Αιφνίδιος θάνατος
Η συμβολή της απεικόνισης στη πρόβλεψη

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ΝΙΚΑΙΑ ΠΕΙΡΑΙΑΣ

Background

- Sudden Cardiac Death = death from definite or probable cardiac causes within 1 hour of symptom onset.
- Ventricular fibrillation is the first recorded rhythm in 75–80% of pts presenting with sudden cardiovascular collapse(bradycardiac is being recognized more often now).

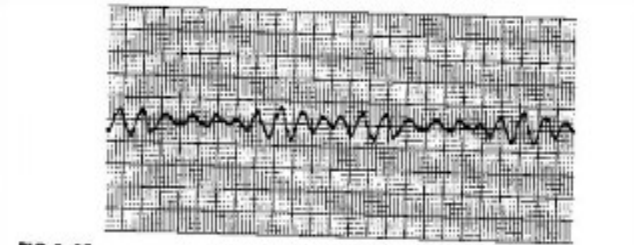
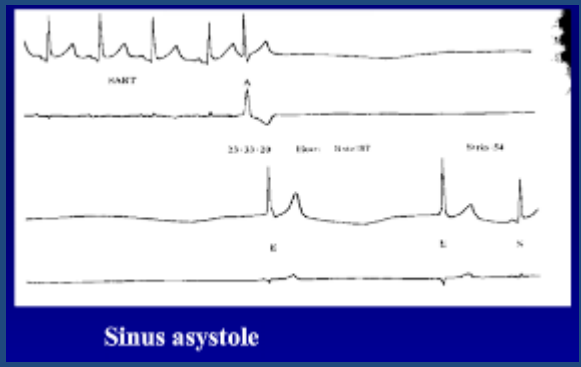


FIG 5–25.
Ventricular fibrillation. Note the irregular fibrillatory QRS waves. This represe
no effective contractions of the ventricles, cardiac arrest.



Sinus asystole

Causes of SCD

Account for >50% cardiac death

- Ove
  - ( ) se (‘hardening of the arteries’)
    - 1st manifestation of CAD in 25% is SCD

The incidence of sudden cardiac death increases with age, in both men and women as well as whites and nonwhites

Identifying those at risk

Imaging targets in sudden cardiac death

- All current imaging seems to address only a few mechanistic targets :
- structure of the heart
- function
- presence of scar
- state of the cardiac autonomic system (in a few cases).
- vulnerable plaque ;

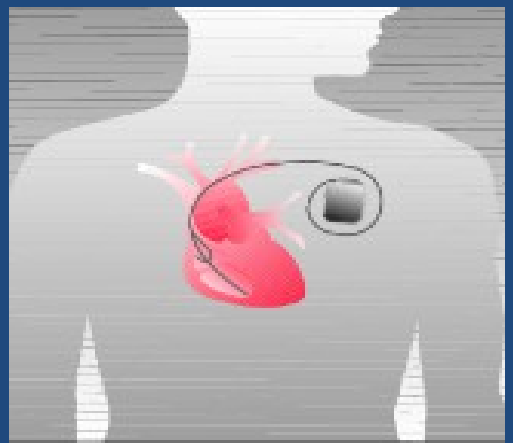
Identification of structural heart disease

- Structural heart disease portends an increased risk for SCD and **imaging provides the best ability to map and characterize cardiac structure.**
- Most of the population-attributable risk (PAR) of **SCD is in subjects without any known structural abnormalities**.

Kadish A.H., Bello D., Finn J.P. (DETERMINE) trial. J Cardiovasc Electrophysiol. 2009;20:982–987. [PubMed

LV Ejection fraction (EF)

- In patients with ischemic and non-ischemic cardiomyopathy and recommendations for ICD treatment for primary prevention of SCD, now considered standard of care, are heavily dependent on levels of EF – namely left ventricular ejection fraction of ≤35% in symptomatic patients (II_III) .



LVEF

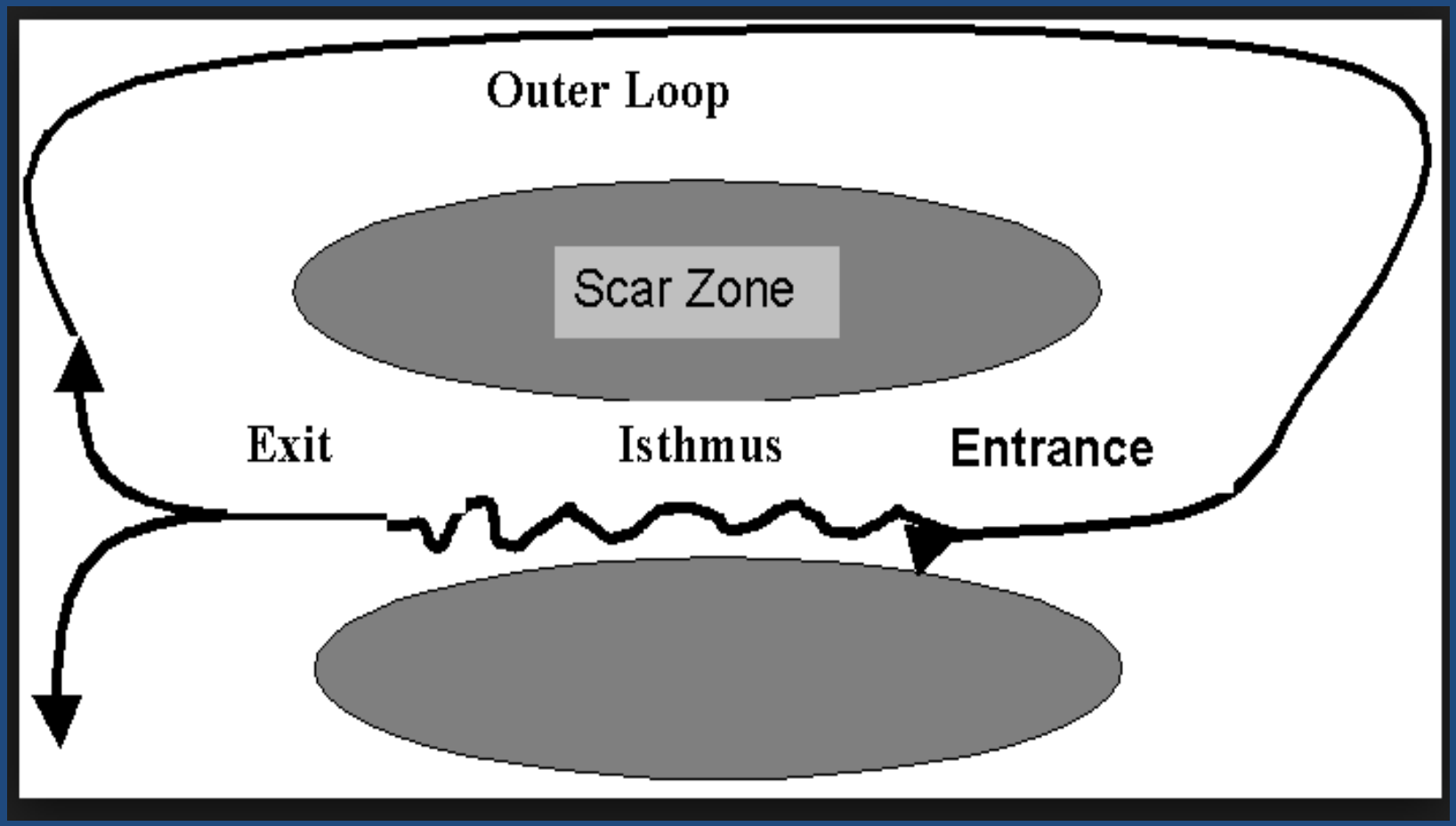
- EF is a poor marker with low sensitivity and specificity. SCD is more common in pts with lesser degrees of LV dysfunction and those with the lowest EF die more often with pump failure.
- EF measurement is highly unreliable with great inter-observer variation and this is even worse in pts with AF or multiple PVCs (both are common and portend SCD).

