ADVANCED CARDIAC IMAGING IN HEART FAILURE

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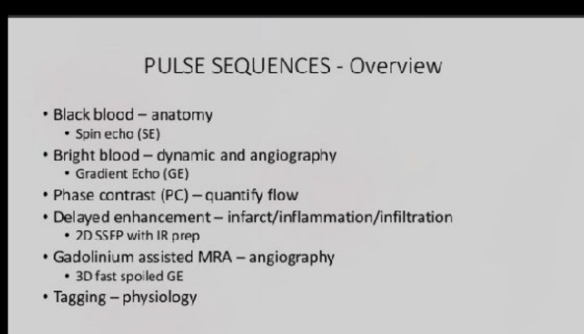
DIFFERENT MODALITIES

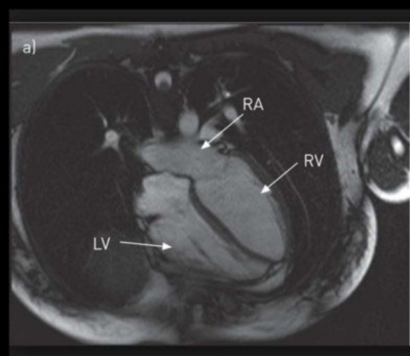
- Cardiac MRI
- Cardiac PET
- Cardiac CT
- Echocardiogram

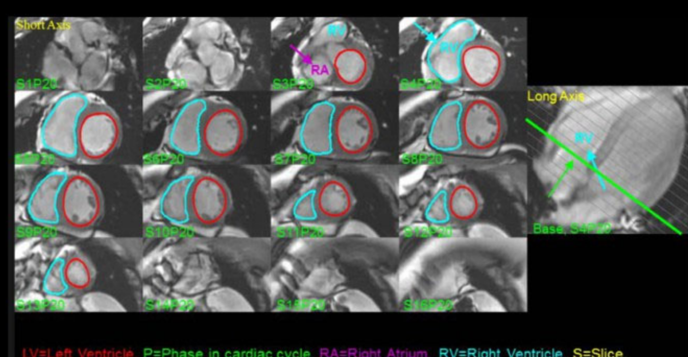
CARDIAC MRI

- CMR has many advantages
- accuracy and reproducibility, no issues with poor acoustic windows like echo
- larger field of view and better spatial and temporal resolution than echo
- no radiation
- ability to characterize myocardial tissue, which helps figure out the etiology of heart failure like myocarditis, sarcoidosis, amyloid , hemochromatosis
- It allows comprehensive evaluation of ventricular size and function including right ventricle and is considered gold standard for LVEF and RVEF
- Very useful for viability testing prior to revascularization

