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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 after direct comparison of 2^{DE}, 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)

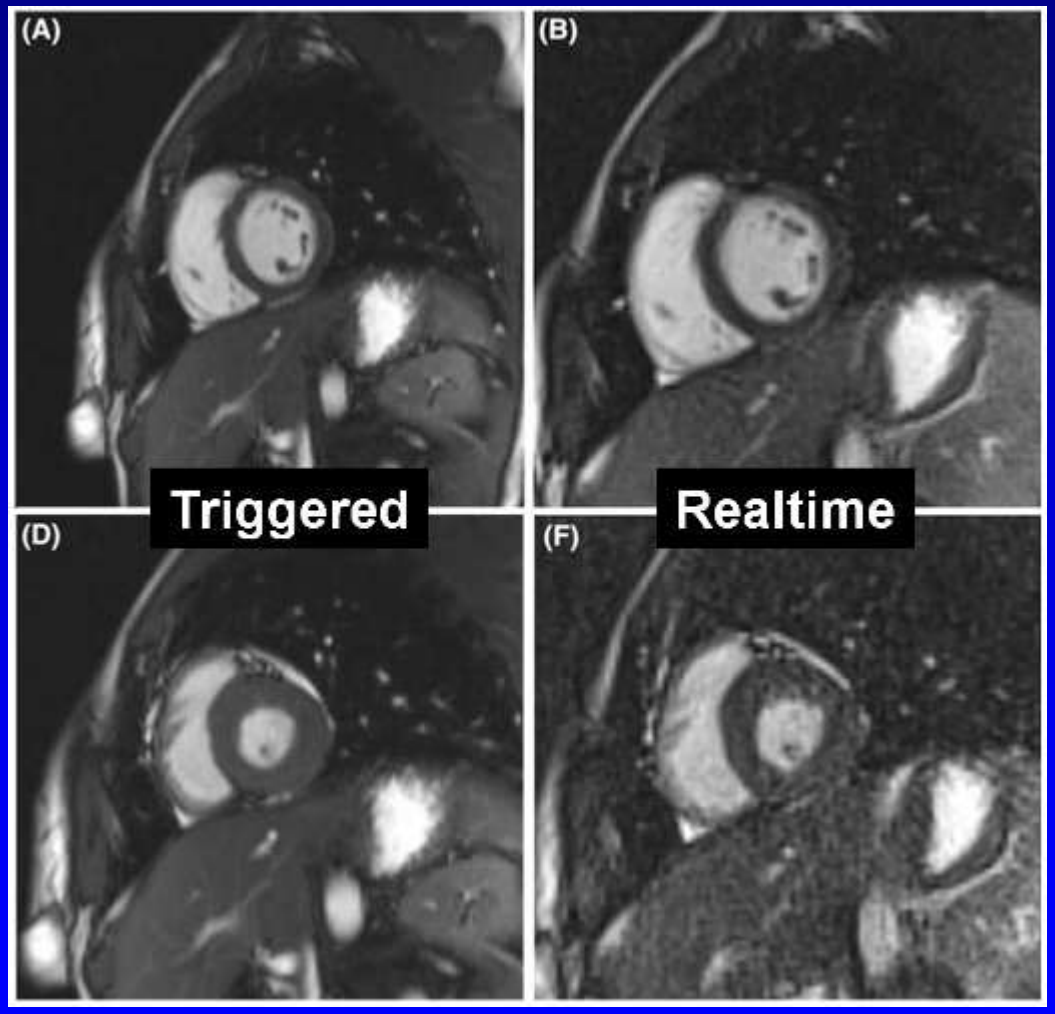
CMR advantages and limitations

Advantages

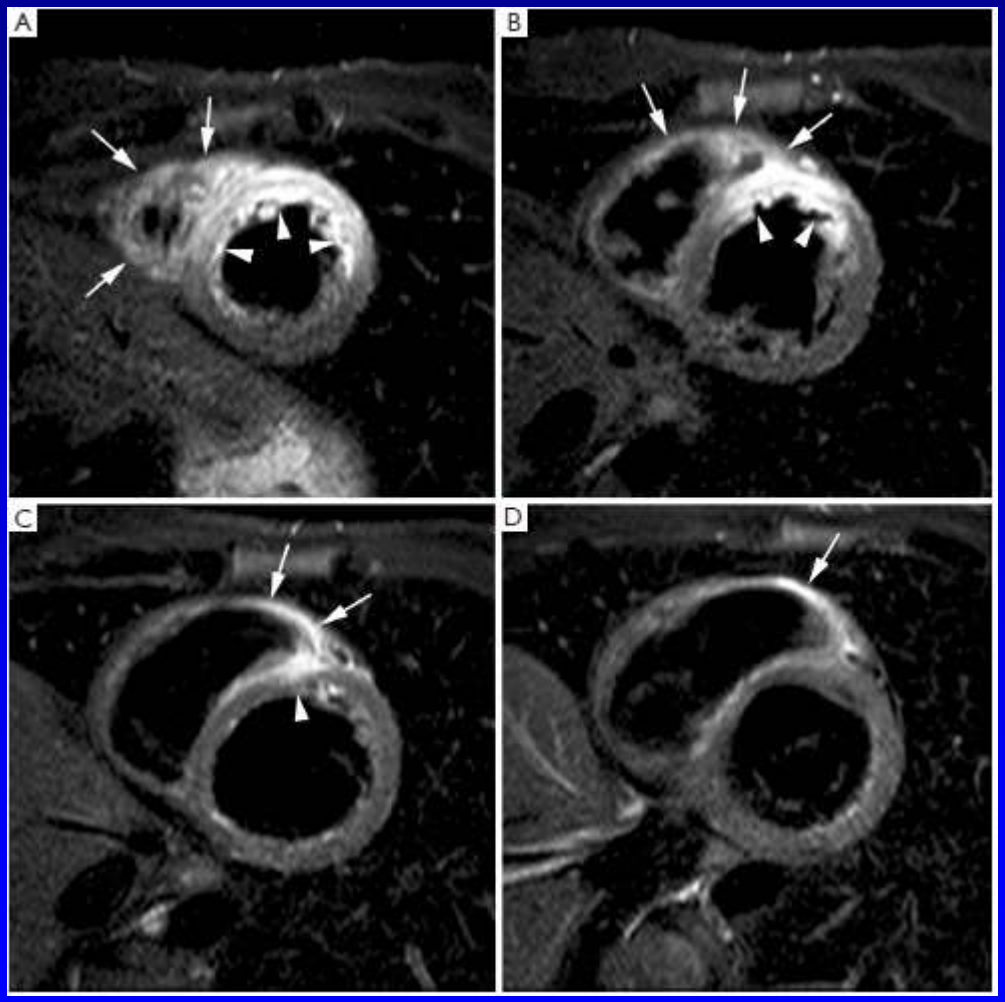
- Spatial resolutions of 1 × 1 × 3 mm voxel size
- Temporal resolutions of 20- to 40-millisecond frame rates with cine sequences
- Qualitative and quantitative assessment in a single examination of
- Cardiac anatomy
- Function
- Perfusion
- Tissue characteristics
- Lack of radiation