LEFT VENTRICULAR FUNCTION

- Viability and dyssynchrony can be best characterized through imaging and remain targets in the evaluation for SCD .

Kadish A.H., Bello D., Finn J.P. J Cardiovasc Electrophysiol. 2009;20:982–987. [PubMed

SCAR

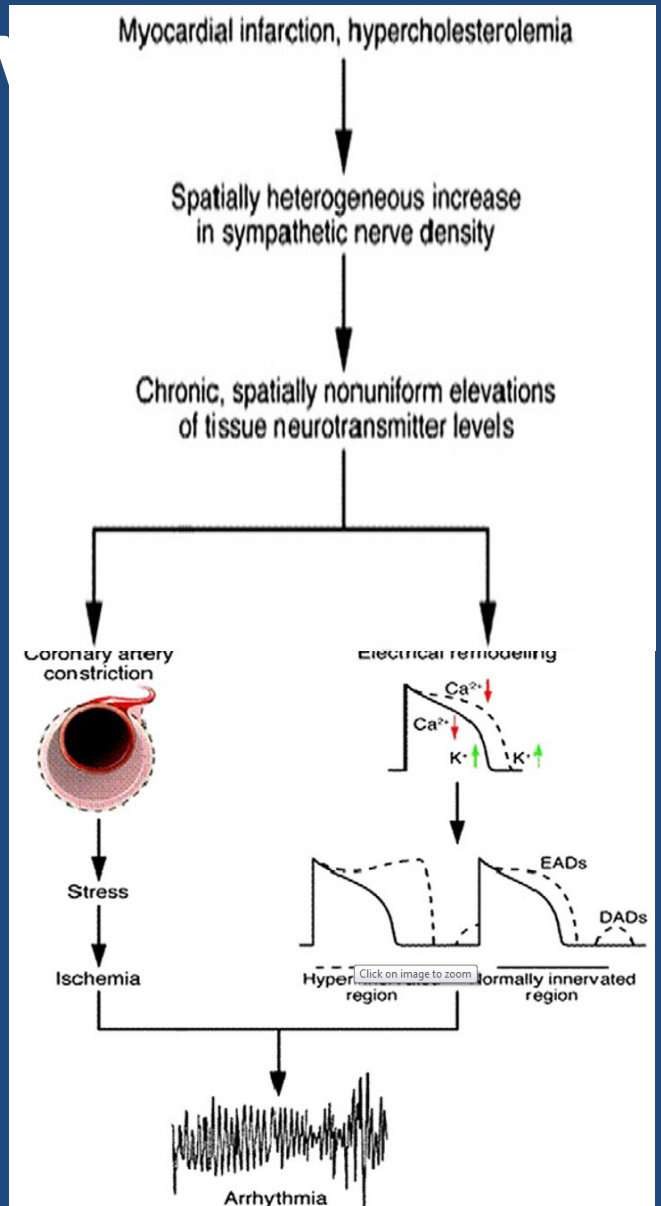


Ventricular scars consist of regions of dense fibrosis with collagen and fibrocytes, but also contain regions with surviving myocyte bundles

Ventricular scars are a major cause of ventricular tachycardia in many forms of heart disease, allows slow conduction and re-entrant currents .