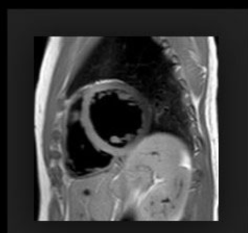


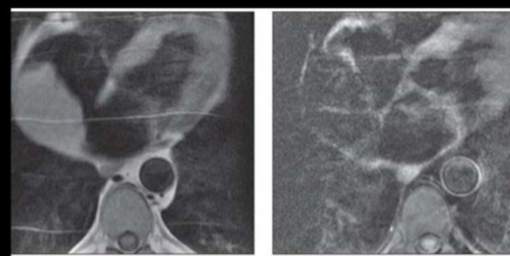
ANATOMY AND FUNCTION



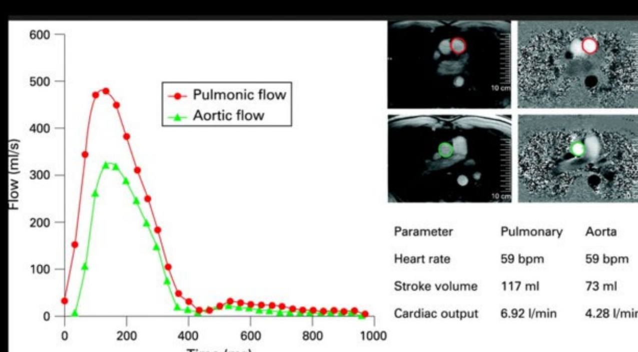


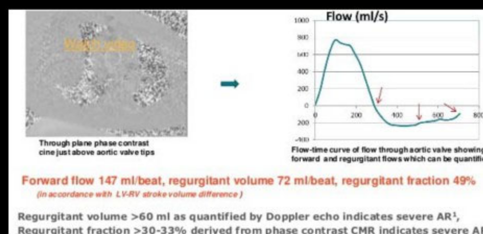
DARK BLOOD IMAGING (DOUBLE INVERSION) AND FAT SATURATION(TRIPLE INVERSION) SEQUENCES





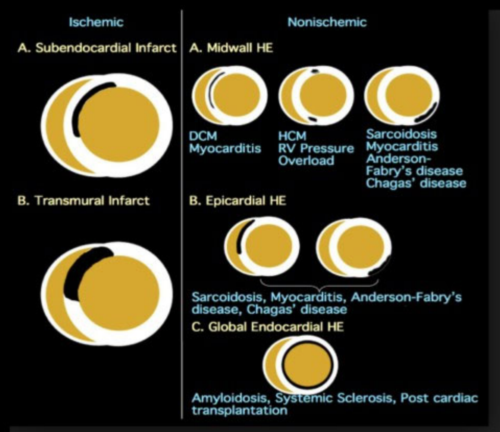
PHASE CONTRAST





DELAYED ENHANCEMENT

PATTERNS OF DELAYED ENHANCEMENT AND ETIOLOGY

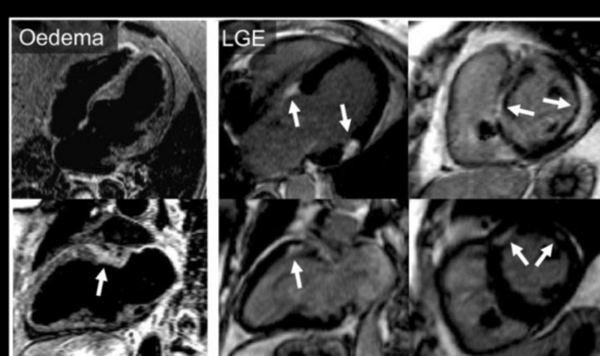


NON- ISCHEMIC CARDIOMYOPATHIES

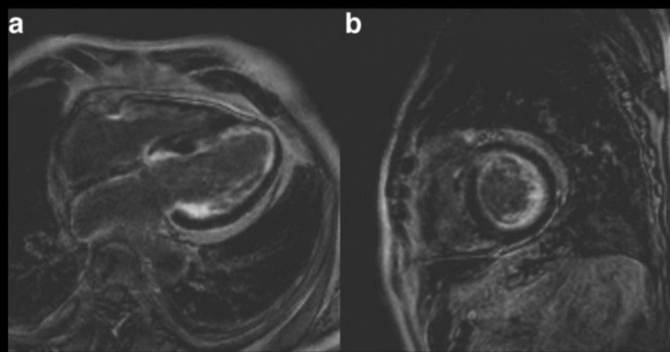
HEMOCHROMATOSIS

Grade of Iron Deposition	Liver T2* (ms)	Heart T2* (ms)
Severe	< 1.8	< 10
Moderate	1.8 - 3.8	10 - 15
Mild	3.8 - 11.4	15 - 20
Normal	>11.4	> 20

