ASSESSMENT FOR CORONARY REVASCULARIZATION IN IHD WITH SEVERE LVSD (LVEF ≤ 35%)

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I CORE CLINICAL PARADIGM AND INITIAL GDMT OPTIMIZATION

- **Decoupling Prognostic Survival Benefit from Symptomatic Relief:** In patients with **Ischemic Cardiomyopathy (ICM)** and severe Left Ventricular Systolic Dysfunction (**LVEF 35 percent or less**), revascularization decision-making by the multidisciplinary **Heart Team** must strictly distinguish **survival benefit (achieved with CABG over long-term follow-up)** from **angina relief (achieved with either CABG or PCI)**.
- **Mandatory Upfront Quadruple GDMT Optimization (Class I):** Prior to or alongside revascularization evaluation, all patients must be initiated and titrated on foundational **Four-Pillar HFrEF Guideline-Directed Medical Therapy (GDMT)**: **ARNI (Sacubitril/Valsartan) or ACEi/ARB**, **Evidence-Based Beta-Blockers (Carvedilol, Metoprolol Succinate, Bisoprolol)**, **Mineralocorticoid Receptor Antagonists (Spironolactone, Eplerenone)**, and **SGLT2 Inhibitors (Dapagliflozin, Empagliflozin)**.
- **Invasive Coronary Angiography and Target Vessel Assessment (Class I):** Defines anatomical complexity (**SYNTAX Score**), presence of **Left Main or proximal LAD / 3-vessel disease**, and most critically the **caliber and runoff quality of the distal epicardial target vessels**, which determines whether surgical bypass grafts can remain patent.

II THE REDEFINED ROLE OF MYOCARDIAL VIABILITY AND ISCHEMIA TESTING

- **Pathophysiological Concept of "Hibernating Myocardium" (Rahimtoola):** Chronically hypoperfused yet living myocytes downregulate contractile function to match reduced oxygen supply (**hibernation**), which is potentially reversible upon restoring blood flow, in contrast to irreversible **collagen scar**.
- **Non-Invasive Viability Modalities and Diagnostic Thresholds:**
  - **Late Gadolinium Enhancement Cardiac MRI (LGE-CMR — Gold Standard for Scar Transmurality):** Segments with **LGE transmurality less than 50 percent of wall thickness** (and preserved end-diastolic wall thickness >=5.5 to 6.0 mm) have a high likelihood (>70%) of functional contractile recovery after revascularization, whereas segments with **>50 percent transmural LGE** represent non-viable scar (<10% recovery).
  - **18F-FDG PET + Perfusion Imaging (Most Sensitive Modality):** Identifies **hibernating myocardium via "Perfusion-Metabolism Mismatch"** (reduced resting perfusion on Rb-82/N-13 ammonia or SPECT coupled with **preserved or enhanced 18F-FDG glucose uptake**), whereas concordantly reduced perfusion and FDG uptake (**"Match"**) indicates non-viable scar.
  - **Low-Dose Dobutamine Stress Echocardiography (DSE — Most Specific Modality):** Demonstrates a **"Biphasic Response"**—contractile improvement in akinetic/hypokinetic segments at **low-dose dobutamine (5 to 10 mcg/kg/min)** (confirming contractile reserve) followed by **worsening wall motion at peak high-dose dobutamine (20 to 40 mcg/kg/min)** (confirming inducible ischemia in a viable jeopardized territory), which has the highest positive predictive value for LVEF recovery.
  - **The Landmark Viability Paradigm Shift (STICH & REVIVED-BCIS2 Viability Substudies):**
  - **STICH Viability Substudy (Bonow et al., *NEJM* 2011 & Panza et al., *NEJM* 2019):** Proved that **the presence or absence of myocardial viability does NOT statistically interact with or predict the long-term survival benefit of CABG over medical therapy alone**; furthermore, even though viable myocardium was associated with some improvement in LVEF, **change in LVEF did not mediate improved survival**.
  - **REVIVED-BCIS2 Viability Substudy (Perera et al., *JAMA Cardiol* 2023):** Confirmed that **extent of viable myocardium did NOT identify any subgroup deriving survival, heart failure, or LVEF benefit from PCI**; instead, **total scar burden (LGE percentage on CMR)** was the strongest independent predictor of mortality and arrhythmias regardless of treatment arm.
  - **Current Guideline Stance (ESC 2024 CCS / ACC-AHA 2021):** Non-invasive viability testing is **Class IIb**—useful selectively to verify that **akinetic/aneurysmal territories subtended by diseased target vessels are not 100% transmural scar** before grafting/stenting in high-risk candidates, but **absence of viability alone must never be used to deny CABG to an anatomically suitable surgical candidate**.