Abnormal cardiac autonomic acti

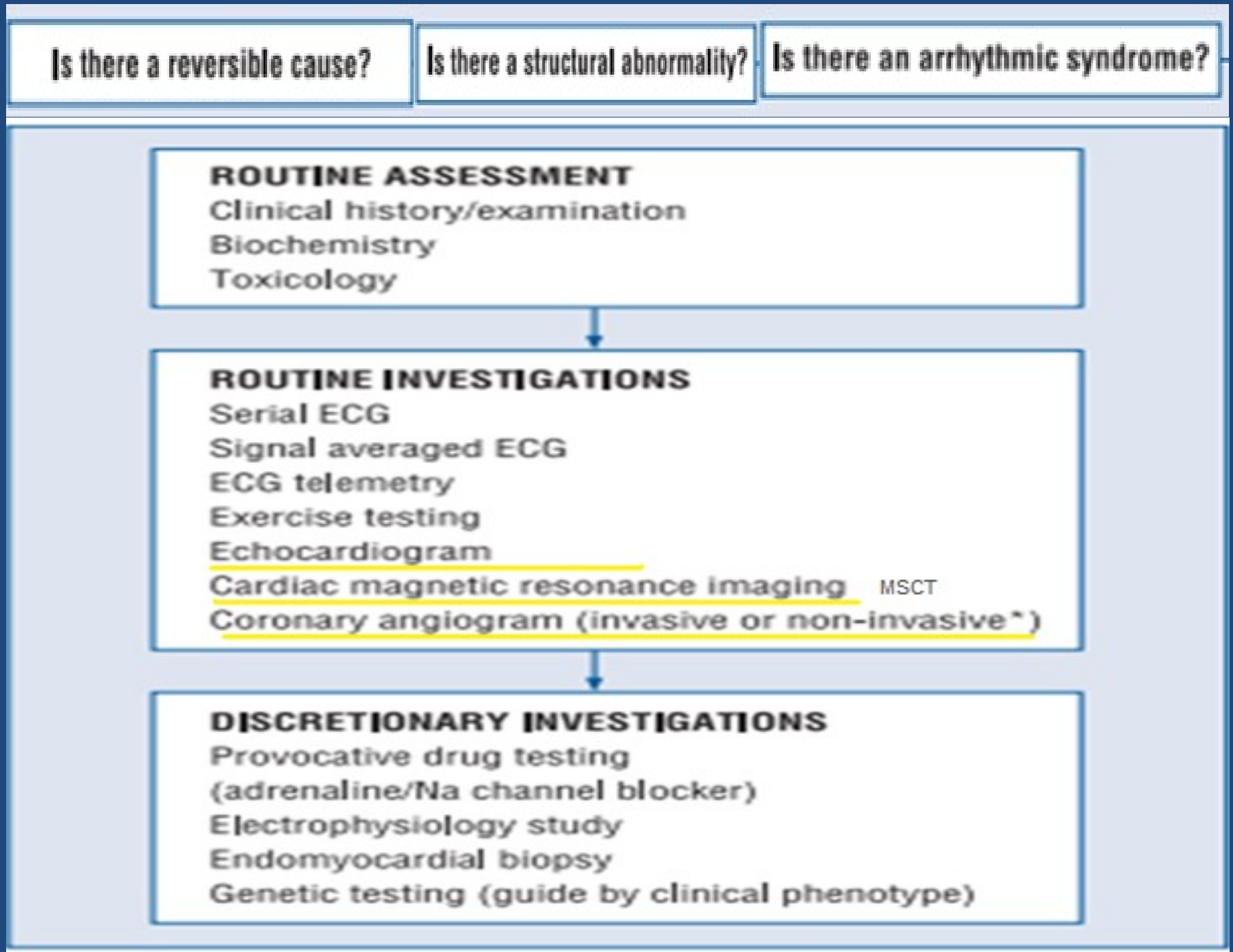
Abnormalities in cardiac autonomic activity are considered to be contributory factors or triggers in SCD.



Abnormal cardiac autonomic activity

- Patients with depressed baroreflex sensitivity(BRS) <3ms/mmHg and depressed HRV SDNN<70ms had been shown to have higher total mortality (17% vs 2% with both tests normal).
- Heart rate turbulence (HRT) show mixed results in trials.

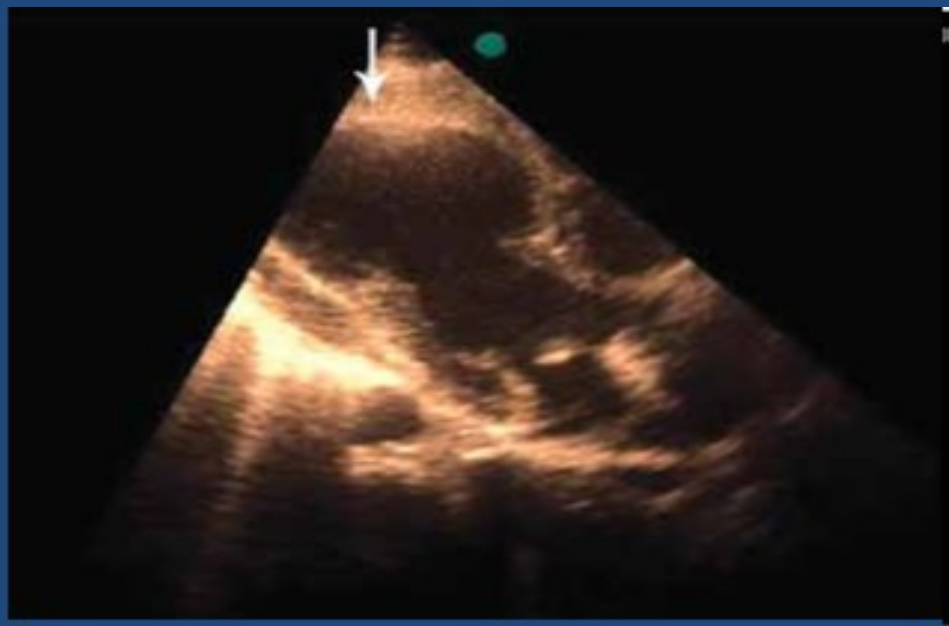
La Rovere MT, Bigger JT, Jr, Marcus FI, et al. Baroreflex sensitivity and heart-rate variability in prediction of total cardiac mortality after myocardial infarction ATRAMI (Autonomic Tone and Reflexes After Myocardial Infarction) investigators. Lancet. 1998;351:478–484. [PubMed]