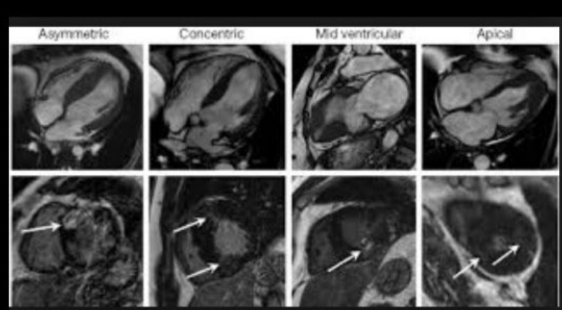
SARCOIDOSIS CARDIAC MRI



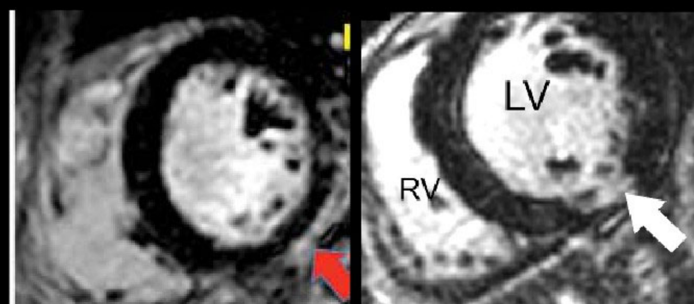
AMYLOID CARDIAC MRI



HCM MORPHOLOGY AND >15% DELAYED ENHANCEMENT PREDICTS SCAR



MYOCARDITIS



ISCHEMIC CARDIOMYOPATHY

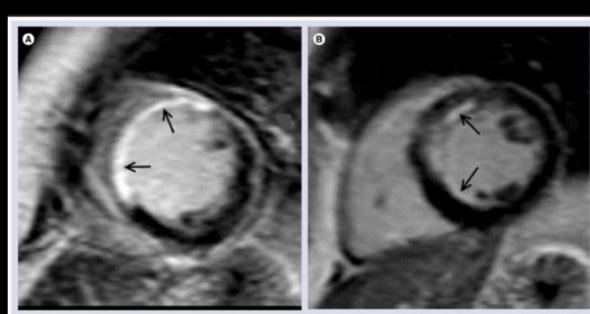
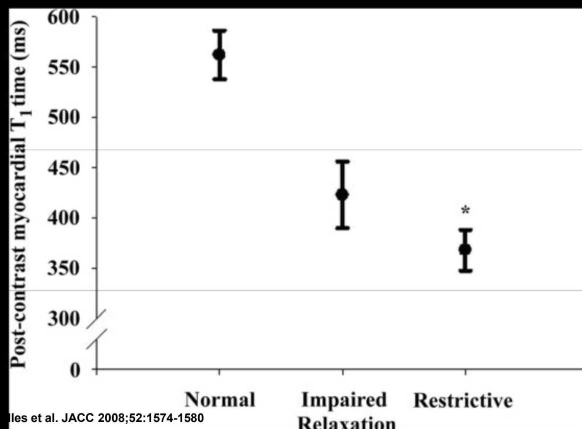


Figure 2. Delayed-enhancement MRI of patients with ischemic cardiomyopathy. Infarcted myocardium can be detected in coronary artery territories spanning the range from transmural or full-thickness hyperenhancement (arrows) **(A)** to partial thickness subendocardial hyperenhancement (arrows) **(B)**.

Post Contrast T1 Myocardial Fibrosis



NUCLEAR IMAGING IN HEART FAILURE

- SPECT
- PET

Advantages of PET

Lesser radiation in 3-4 m SEV as compared to SPECT of 9-15 mSEV

Provides Myocardial blood flow and flow reserve

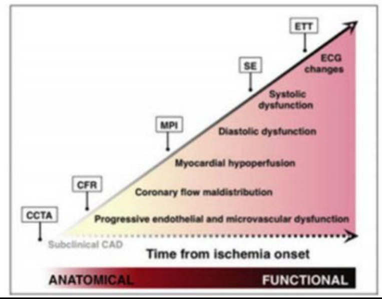
Useful in post transplant patients cardiac vasculopathy and its early detection

