APPLICATION OF MRI IN CARDIOMYOPATHIES

Prepared by **Dr. Sidhartha Mullapudi**, DrNB (Cardiology), MD (General Medicine)
Last reviewed: October 2026

I DEFINITION AND CLINICAL ROLE

- **Definition:** Cardiovascular Magnetic Resonance (CMR) is the non-invasive reference standard for the precise quantification of biventricular volumes, ejection fraction, and myocardial mass, uniquely providing *in vivo* tissue characterization (edema, infiltration, and fibrosis) without ionizing radiation.
- **Clinical Goal:** To differentiate ischemic from non-ischemic cardiomyopathies, establish the specific etiology of non-ischemic phenotypes, and risk-stratify patients for Sudden Cardiac Death (SCD) and Implantable Cardioverter-Defibrillator (ICD) placement.

II CORE CMR SEQUENCES (THE TISSUE TOOLKIT)

- **Cine Imaging (Steady-State Free Precession [SSFP]):** The gold standard for assessing regional and global wall motion, exact biventricular ejection fraction (EF), and myocardial wall thickness.
- **T2-Weighted Imaging and Parametric T2 Mapping:** Detects increased myocardial free water content to identify acute myocardial edema (active inflammation, acute myocarditis, or acute ischemic injury).
- **Parametric Native T1 Mapping and Extracellular Volume (ECV):** Quantifies the interstitial space between myocytes. Elevated Native T1 and ECV detect diffuse interstitial fibrosis (e.g., early diabetic cardiomyopathy) or massive extracellular infiltration (the hallmark of Cardiac Amyloidosis), whereas low Native T1 identifies intracellular glycosphingolipid accumulation (Fabry disease) or myocardial iron overload.
- **Late Gadolinium Enhancement (LGE):** Gadolinium-based contrast agents are extracellular tracers that wash out of normal myocardium but pool in regions of expanded extracellular space or ruptured myocyte membranes, identifying focal replacement fibrosis and myocardial scar.

III LGE PATTERNS: THE DIAGNOSTIC ROSETTA STONE

- **Ischemic vs. Non-Ischemic Fundamental Rule:**
  - **Ischemic Cardiomyopathy:** LGE invariably involves the **subendocardium** and extends toward the epicardium (subendocardial to transmural) following the wavefront of necrosis within a specific epicardial coronary artery territory.
  - **Non-Ischemic Cardiomyopathy:** LGE typically **spares the subendocardium**, localizing to the **mid-wall or subepicardium** in patterns that do not respect epicardial coronary distributions.

Cardiomyopathy Phenotype	Classic LGE Distribution Pattern	Key Associated CMR / Parametric Hallmark
Ischemic Cardiomyopathy	**Subendocardial to transmural** within a coronary artery territory	Transmurality >50% predicts non-viable myocardium
Dilated Cardiomyopathy (DCM)	**Linear mid-wall striae** in the basal-to-mid interventricular septum	Strong independent predictor of VT and SCD regardless of LVEF
Hypertrophic Cardiomyopathy (HCM)	**Patchy mid-wall LGE** at the **RV septal insertion points** and most hypertrophied segments	**LGE >=15% of LV mass** is a major SCD risk factor (Class IIa for ICD)
Cardiac Amyloidosis	**Global, circumferential subendocardial** or transmural LGE (including atria/RV)	**Abnormal inversion-time (TI) nulling kinetics** (myocardium nulls before or with blood pool) + **massively expanded ECV**
Acute Myocarditis	**Patchy subepicardial or mid-wall LGE**, classically in the **basal-to-mid inferolateral wall**	Positive T2 edema + T1/LGE criteria (2018 Revised Lake Louise Criteria)
Cardiac Sarcoidosis	**Multifocal, patchy basal septal, subepicardial, or transmural LGE** extending into the RV	Basal septal thinning and “hook sign”; paired with 18F-FDG PET for active inflammation
ARVC / ACM	**RV free-wall and LV subepicardial (“ring-like”) LGE** with regional akinesia/dyskinesia/aneurysm	Quantifies Task Force RV End-Diastolic Volume Index and RVEF cut-offs

IV PROGNOSTIC RISK STRATIFICATION AND ICD GUIDELINES (ESC 2023 / AHA-ACC 2024)

- **Hypertrophic Cardiomyopathy (HCM):** Extensive replacement fibrosis (**LGE comprising 15 percent or more of total LV mass**) or an **LV apical aneurysm** on CMR is a major independent risk factor for SCD and supports **Class IIa primary-prevention ICD implantation**, even when LVEF is preserved.
- **Dilated and Non-Dilated Left Ventricular Cardiomyopathy (DCM / NDLVC):** Presence of **mid-wall septal LGE** or subepicardial **ring-like LGE** (characteristic of high-risk *DSP, FLNC, LMNA*, and *PLN* genotypes) strongly predicts malignant ventricular arrhythmias and refines primary-prevention ICD selection beyond an isolated LVEF <=35 percent threshold.
- **Cardiac Sarcoidosis:** Presence of significant myocardial LGE on CMR is an independent **Class IIa indication for primary-prevention ICD implantation** even when LVEF is greater than 35 percent.

KEY REFERENCES

- **Arbelo E, Protonotarios A, Gimeno JR, et al.:** 2023 ESC Guidelines for the management of cardiomyopathies, *European Heart Journal*, 2023.
- **Ommen SR, Ho CY, Asif IM, et al.:** 2024 AHA/ACC/AMSSM/HRS/PACES/SCMR Guideline for the Management of Hypertrophic Cardiomyopathy, *Circulation / Journal of the American College of Cardiology*, 2024.
- **Libby P, Bonow RO, Mann DL, Tomaselli GF, Bhatt DL, Solomon SD:** *Braunwald’s Heart Disease: A Textbook of Cardiovascular Medicine*, 12th Ed., Elsevier, 2022.