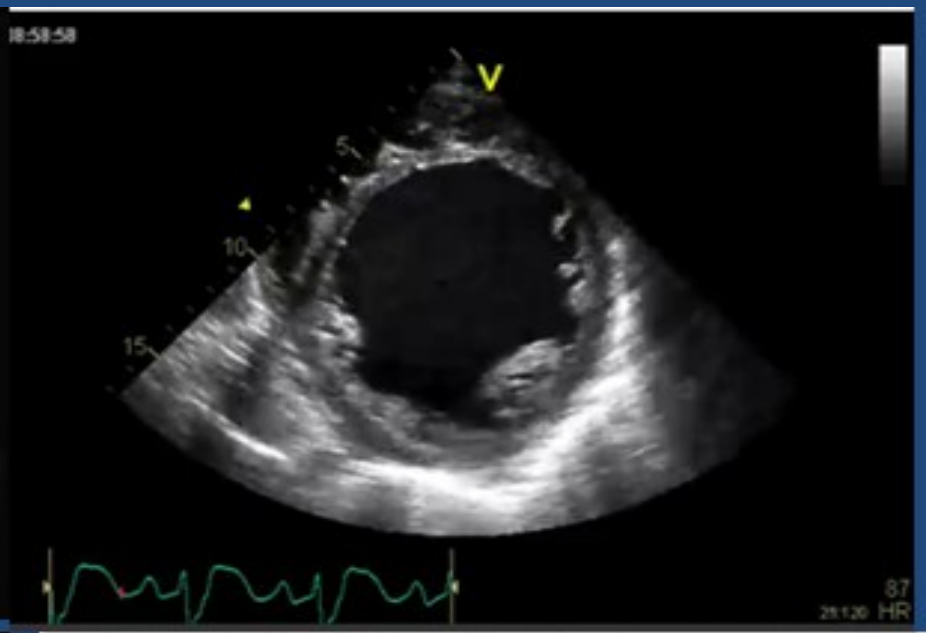

Is there a reversible cause?
Is there a structural abnormality?
Is there an arrhythmic syndrome?
ROUTINE ASSESSMENT
Clinical history/examination
Biochemistry
Toxicology
ROUTINE INVESTIGATIONS
Serial ECG
Signal averaged ECG
ECG telemetry
Exercise testing
Echocardiogram
Cardiac magnetic resonance imaging
MSCT
Coronary angiogram (invasive or non-invasive*)
DISCRETIONARY INVESTIGATIONS
Provocative drug testing
(adrenaline/Na channel blocker)
Electrophysiology study
Endomyocardial biopsy
Genetic testing (guide by clinical phenotype)

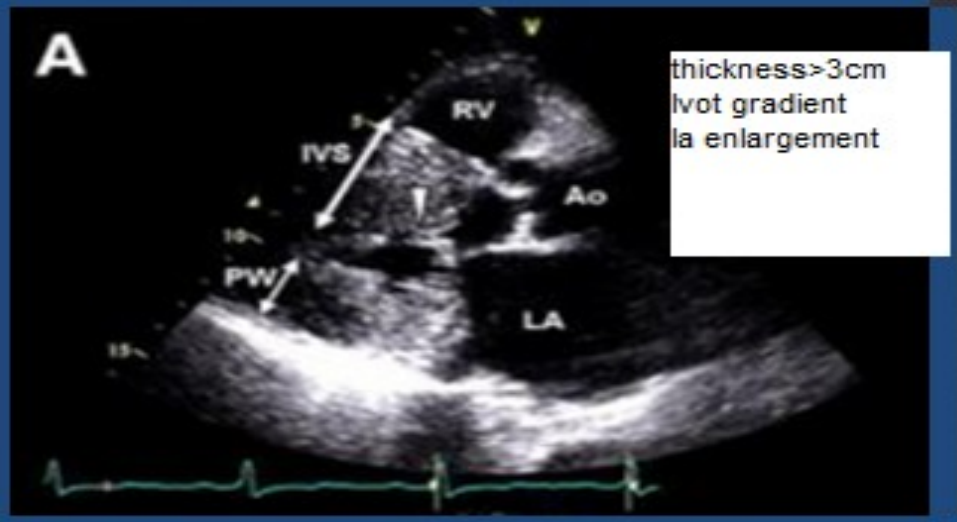
Echocardiography

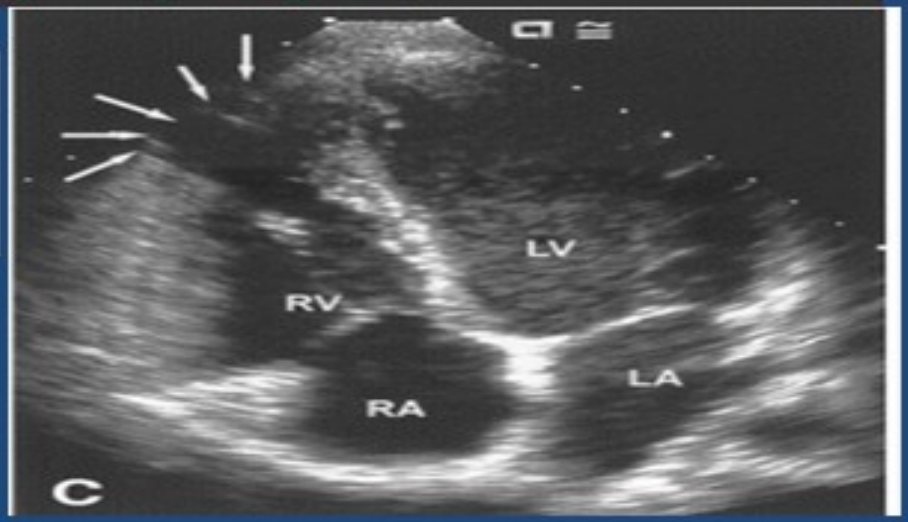
- evaluation of patients with suspected structural heart disease
- regional and global function
- ventricular volumes -EF
- thickness and mass .

STRUCTURALE HEART DISEASE









EF assessment

- **Most of the trials showing benefit in identification and treatment of pts prone to SCD have used Echo.**
- CMR remains the best option to measure EF – it is highly accurate and reproducible.
- Radionuclear techniques are available for EF measurements but suffer from many of the same limitations in pts with abnormal rhythms (e.g. AF).

Bloch Thomsen P.E., Jons C. Circulation. 2010;122:1258–1264. [PubMed]