FDG PET can be used for viability

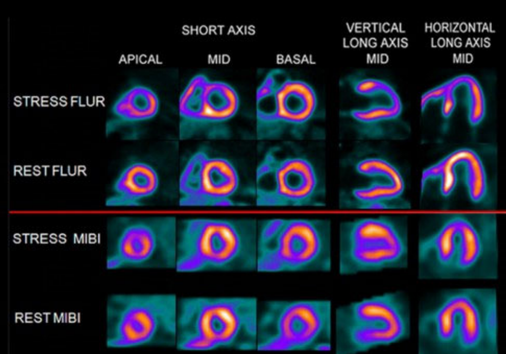
Table 2. Typical radiation exposure, as measured by effective dose, from rest-stress MPI, CCTA, and angiography in women. Adapted with permission[5]

Typical radiation exposure (by Effective Dose) from cardiac imaging in women	Effective dose, mSv
Annual background exposure	≈ 3
Invasive coronary angiography	≈ 7
Rest-stress MPI SPECT	
Dual-isotope MPI SPECT—should be avoided	≈ 22
Technetium Tc 99m (NaI camera)	≈ 11
Technetium Tc 99m (CZT camera)	≈ 6
Stress-only MPI SPECT	≈ 1-3
Rest-stress MPI PET	
Rubidium Rb82	≈ 3
Nitrogen N13	≈ 2
CCTA	
Overall	≈ 10
With dose-reduction techniques	<2-5
Coronary artery calcium scoring	≈ 1-2

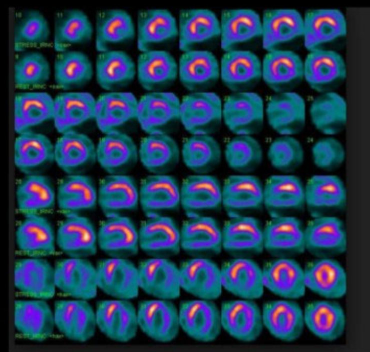
CCTA, coronary computed tomographic angiography; *MPI*, myocardial perfusion imaging; *NaI*, sodium iodine; *CZT*, cadmium zinc telluride; *PET*, positron emission tomography; *SPECT*, single-photon emission computed tomography



