter-defibrillators was optimized in REVIVED and underutilized in STICH, while the use of modern medications, such as SGLT2 inhibitors and sacubitril-valsartan, present in REVIVED and absent in STICH, makes it unlikely that an invasive intervention will demonstrate superiority over the current COT. Furthermore, the nature of the procedures differs substantially: CABG tends to offer more complete revascularization and protection against future infarctions, while PCI treats focal lesions.^{8,10,11}

Revascularization as a prognostic strategy

According to STICHES, CABG is indicated with the prognostic objective of long-term survival, and the decision should not be based solely on the expectation of recovery of LV function. This recommendation can be extended to PCI when CABG is not feasible, according to recent guidelines.^{1,8} The prognostic benefit without improvement in LV function seems to stem primarily from the prevention of future myocardial infarctions, since, in patients with severe LV dysfunction, any new ischemic event can further aggravate the pumping function.⁵ The reduction in the risk of fatal ventricular arrhythmias related to ischemia is another plausible hypothesis, especially in the presence of chronic total occlusion, since revascularization can attenuate the arrhythmogenic substrate. In such patients, ischemic, necrotic, and viable myocardium frequently coexist, not always fully identifiable by available imaging exams.^{5,12}

Myocardial viability

A pre-specified analysis of REVIVED showed that the extent of viable myocardium did not determine which patients would benefit from PCI in terms of survival or EF improvement, but the extent of fibrotic myocardium correlated with a higher risk of mortality.¹³ Similarly, in STICH Viability, the presence

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Mailing Address: Luhanda Leonora Cardoso Monti Sousa •

Instituto do Coração do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo - Av. Dr. Enéas de Carvalho Aguiar, 44. Postal Code 05403-000, Cerqueira César, São Paulo, SP – Brazil
E-mail: luhandacardio@gmail.com

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of viability also did not select the best candidates for CABG.⁹ These findings suggest that viability marks a better prognosis, but does not predict response to a specific therapeutic strategy. Thus, viability should be considered a prognostic marker, and EF recovery, a theoretical yet unpredictable potential.^{1,2,4,9,13}

Decision making

In clinical practice, viability, metabolic reserve, or contractile reserve tests (magnetic resonance imaging, PET FDG, thallium scintigraphy, or dobutamine stress echocardiography) should be reserved for cases where the benefit of revascularization is uncertain, or when functionally complete revascularization is sought. Ischemia assessment is equally important, as not all viable myocardium is dysfunctional due to coronary etiology. Clinical factors that impose a high risk for PCI or CABG, as well as technical feasibility, should be considered. Therefore, the decision to revascularize or not a patient with heart failure and reduced ejection fraction, aiming at prognosis, should be individualized and ideally discussed in a Heart Team. Viability tests should be used in an integrated, not dichotomous, manner. Figure 1 summarizes the rationale for revascularization decision-making in this population.

Conclusion

Revascularization in patients with CCS and HF with reduced EF is a long-term prognostic strategy that minimizes future ischemic events and worsening ventricular function in a high-

risk population. However, contemporary clinical treatment has evolved substantially and modified the impact of interventions. The hibernating myocardium paradigm remains an open question. Evidence of viability should be interpreted in conjunction with clinical and anatomical factors, and not in isolation. The choice between PCI and CABG should be individualized and discussed in a Heart Team. Two ongoing studies, STICH3C (Canadian CABG or PCI in Patients With Ischemic Cardiomyopathy) and MASS VI HF (Evaluation of a randomized comparison between patients with coronary artery disease associated with ischemic cardiomyopathy who undergo medical or surgical treatment), should clarify outstanding questions about the role of revascularization in ischemic heart failure.

Author Contributions

Conception and design of the research, Analysis and interpretation of the data, Writing of the manuscript: Sousa LLCM; Critical revision of the manuscript for intellectual content: Sousa LLCM, Gowdak LHW.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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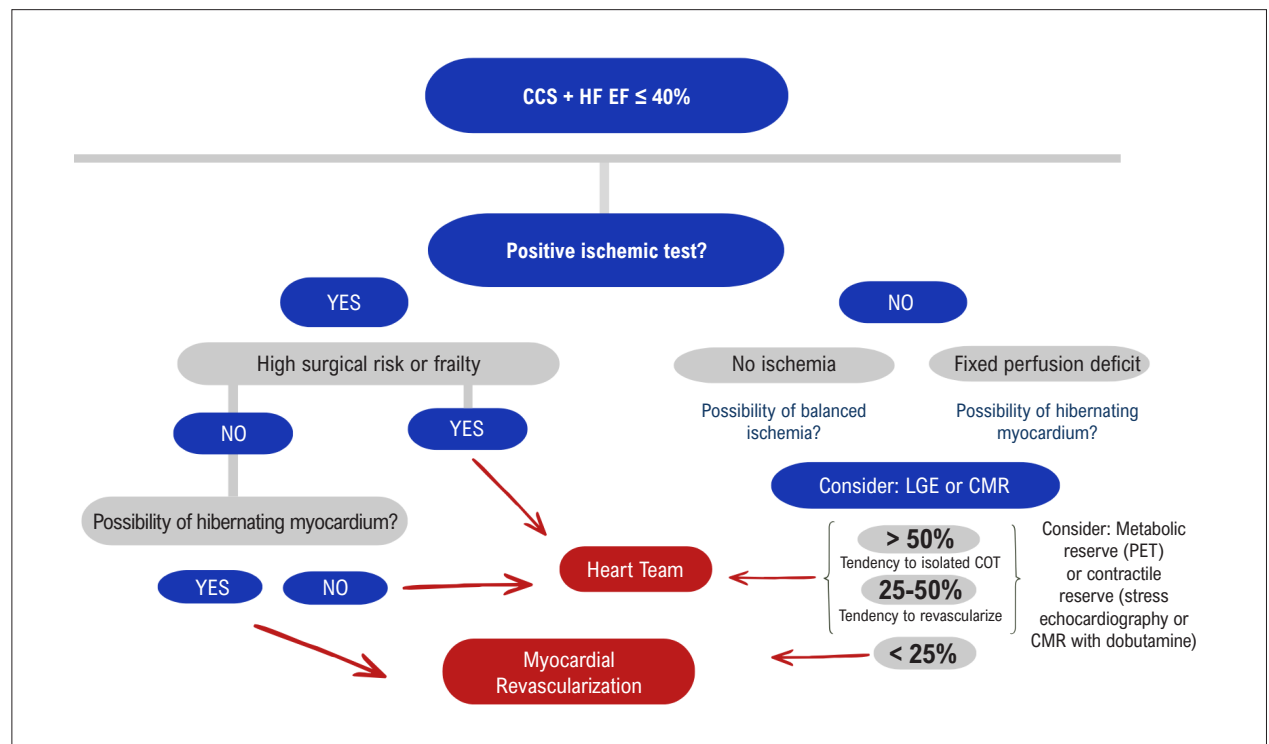


Figure 1 – Rationale for myocardial revascularization in CCS with ventricular dysfunction. LGE: Late gadolinium enhancement; CMR: Cardiac magnetic resonance imaging; Echo: Echocardiogram; PET: Positron emission tomography; PCI: Percutaneous coronary intervention; CABG: Coronary artery bypass grafting; CCS: Chronic coronary syndrome; HF: Heart failure; EF: Ejection fraction.

Study Association

This study is not associated with any thesis or dissertation work.

Ethics Approval and Consent to Participate

This article does not contain any studies with human participants or animals performed by any of the authors.

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