The role of other imaging techniques (scintigram, CT and MRI)
No conflict of interest
Role of imaging in heart failure

1. Diagnosis

2. Risk stratification

3. Therapeutic interventions
### Table 2  Appropriateness criteria for the use of CVI for the diagnosis of HF aetiology

<table>
<thead>
<tr>
<th>Clinical Indications</th>
<th>Cardiovascular imaging modalities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Echo</td>
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<tr>
<td>Diagnosis of ischaemic aetiology</td>
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<tr>
<td>HF with normal findings on echocardiogram</td>
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<tr>
<td>HF with regional wall motion abnormalities (RWMA) typical for ischaemic aetiology</td>
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<tr>
<td>HF with RWMA not typical for ischaemic aetiology</td>
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<tr>
<td>Before coronary angiogram</td>
<td>–</td>
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<tr>
<td>After coronary angiogram</td>
<td>–</td>
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<tr>
<td>Viability assessment</td>
<td>–</td>
</tr>
<tr>
<td>Before coronary angiogram</td>
<td>–</td>
</tr>
<tr>
<td>After coronary angiogram</td>
<td>–</td>
</tr>
<tr>
<td>Diagnosis of non-ischaemic aetiology</td>
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</tr>
<tr>
<td>Valve disease on initial echo</td>
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<tr>
<td>Valve disease severity explains HF symptoms</td>
<td>–</td>
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<tr>
<td>Cardiac tumour on initial echo</td>
<td>–</td>
</tr>
<tr>
<td>Pericardial disease on initial echo</td>
<td>–</td>
</tr>
<tr>
<td>Congenital heart disease on initial echo</td>
<td>–</td>
</tr>
<tr>
<td>Diagnosis of diastolic dysfunction as HF aetiology</td>
<td>–</td>
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<tr>
<td>Diagnosis of diastolic dysfunction</td>
<td>–</td>
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<tr>
<td>Diagnosis of diastolic dysfunction aetiology</td>
<td>–</td>
</tr>
</tbody>
</table>
1. Assessment of ventricular volumes and function

2. Assessment of diastolic function
   - Filling time, time to peak filling, filling fraction

3. Imaging of autonomic dysfunction
PET assessment of sympathetic function

PAREPET:
quantitative $^{11}$C-HED PET imaging was one of the best predictors of sudden cardiac death (SCD)

Myocardial $^{11}$C-meta-hydroxyephedrine ($^{11}$C-HED) uptake
4. Assessment of ischemic heart disease (stress and rest myocardial perfusion)

Nuclear imaging

- Perfusion
- Metabolism
- Viability

SPECT
5. Assessment of myocardial viability

<table>
<thead>
<tr>
<th>Short Axis</th>
<th>Vertical Long Axis</th>
<th>Axial</th>
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<tbody>
<tr>
<td>Perfusion</td>
<td>Glucose Metabolism</td>
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<tr>
<td>Viable</td>
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<td></td>
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</tbody>
</table>

Nuclear imaging

- Perfusion
- Metabolism
- Viability

PET

(a) [PET scanner image]
(b) [PET scan image]
6. For prediction of CRT response

7. For the diagnosis of cardiac amyloid

99mTc-DPD localizes cardiac amyloid deposits very sensitively

- Especially in patients with ATTR type
- Uptake of 99mTc-DPD occurs in about 1/3 of patients with cardiac AL amyloidosis
- 99mTc-DPD-SPECT-CT can help to distinguish AL from ATTR

8. For the diagnosis of cardiac sarcoidosis
Ventilation – perfusion SPECT for the diagnosis of HF

Cardiac computed tomography
1. Evaluation of cardiac morphology and function

2. **Assessment of coronary artery course and origins (ischemic heart disease)**

3. Prognostic information in:
   - Chronic thromboembolic disease
   - Coronary arteries stenoses

4. Assessment of post-implant complications of LVADs

Cardiac CT
Three-vessel myocardial bridging:
A possible cause of biventricular failure and myocardial stunning

Almeida AR. Rev Port Cardiol 2018
Fig. 3. Cardiac chamber size measurements on MDCTA scans. Right and left atrial (dRA, dLA) and ventricular (dRV, dLV) diameters were assessed on transverse image at the end diastole.

Fig. 5. Cardiac thrombi in patients with CTEPH. Axial MDCTA image shows wall-adherent thrombus (arrow) in the right atrium.