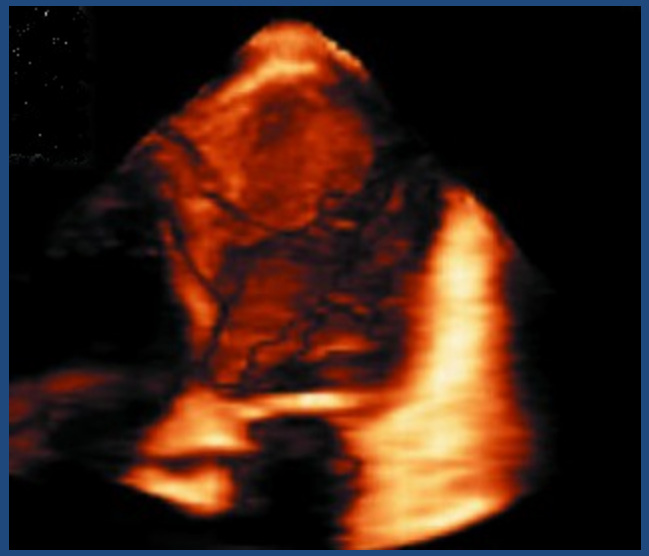
3D - ECHO

-3D is better for quantifying

EF and volumes compared

to 2D echo

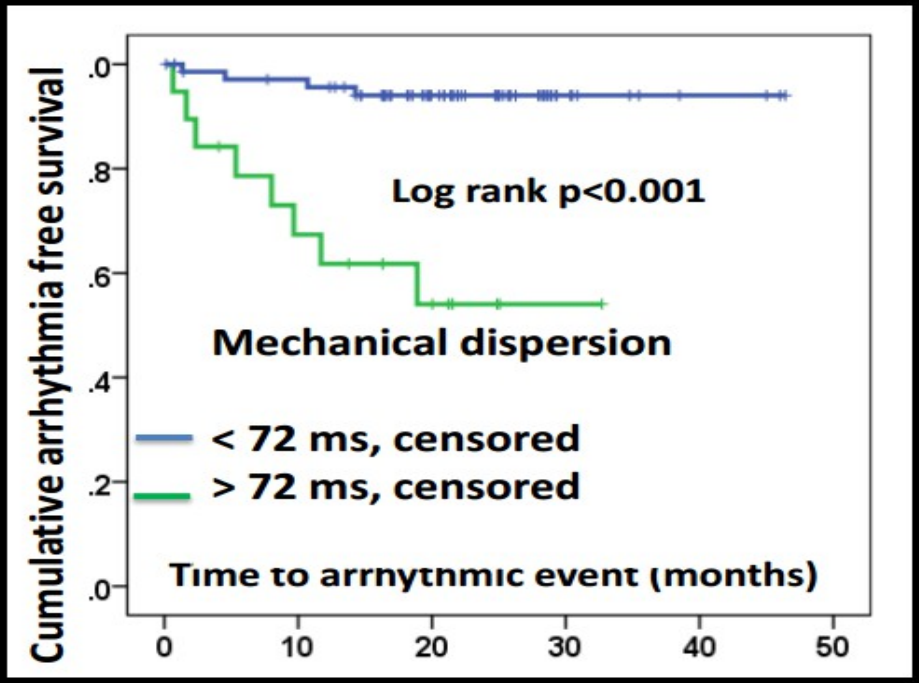
- While 3D echo will give us a more accurate EF, it is not known if this as yet translates to better prediction of SCD.



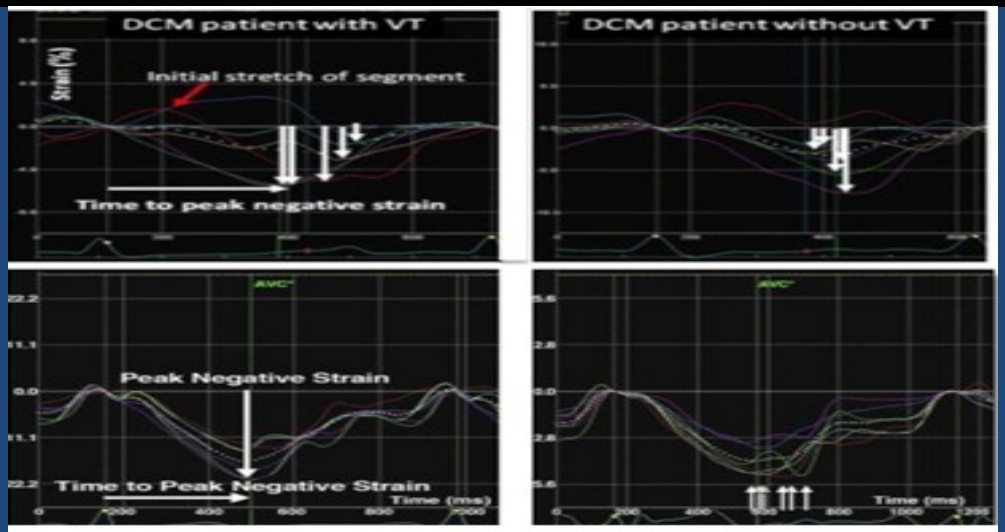
Bloch Thomsen P.E., Jons C. Circulation. 2010;122:1258–1264. [PubMed]

Kristina H. Haugaa, MD, PhD, Björn Goebel, MD, Thomas Dahlslett, MD, Kathleen Meyer, MD, Christian Jung, MD, Alexander Lauten, MD, Hans R. Figulla, MD, PhD, Tudor C. Poerner, MD, PhD, and Thor Edvardsen, MD, PhD, *Oslo, Norway; Jena, Germany*

Mechanical dispersion predicted ventricular arrhythmias in patients with non- ischemic cardiomyopathy independently of EF



K Haugaa et al J Am Soc Echocardiogr 2012



Myocardial strain

- Myocardial strain curves are better than EF in predicting LV function as well as ventricular arrhythmias ;.
- GLS thus might be an important and easily obtainable parameter in predicting risk in pts early after MI, especially in those with EF >35% .

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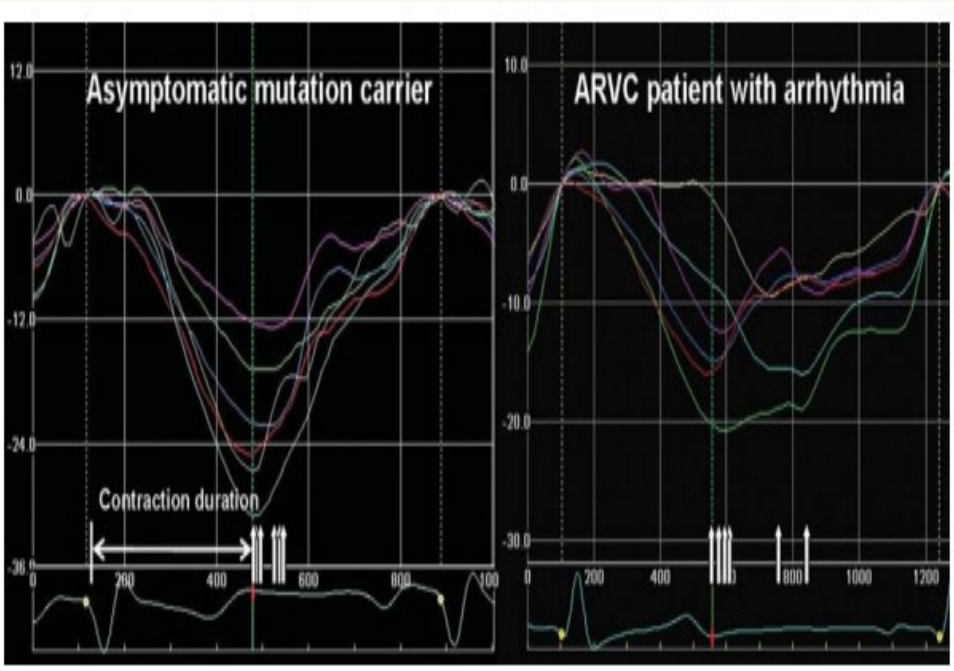
ARVC