ISCHEMIA



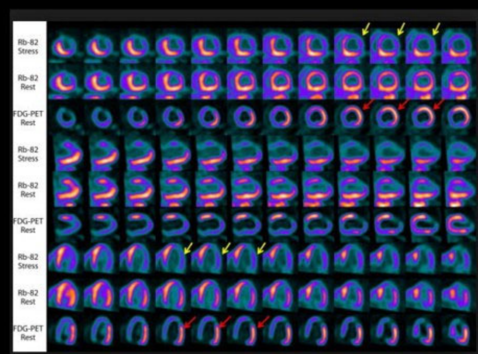
HIBERNATING MYOCARDIUM



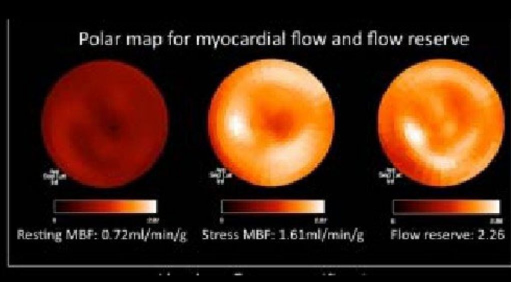
FDG PET VIABILITY

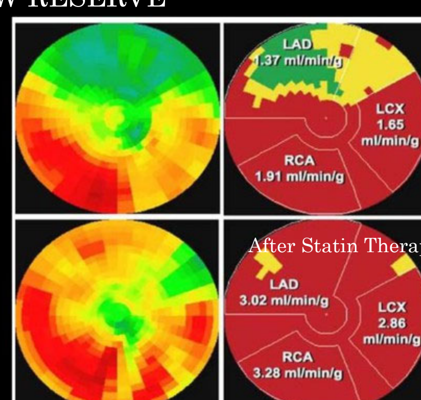
	Spectrum of disease by PET/CT to evaluate rest perfusion and metabolism					
	Normal perfusion and metabolism		Abnormal metabolism		Abnormal perfusion and/or metabolism	
Perfusion	Normal	Normal	Normal	Abnormal	Abnormal	Abnormal
FDG	Normal (Negative)	Diffuse (non-specific)	Focal increase	Focal increase	Focal increase (different areas)	Normal (Negative)
Interpretation	**Normal**	**Non-specific***	**Early Disease**	**Mismatch Pattern**	**Scar and Inflammation**	**Scar**

*Likely failure to suppress FDG uptake by normal myocardium although rarely can also be seen with diffuse disease

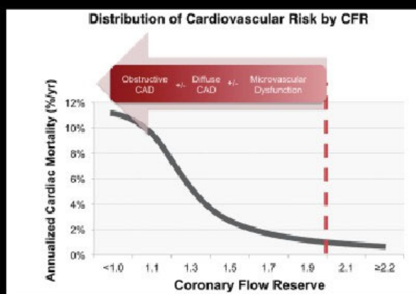


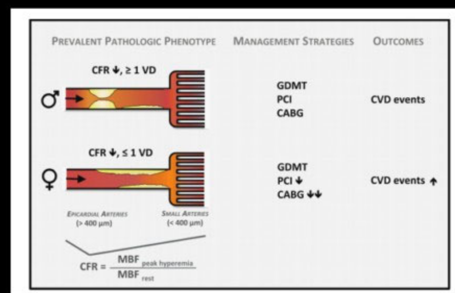
MYOCARDIAL BLOOD FLOW AND CORONARY FLOW RESERVE



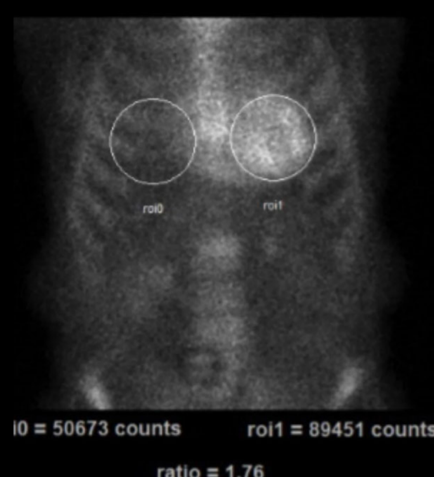


CORONARY FLOW RESERVE





PYP FOR CARDIAC AMYLOID



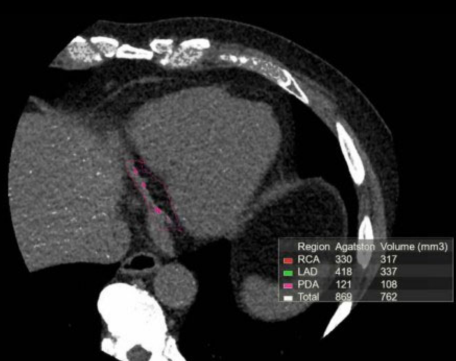
CARDIAC CCTA

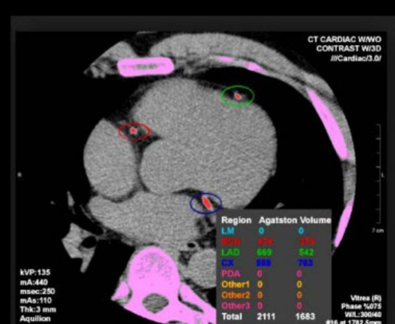
High spatial resolution with results in superior anatomical details

Less radiation wither newer techniques of prospective gating and less tube voltage