- 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

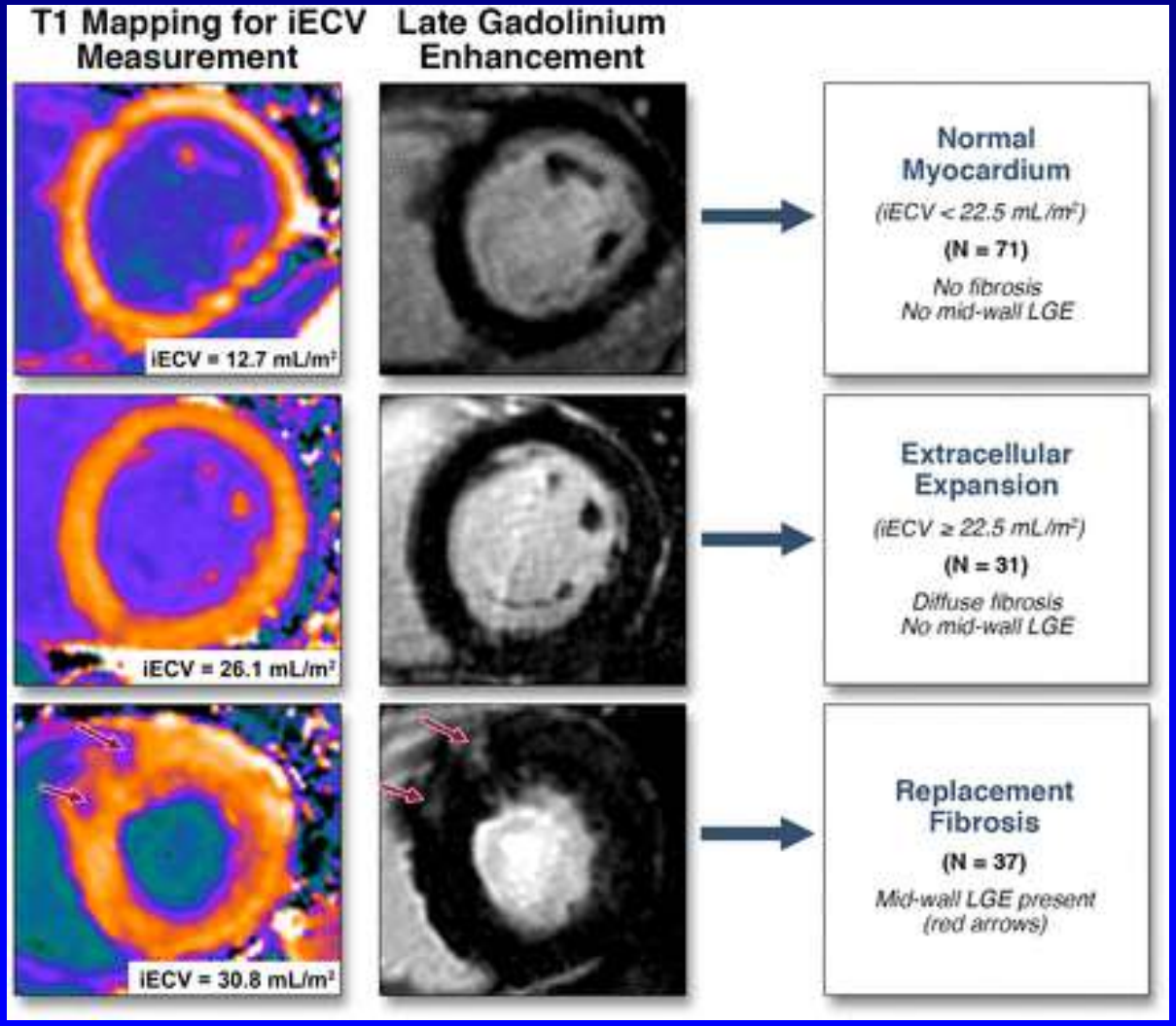
Evaluation of RV-LV function



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