Mechanical dispersi
heterogeneity and
decreased myocardi
strain is prominent
in patients with ARV
showing arrhythmia
and could be used f
risk stratification of

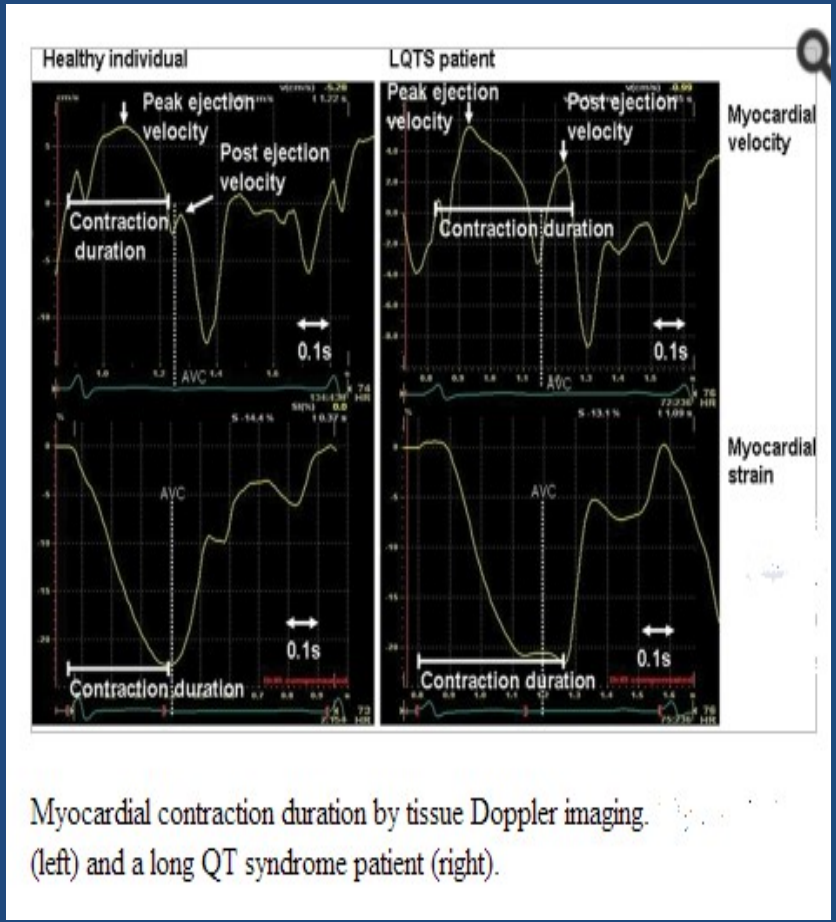


Mechanical dispersion in an asymptomatic mutation carrier (left panel) and an arrhythmogenic right ventricular cardiomyopathy patient with recurrent arrhythmias (right panel). Horizontal white arrow indicates contraction duration defined as the time from onset R to maximum myocardial shortening. Vertical arrows indicate the timing of maximum myocardial shortening in each segment. Right panel shows more pronounced mechanical dispersion.

Boogers M.J., Borleffs C.J.W., Henneman M.M. J Am Coll Cardiol. 2010;55:2769–2777. [PubMed]

Eur Heart J. 2009 Feb;30(3):330-7. **Left ventricular mechanical dispersion by tissue Doppler imaging: a novel approach for identifying high-risk individuals with long QT syndrome.** Haugaa KH et al.

Dispersion of myocardial contraction assessed by TDI was increased in LQTS patients. Prolonged contraction duration was superior to QTc for risk assessment.



Myocardial contraction duration by tissue Doppler imaging. (left) and a long QT syndrome patient (right).

Nuclear imaging and SCD

Nuclear techniques including most commonly, (SPECT-MPI), can predict high risk of cardiovascular events, including SCD.

It provides information beyond EF measurement on gated studies; it can assess ischemia, viability and scar tissue that are predictors of death or recurrent ventricular arrhythmias.

Boogers M.J., Borleffs C.J.W., Henneman M.M. .J Am Coll Cardiol. 2010;55:2769–2777. [PubMed]

Abnormal cardiac autonomic activity and imaging /Cardiac iodine-123 metaiodobenzylguanidine imaging (MIBG)

- Radiotracers that are picked up into the cardiac adrenergic synapse, using a mechanism similar to catecholamines, are used to measure cardiac adrenergic activity (123Iodine-MIBG) .
- Cardiac MIBG, but not **signal-averaged electrocardiogram** (SAECG)**, heart rate variability, and QT dispersion**, is a powerful predictor of SCD in pts with mild-

Cardiac magnetic resonance imaging (CMR)