III REVASCULARIZATION MODALITIES AND LANDMARK TRIAL EVIDENCE

Revascularization Modality	Guideline Class (ESC 2024 CCS / ACC-AHA 2021-2023)	Landmark Trial & Primary Outcome	Mechanistic Explanation ("Why CABG Beats PCI in ICM")
CABG + GDMT (Acceptable surgical risk & graftable distal targets)	**Class I (Level B):** First-line revascularization strategy to **improve long-term survival** in multivessel CAD + LVEF <=35%	**STICHES (10-Year STICH Extension, *NEJM* 2016):** CABG reduced **all-cause mortality by 16%** (58.9% vs. 66.1%; HR 0.84; p = 0.02; **NNT = 14**; +1.4 yr median survival) and **CV mortality by 21%** (**HR 0.79**)	**Surgical "Collateralization":** A bypass graft (especially **LIMA-to-LAD**) is anastomosed to the mid/distal vessel, bypassing the entire proximal 5–6 cm "vulnerable plaque zone" and **protecting against future fatal spontaneous Type 1 MIs**
PCI + GDMT (High/prohibitive surgical risk or patient preference)	**Class IIb (ESC 2024) / Class IIa for refractory angina:** Alternative to CABG after Heart Team review; **NOT indicated purely to improve survival in stable non-anginal ICM**	**REVIVED-BCIS2 (*NEJM* 2022, n = 700, LVEF <=35% + BCIS-Jeopardy Score >=6 + proven viability):** PCI + OMT **failed to reduce all-cause death or HF hospitalization** (37.2% vs. 38.0%; **HR 0.99**; p = 0.96) and **did not improve LVEF** at 6 or 12 months	**Focal Lesion Treatment:** Stents treat only focal flow-limiting stenoses while leaving adjacent non-obstructive vulnerable plaques unprotected in a diffusely diseased tree, while carrying periprocedural Type 4a MI risk

- **The STICH Trial Surgical Timing Caveat (The "Early Hazard vs. Late Payoff" Rule):** In the original 5-year **STICH Trial** (*NEJM* 2011, n = 1,212, LVEF <=35%), CABG incurred a **higher early (30-day) perioperative mortality** that took **2 years** to cross over, narrowly missing statistical significance for all-cause mortality at 5 years (p = 0.12) before achieving a **definitive, highly significant 16 percent all-cause mortality reduction and 28 percent reduction in death or CV hospitalization at 10 years in STICHES (*NEJM* 2016)** (with greatest benefit in patients with **all three prognostic factors: 3-vessel CAD, LVEF <27%, and LVESVi >79 mL/m2**, and in patients **under 60 to 65 years of age**).
- **Surgical Ventricular Reconstruction (SVR / Dor Procedure — STICH Hypothesis 2, *NEJM* 2009):** Adding routine surgical anterior left ventricular aneurysm plication/reconstruction to CABG reduced LV end-systolic volume by 19 percent (vs. 6 percent with CABG alone) but produced **zero improvement in symptoms, exercise tolerance, death, or cardiac hospitalization**, so routine SVR is **not** recommended unless required to resect a large, distinct dyskinetic true aneurysm causing refractory heart failure, mural thromboembolism, or incessant ventricular tachycardia.

IV PRACTICAL CONSIDERATIONS IN THE INDIAN CLINICAL CONTEXT

- **The Diffuse Diabetic Small-Vessel Phenotype:** Indian patients present with ischemic cardiomyopathy at a **younger age (often in the 50s—the younger age group in which STICHES showed the greatest 10-year survival benefit from CABG)**, but frequently exhibit a malignant diabetic coronary phenotype characterized by **diffuse tandem atherosclerosis, heavy calcification, and small distal reference vessel diameters (<2.0 to 2.25 mm)**.
- **Heart Team Navigation of "Poor Distal Targets":** When diffuse distal LAD/coronary disease renders surgical grafting anatomically unfeasible (or when advanced frailty/CKD/cirrhosis yields a prohibitive STS/EuroSCORE II), the Heart Team prioritizes **aggressive Quadruple GDMT + CRT/ICD (if indicated)**, reserving **intravascular-imaging-guided Complex High-Risk Indicated PCI (CHIP)** (with rotational atherectomy/IVL and hemodynamic IABP/Impella support when needed) strictly for patients with **limiting angina or acute coronary syndrome presentations** rather than stable asymptomatic LV dysfunction.

KEY REFERENCES

- **Velazquez EJ, Lee KL, Jones RH, et al. (STICHES Investigators):** Coronary-Artery Bypass Surgery in Patients with Ischemic Cardiomyopathy (10-Year Follow-Up of the STICH Trial), *New England Journal of Medicine*, 2016.
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- **Vrints C, Andreotti F, Koskinas KC, et al.:** 2024 ESC Guidelines for the management of chronic coronary syndromes, *European Heart Journal*, 2024.