.

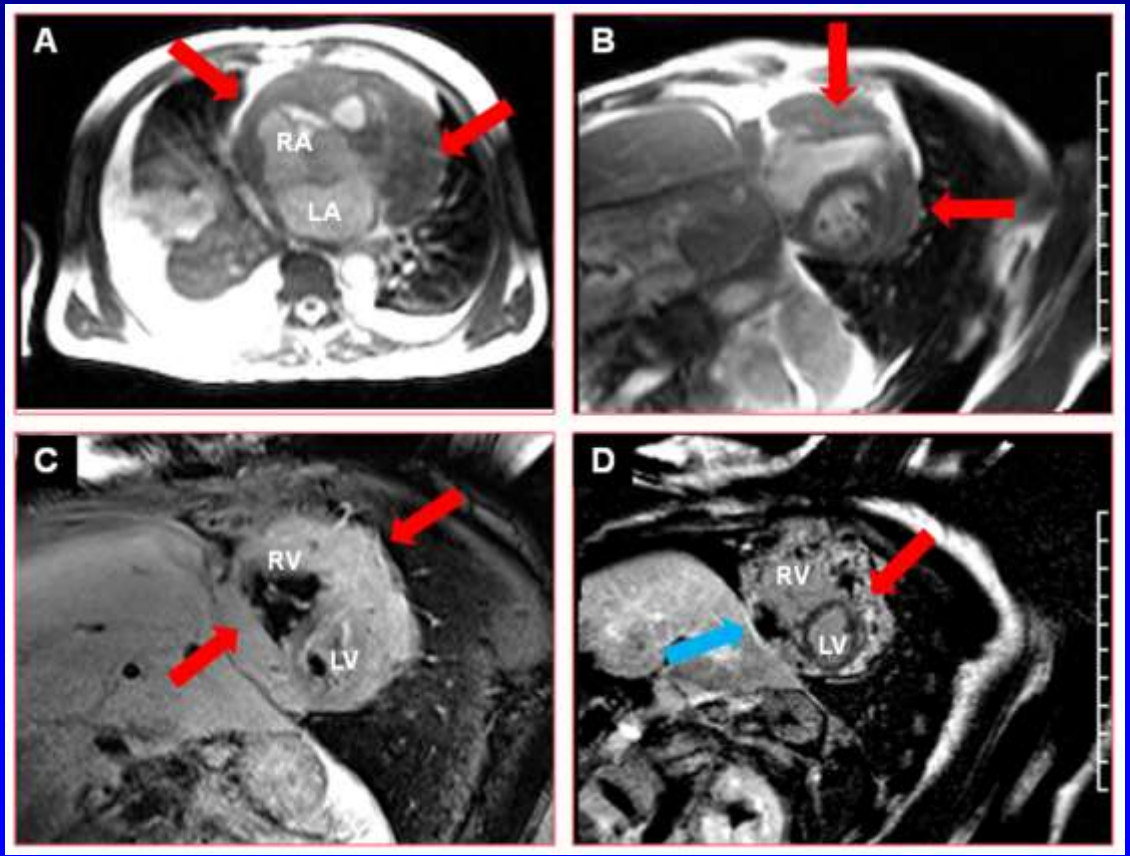
Metastatic Cardiac Tumors (CT)

- **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.