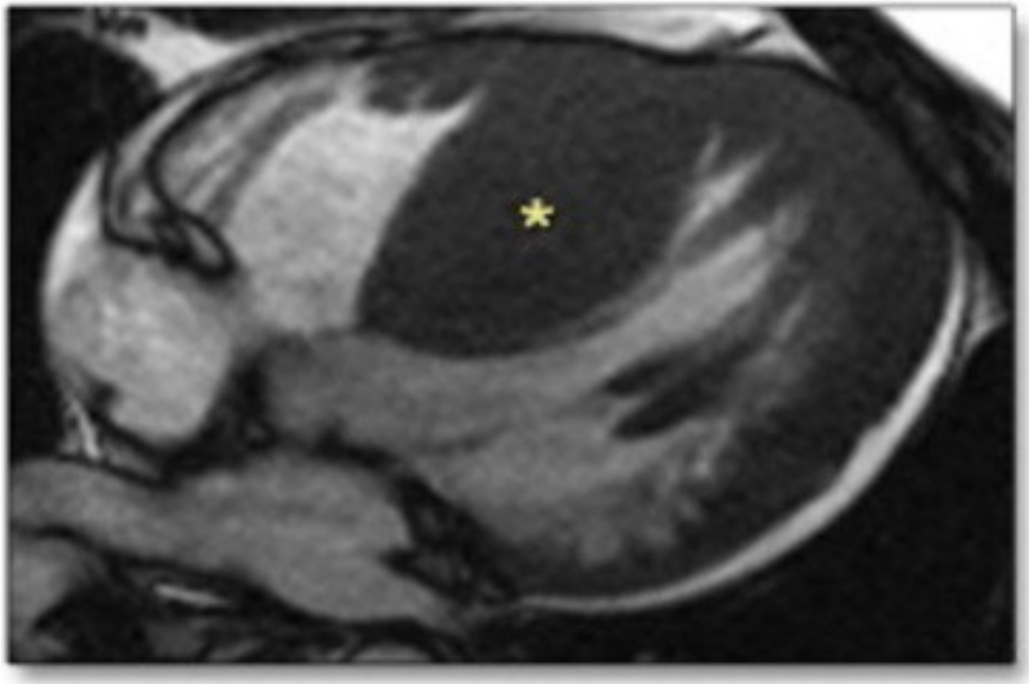
- The gold standard, for morphology (EF, Volume, Thickness and Mass), and propably inducible ischemia.

The gold standar for Scar recognition (heart failure with preserved as well as reduced EF, HCM, ARVC and infiltrative diseases.

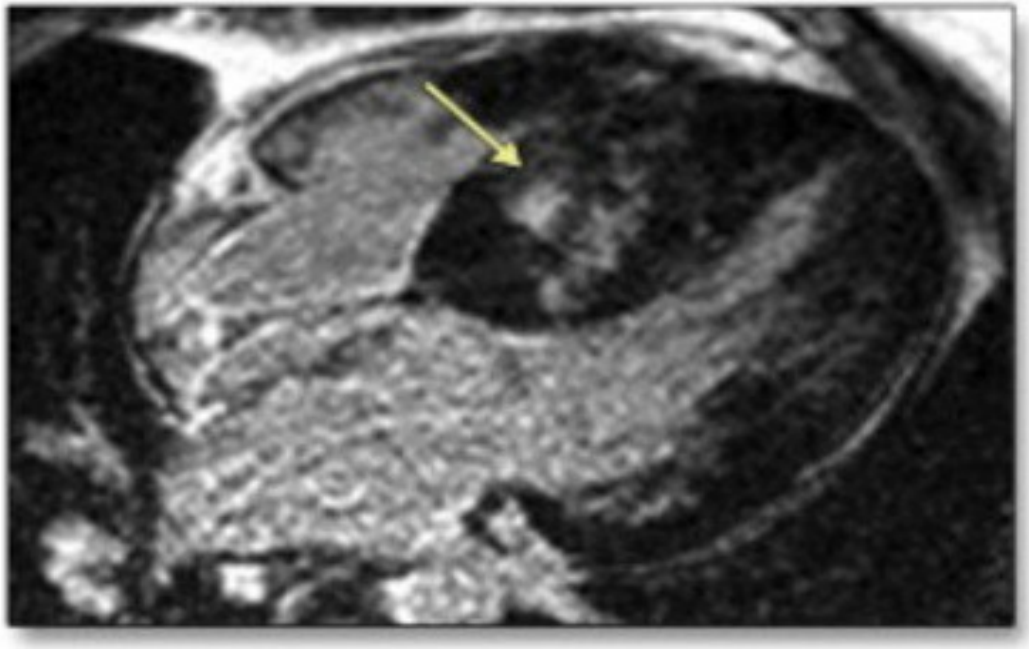
The gold standar for identification the characteristics of the peri infarct zone (presumably a mixture of dead and living cells with variable degree of viability - an arrhythmogenic substrate)

Kadish A.H., Bello D., Finn J.P. (DETERMINE) trial. J Cardiovasc Electrophysiol. 2009;20:982–987. [PubMed

Cine Imaging
End-diastole



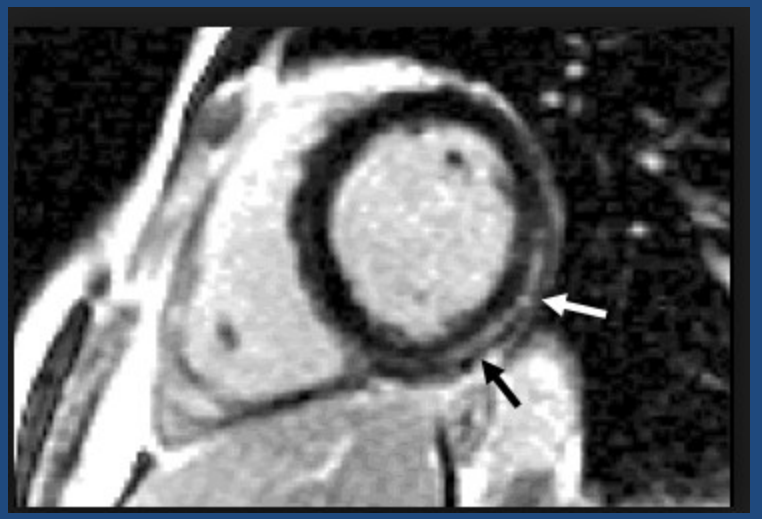
Delayed Enhancement
Imaging Post Gd
Injection



CMR - Myocarditis

No patient with biopsy proven myocarditis but without LGE died on follow up; this was irrespective of LV size and function.

