Imaging in Heart Failure: Which, When and How?

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• **Disclosures:**
Consultancy, advisory boards and lecture fees:

Abbott, Astra Zeneca, Bayer, Bial, BMS, Benecke, Biotronik, Boehringer Ingelheim, Covidien, GE, Irokio, Medtronic, Menarini, Merck, MSD, Novartis, Pfizer, Sanofi, Servier, St Jude Medical, Tabuk
• 79 yo male, HTN, dyslipidemia
• s/p AMI x2 and CABG@71 yo
• Angina, SOB-orthopnea worsening over the last months
• Optimal medical treatment
Echocardiogram:

TDV: 127 mL

TSV: 102 mL

EF Simpson biplane: \(20\%\) *

dP/dT: 551 mmHg/seg
Intra-ventricular dyssynchrony

Septal flash
TERAPÊUTICA DE RESSINCRONIZAÇÃO CARDÍACA

Global longitudinal strain (speckle tracking):

-6,7%

Stress Echocardiogram:

RCA territory: Necrosis;
LAD territory: Myocardial Viability

GLPS-4C: -6,5%
GLPS-2C: -5%
GLPS-3C: -8,6%
• **Coronary Angiography:**
  - **Native arteries:** total occlusion left main and proximal
  - **Bypasses:**
    - LIMA-LAD patent with no lesions and good flow
    - 2 SVGs occluded
  - **Conclusion:** Non revascularizable – Medical treatment and ....
**Intra-ventricular Dyssynchrony**

- Septal-to-posterior peak wall motion delay (MM, radial)  
  - 37 ms  
  - (≥130 ms<sup>1</sup>)
- Septal-to-posterior wall motion delay (color-TDI MM, radial)  
  - 58 ms  
  - (≥130 ms)
- Opposing wall delay (peak velocity; color-TDI):
  - Septal-to-lateral  
    - 76 ms  
    - (≥65ms<sup>3</sup>)
  - Inferior-to-anterior  
    - 47 ms  
    - (≥65ms<sup>3</sup>)
  - Septal-to-posterior  
    - 118 ms  
    - (≥65ms<sup>3</sup>)
- Maximum wall delay, 12 sites (peak velocity; color-TDI)  
  - 118 ms  
  - (≥100ms<sup>4</sup>)
- Mechanical dyssynchrony index / Yu index (time-to-peak velocity)  
  - 47 ms  
  - (≥33ms<sup>5</sup>)
**Intra-ventricular Dyssynchrony**

SD *strain* longitudinal (speckle tracking)  
79 ms

SD *strain* transversal (speckle tracking)  
101 ms
Intra-ventricular Dyssynchrony

EF: 18%
**CMR**

Apical 2-chambers

SSFP cine-CMR

Apical 4-chambers

**LV** - TDV: 195 mL (105 mL/m²)  
EF: **23%**

**RV** - TDV: 56 mL/m²  
EF: 58%
CMR

Apical 3-chambers

SSFP cine-CMR

Short axis

LV- TDV: 195 mL (105 mL/m²)
EF: 23%

RV- TDV: 56 mL/m²
EF: 58%
CMR-late enhancement

Apical 3-chambers

Apical 3-chambers

Apical 3-chambers

Apical 4-chambers
CMR-late enhancement

Short axis
Clinical Evolution (12 months)

Symptomatic Improvement, NYHA-II since the 3rd month of CRT. No readmission for HF. No recurrence of flutter or Afib.
Avaliação basal (08.Jul.2009)  FEj: 20%
Avaliação 3 Meses  FEj: 31%
Avaliação 6 Meses  FEj: 31%
Avaliação 12 Meses  FEj: 32%
Imaging Modalities in Heart Failure

- Echocardiography
- Radionuclide Imaging
- CMR
- CT
- PET
Imaging in Heart Failure

Heart Failure
Assessing LV Function and Defining Prognosis
Myocardial Motion and Deformation

(A) Motion
(B) Deformation
(C) 4-chamber view
(D) Strain Rate

Courtesy of George Sutherland, MD
2D Strain/Speckle Tracking Imaging
Normal AFI
Two-dimensional strain in an apical four-chamber view in a patient with heart failure and preserved ejection fraction (A) and in a control patient (B).
Four-chamber global longitudinal strain in patients with heart failure and preserved ejection fraction and in controls.
CMR in CAD
Comprehensive Study

- Ischemia
- contractility
- perfusion
- LV Function
- gold-standard
- Irreversible lesion vs viability
- Validated against pathology
CONTRAST ENHANCEMENT PATTERNS

**Ischemic**

**Non-Ischemic**

- Idiopathic Dilated Cardiomyopathy (midwall-striations occur in 30%),
  - Myocarditis

- Hypertrophic Cardiomyopathy,
- Right ventricular pressure overloaded states (e.g. with congenital heart disease, pulmonary hypertension)

- Sarcoidosis,
- Myocarditis,
- Anderson-Fabry,
  - Chagas
- Other infiltrative disorders
CMR – How to diagnose ischemia?

Stress/perfusion CMR

Stress/dobutamine CMR
Assessment of myocardial scarring in a responder with ischemic cardiomyopathy (3-vessels coronary artery disease) prior to cardiac resynchronization therapy. (A-C) SSFP cine-CMR demonstrating severe LV systolic dysfunction, with akinesis and severe thinning at the apex, mid-apical anterior and septal walls, and mid-basal segments of the inferior wall. (D-F) Delayed contrast enhancement CMR demonstrating transmural myocardial scarring in those areas (yellow arrows) and non-transmural hyperenhancement in the basal posterior wall (white arrow). The absence of transmural scar tissue in mid posterolateral wall, where the LV lead is usually positioned, suggests that effective pacing is possible.
Image fusion of a low-dose gated adenosine stress SPECT-MPI with 13 MBq 99mTc-tetrofosmin and CT coronary angiography using prospective ECG-triggering.

Herzog B. European Heart Journal 30;6:644.
Fusion (PET-CT) Imaging in a 66-Year-Old Woman With a History of Stress-Associated Chest Pain, Risk Factors, and Electrocardiographic Evidence of LVH With Strain

Imaging in Heart Failure
– Assess morphology
– Assess function (Hemodynamics)
– Define prognosis (patient outcome)
– Help to establish, monitor and follow up a therapeutic strategy