1. Cannula malposition
2. LVAD infection

CT complications of LVADs
3. Pump malfunction

CT complications of LVADs
3. Pump malfunction
4. Pericardial effusion

Kink in the outflow graft

Pericardial tamponade

CT complications of LVADs
5. Pump and aortic root thrombosis

6. Pericardial hematomas

CT

complications of LVADs
Myocardial Delayed Enhancement CT for the evaluation heart failure

Idiopathic DCM

Attikon University
National and Kapodistrian University of Athens

Cardiac CT
Tissue characterization

Extracellular volume quantitation using dual-energy CT in patients with heart failure


Table 2
Correlation between both ECVs and cardiac function parameters and BNP.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DECT-ECV R Value</th>
<th>P Value</th>
<th>CMR-ECV R Value</th>
<th>P Value</th>
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</thead>
<tbody>
<tr>
<td>LVEF</td>
<td>-0.392</td>
<td>0.035</td>
<td>-0.412</td>
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<tr>
<td>EDV</td>
<td>0.138</td>
<td>0.491</td>
<td>0.145</td>
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<tr>
<td>ESV</td>
<td>0.194</td>
<td>0.332</td>
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<td>CO</td>
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<td>BNP</td>
<td>0.032</td>
<td>0.936</td>
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</table>
3D Fusion of LV Venous Anatomy on Fluoroscopy Venograms With Epicardial Surface on SPECT Myocardial Perfusion Images for Guiding CRT LV Lead Placement

Cardiovascular imaging fusion

Fluoroscopy venogram and SPECT for CRT implantation

Zhou W. JACC Cardiovasc Imaging. 2014 Dec;7(12):1239-48
Cardiovascular imaging fusion

Coronary CT and 3D wall motion tracking
MDCT and SPECT with Tc-tetrofosmin
MDCT with PET with FDG

Hybrid imaging in heart failure

Occluded stent in LCx. Lack of viability
Hybrid imaging in heart failure

Cardiac magnetic resonance
Core CMR Protocol

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Scans/Anatomy</th>
<th>Function</th>
<th>Tissue Characterization</th>
<th>Rest Perfusion</th>
<th>Washout Delay</th>
<th>Scar Imaging</th>
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</tbody>
</table>

Contrast Administered
CMR
1. Quantification of biventricular volumes and systolic function

1. Quantification of biventricular volumes and systolic function

2. Tissue characterization

- Myocardial fibrosis
2. Tissue characterization

- Myocardial edema/inflammation
2. Tissue characterization

- Iron deposition

Typical Examples of T2* Cardiac MRI Imaging to Assess Both Myocardial and Liver Iron Overload
3. Assessment of ischemia

<table>
<thead>
<tr>
<th>4-chamber</th>
<th>midventricular short axis</th>
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<tbody>
<tr>
<td>ED</td>
<td>ES</td>
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<tr>
<td><strong>rest</strong></td>
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<td><img src="image1" alt="Rest images" /></td>
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<td><strong>40 µg</strong></td>
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<tr>
<td><img src="image9" alt="40 µg images" /></td>
<td><img src="image10" alt="40 µg images" /></td>
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</tbody>
</table>
3. Assessment of viability

- End-diastolic wall thickness
- LGE
- Low dose dobutamine stress
- Newer techniques

CMR
3. Assessment of viability

- End-diastolic wall thickness
- LGE
- Low dose dobutamine stress

CMR
4. Determine the etiology of systolic heart failure

- Congenital heart disease
- Cardiomyopathies
Non-compaction

ARVC

CMR
Constrictive pericarditis

CMR
Graft disease: Role of CMR

- Primary graft failure
  - Severe LVSD (within hours/days)

- Acute rejection
  - Elevated T2 time (oedema); Increased EGE relative signal intensity
  - Caution with interpretation – T2 time usually elevated in first 6/12

- Allograft vasculopathy
  - CMR useful in detecting silent infarcts (ischaemic LGE pattern)
  - Worse strain rate (from tagging sequences)

- Other consideration
  - Erratic response to adenosine in stress perfusion (due to denervation)
  - Increased incidence of solid organ tumours and haematological malignancy (Careful scrutiny of extra-cardiac images)
CMR
Rejection in heart transplantation

CMR in cardio-oncology
CMR in cardio-oncology

Fulminant myocarditis in a patient with metastatic melanoma shortly after receiving his first cycle of Ipilimumab/Nivolumab
CMR in cardio-oncology

Pericardial constriction after radiotherapy for Hodgkin’s lymphoma
Αλήμοι σ' αυτούς που δεν γνωρίζουν ότι δεν γνωρίζουν αυτά που δεν γνωρίζουν.

Σωκράτης