Physiology now available with CT- FFR along with anatomical stenosis at no extra radiation or scan times

CALCIUM SCORE

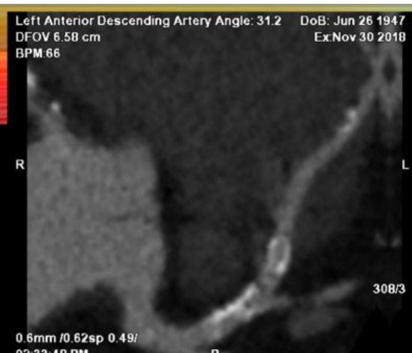




Reference 6

Risk Implications

CACS	10-Year Risk of Nonfatal MI or CHD Death	Risk Stratification
0	Less than 1%	Lower
1 – 99	4%	Lower to moderate
100 – 399	13%	Moderate
400 or greater	24%	High



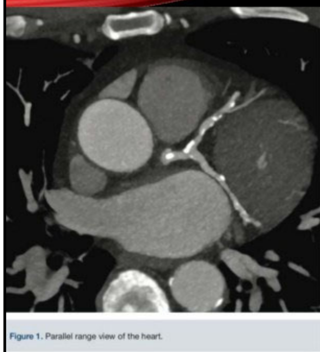
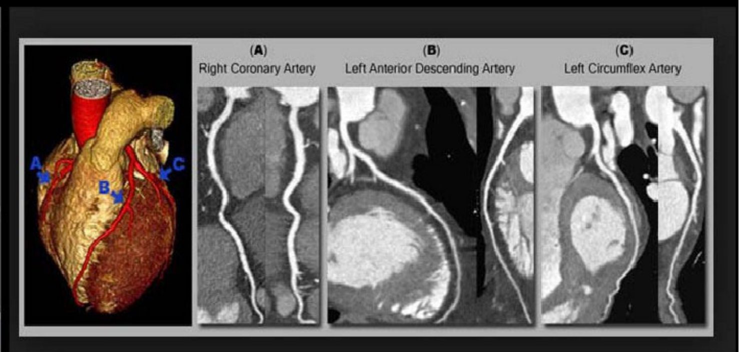


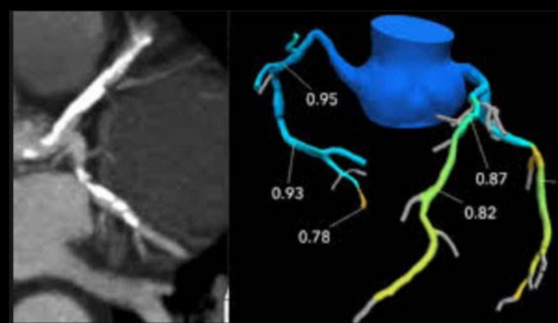
Figure 1. Parallel range view of the heart.



Reference 5

- FFR derived from CCTA images is emerging as a novel noninvasive method to evaluate lesion-specific drop of CAD.
- CT-derived FFR is calculated by processing the same images used for evaluating coronary arteries under resting conditions.
- The significance of coronary lesions at hyperemic flow condition can be estimated by computational flow modeling, and no adenosine is required. Thus, CT-derived FFR estimates virtual hyperemia for the calculation.
- Hence, additional image acquisition, radiation exposure, or pharmacological stress during CCTA scanning are not necessary for the computation of FFR from coronary CT.

CT-FFR



Reference 4

QUESTIONS

Pattern of delayed enhancement in amyloidosis

□ Sub epicardial
□ Sub endocardial
□ Mid myocardial
□ Transmural

What is the accepted cut-off of coronary flow reserve

□ 0.5
□1
□ 1.5
□2

REFERENCES

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- Cardiovascular MRI ECR Journal
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- Diagnostic and interventional cardiology July 23,2018 dave fornell et al
- Low dose CTA UCLA
- Virtual medical center