Tham et al. JCMR 2013

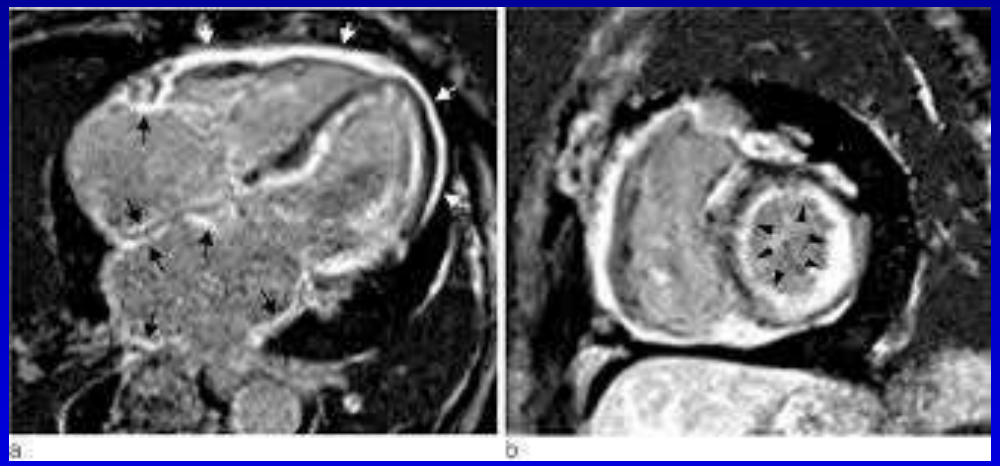
Anthracycline-Associated T1 Mappings are Elevated Independent of CV Comorbidities in Cancer Survivors

- **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**

Jordan JH et al. Circ Cardiovasc Imaging 2016

Cardiac Amyloidosis in Cancer

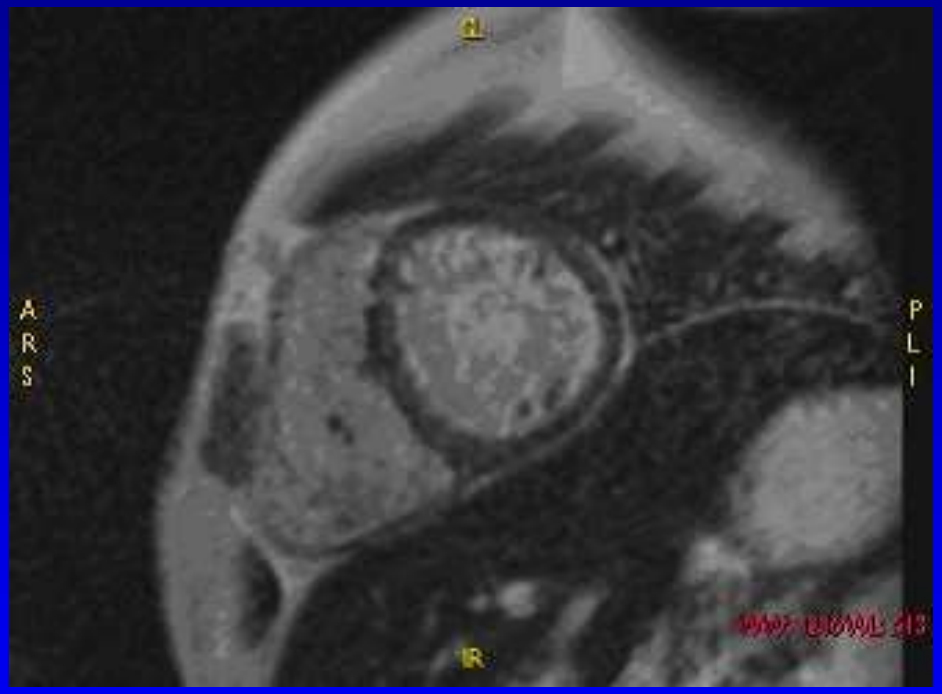
- CMR is the benchmark modality for diagnosis of infiltrative disorders like amyloidosis.
- LGE remains in myocardium longer, due to replacement of myocytes by amyloid



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.**



Anderson LJ et al. Eur Heart J. 2001

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
- (Bovelli D et al. Ann Oncol. 2010)

- 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
- (Plana JC et al. J Am Soc Echocardiogr. 2014)

CARDIO-ONCOLOGY
It takes two to Tango