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CMR vs ECHO

- CMR and ECHO show high correlation (absolute values may differ).
- LVEF by CMR, ECHO, radionuclide ventriculography were not interchangeable.
- Armstrong et al. after direct comparison of 2DE, 3DE and CMR showed that 3DE was superior to 2DE, but both 3DE and 2DE were suboptimal at identifying patients with LVEFs below a threshold value of 50% defined by CMR.
- These data suggest that
- CMR preferred for LVEF when ECHO reaches a threshold value of LV dysfunction.
- It is the recommendation of this committee to consider the use of CMR:
  - If discontinuation of chemotherapy secondary to CTRCD is considered
  - If the quality of ECHO is controversial or unreliable.
- CMR may provide an important advantage in patients with extracardiac masses.
Problems of MUGA scan

- Deterioration in LVEF on MUGA scans during anthracycline chemotherapy was associated with the development of CHF.

- Protocols rely on serial LVEF by MUGA or transthoracic echo to identify chemo-or immunotherapy LVEF reduction.

- Distinguishing small LVEF changes can be problematic.

- As a result, more advanced transthoracic echo (strain or diastolic function) assessments, with or without concomitant serum biomarkers (such as serum troponin)
CMR advantages and limitations

Advantages

- Spatial resolutions of $1 \times 1 \times 3$ mm voxel size
- Temporal resolutions of 20- to 40-millisecond frame rates with cine sequences
- Qualitative and quantitative assessment in a single examination of
  - Cardiac anatomy
  - Function
  - Perfusion
  - Tissue characteristics
  - Lack of radiation

Limitations

- Long examination and processing time
- Reactions to contrast media/NSF in patients with GFR<30
- High cost
- Need for breath holds
- ECG gating
- Claustrophobia
- Non–MRI-compatible medical devices
- Unable to detect calcium in the coronary arteries
Evaluation of RV-LV function
Oedema Imaging
Fibrosis imaging
Καρδιακοί όγκοι
Benign Cardiac Tumors

Primary cardiac tumors are rare and typically benign

- Myxoma
- Papillary Fibroelastoma
- Lipoma
- Rhabdomyoma
- Fibroma
- Hemangioma
Malignant Primary Cardiac Tumors

- Angiosarcoma
- Rhabdomyosarcoma / Other Sarcomas
- Lymphoma

Primary malignant or metastatic cardiac tumors FINDINGS
- Diameter >5 cm,
- Invasive behavior with irregular borders,
- Rightsided or pericardial involvement,
- Tissue heterogeneity on T1- and T2-weighted imaging,
- A broad base of attachment,
- Enhancement after the administration of Gd,
- Associated hemorrhagic pericardial or pleural effusions.
Metastatic Cardiac Tumors (CT)

- **Metastatic** are 40 times more prevalent than primary CT
- Autopsy studies have shown that known malignant neoplasms have cardiac metastases in 10-12% of cases.

- The neoplasms most commonly metastasize to the heart:
  - melanoma
  - bronchogenic carcinoma
  - lymphoma
  - leukemia
  - breast carcinoma
  - esophageal carcinoma

In CMR low T1- and high T2-weighted signal with variable enhancement patterns
CARDIAC METASTASIS

• Lung cancer with metastases.

• Panel A. The red arrows point to the pericardial mass, which encases the entire RA, RV, LV.

• Panel B. The anterolateral wall of the LV and the free wall of the RV are tethered to the mass (arrows).

• Panel C. The red arrows point to hyperintense mass.

• Panel D. The red arrow points to the areas of LGE within the mass. The blue arrow points to the necrotic areas within the mass.

Vasu S et al. JCMR 2013
CMR POST CHEMOTHERAPY
CVD in cancer survivors

• 5-year SR for breast cancer/hematologic malignancies increased from 53% in 2007, to 85% in 2012.

• This trend in improved cancer-related mortality is tempered by an increase in CV disease

• The results from several studies suggest that this is related to cancer therapies
CMR for post cancer evaluation

• CMR does **not** incorporate **ionizing radiation**, thus is useful for repetitive evaluations.

• During a **single exam**, both the **heart and vasculature** can be simultaneously assessed.

• In addition, CMR can be utilized to **detect multiple aspects of a disease process** by characterizing tissue, measuring function, and identifying structural or metabolic abnormalities that can be impacted by the treatment of cancer.
CMR vs Echo

- The **inter-study reproducibility** for CMR:
  - LVEDV was **4.4% to 9.2%** (12.7 to 20.3% for 2D echo),
  - LVEF was **2.4% to 7.3%** (8.6% to 9.4% for 2D echo),
  - LV mass was **2.8% to 4.8%** (11.6% to 15.7% for 2D echo)

- **Low inter-observer variability** was noted comparing CMR volumes derived by cine and spin echo CMR.

- The 3-dimensional acquisitions of LV volumes and EF are very useful when cardiac function becomes reduced and the LV assumes an abnormal shape (different from a prolate ellipsoid assumed for LVEF, using a 2D technique).
Myocardial Tissue Characterization with CMR

• A study of 46 women with breast cancer treated with anthracyclines and/or trastuzumab, myocardial edema identified by qualitative T2-w was reported in 49% of the patients at 1 or 4 months during therapy.

• In a subgroup of 35 patients with 12 months follow-up, patients with edema were more likely to have persistent reduction in RV but not LV function.

Grover S et al. Int J Cardiol. 2013
Diffuse myocardial fibrosis by T1-mapping in children with subclinical anthracycline cardiotoxicity: relationship to exercise capacity, cumulative dose and remodeling

- Myocardial T1 and ECV were early tissue markers of LV remodeling that may represent diffuse fibrosis in children with normal LVEF post-anthracycline.

- They are related to cumulative dose, exercise capacity and myocardial wall thinning.
Three years after anthracycline chemotherapy, increased T1 and ECV occur independent of underlying cancer or CV comorbidities, suggesting that interstitial fibrosis in cancer survivors is related to prior receipt of a potentially cardiotoxic cancer treatment.

Cardiac Amyloidosis in Cancer

- CMR is the benchmark modality for diagnosis of infiltrative disorders like amyloidosis.

- LGE remains in myocardium longer, due to replacement of myocytes by amyloid

Syed IS et al. JACC Cardiovasc Imag 2010
Cardiac iron overload

- When T2* drops below 20 msec due to cardiac iron overload, the LVEF has been shown to decrease with an associated increased mortality.

Recommendations

- Despite the excellent reliability of nuclear techniques, ESMO recommend 2D echo for the serial cardiac monitoring during and after anticancer therapy without mention of MUGA or ERNA

- Most centers consider patient age, body habitus, echogenicity, availability, expertise, previous modality used for LVEF.

- The Expert Consensus for Imaging of Cancer Patients recommends:
  - baseline monitoring using echocardiography to measure and report 2D and 3D LVEF and GLS.
  - CMR if quality suboptimal
CARDIO-ONCOLOGY
It takes two to Tango