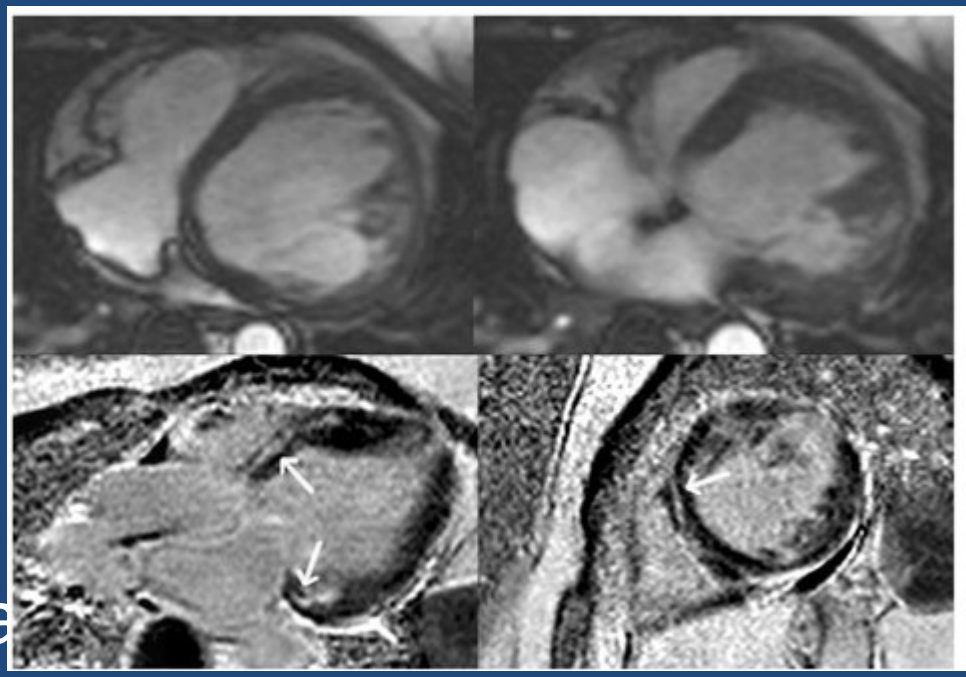
On the other hand, the presence of



. Maron M.S. Contrast-enhanced CMR in HCM; J Am Coll Cardiol Imaging. 2013;6:597–599. [PubMed]

CMR - ARVC

Right ventricular LGE predicts increased likelihood of inducible sustained ventricular tachycardia in patients with ARVC. Presence of diffuse disea including left ventricular involvement with CMR,



. Maron M.S. Contrast-enhanced CMR in HCM: J Am Coll Cardiol Imaging. 2013;6:597–599. [PubMed]

MDCT
Coronary arteries variants & congenital anomalies; using

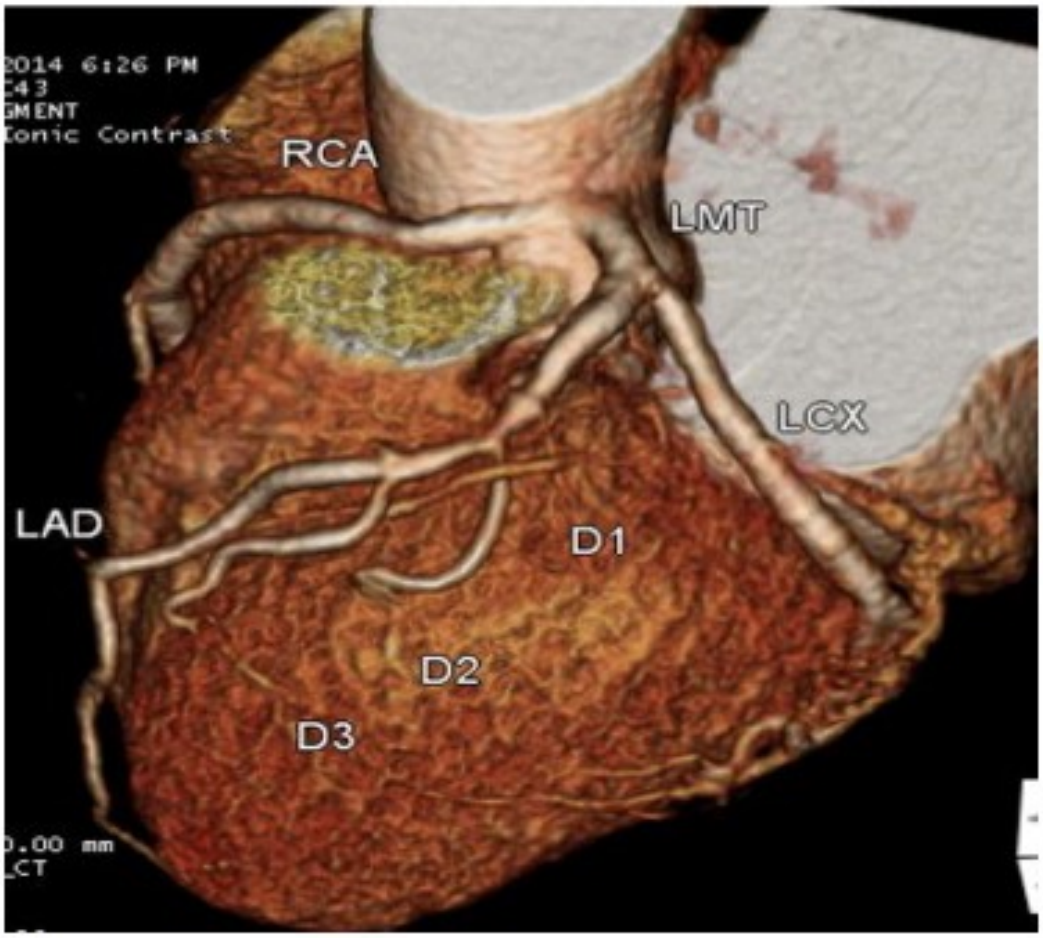


Fig. 3.

Ectopic origin of RCA from LCS. (A) RCA appears from the left coronary sinus anterior aspect. The proximal segment runs between the ascending aorta and the RVOT (inter-arterial course) with caliber

PET

- Cardiac PET has advantages in defining inflammation and this may have prognostic potential in predicting SCD in conditions like cardiac sarcoidosis where SCD is common and cardiac arrest can be the initial manifestation even in patients with preserved EF.

STAGES	Perfusion/FDG Patterns			
	Perfusion Defect		FDG-Uptake	
Normal	None		No/ Low	
Early	None		FDG uptake high	
Progressive	Mild			
Peak active	Moderate			
Progressive myocardial.impairment	Severe			
Fibrosis	Severe		Low	

Conclusion

- Identifying subjects who are at risk for SCD and stratifying them correctly into low or high-risk groups is the holy grail of Cardiology.
- Imaging is an exciting modality, but it is important to understand that imaging may not be a panacea even if we had a good screening tool in SCD imaging.
-