CT for substrate identification in ischemic cardiomyopathy

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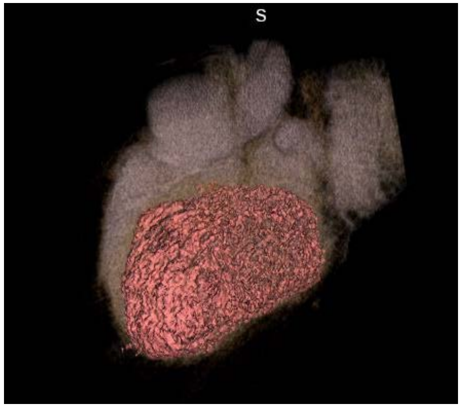
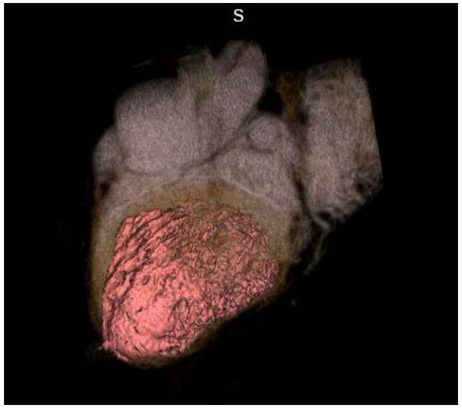
Ischemic Cardiomyopathy

Assessment of LV function

70M, PSVT

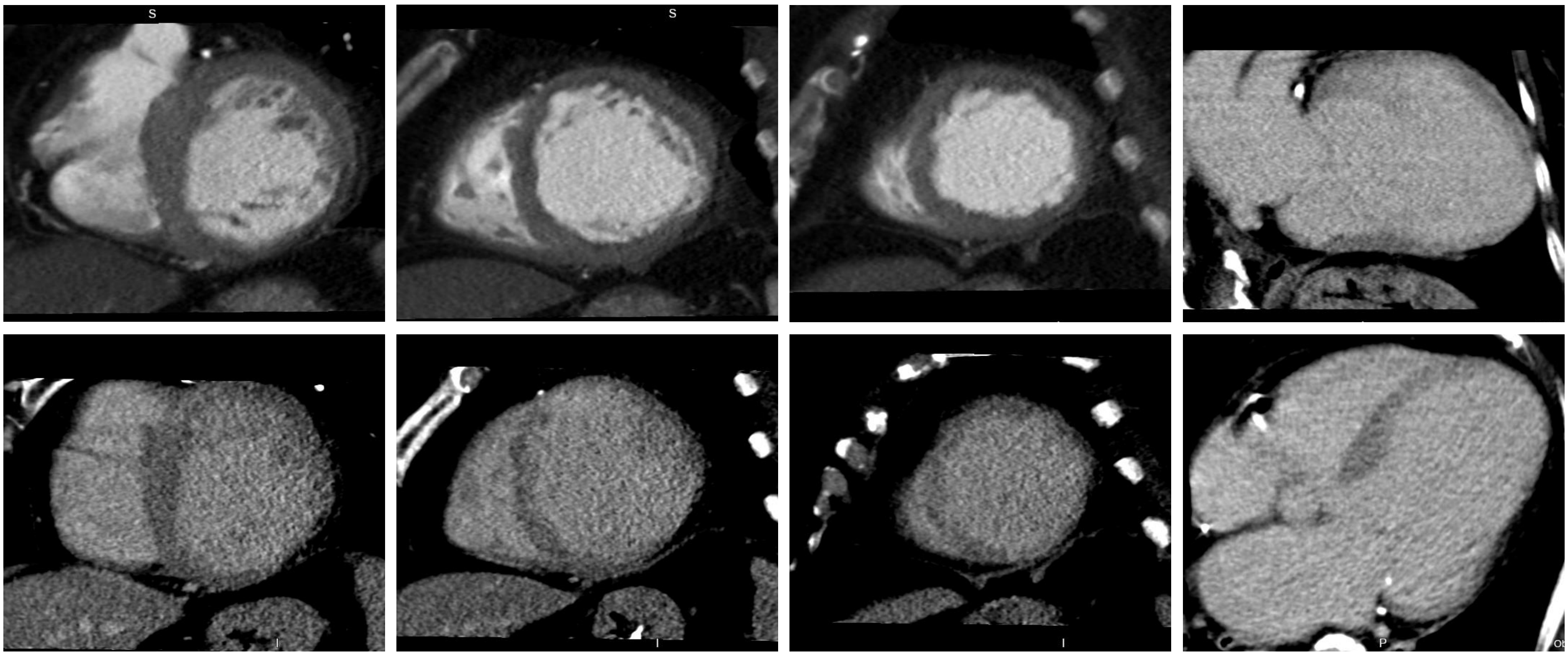
	Echo	CT
EDV	120	198
ESV	88	137
SV	34	61
EF	26.4%	31%





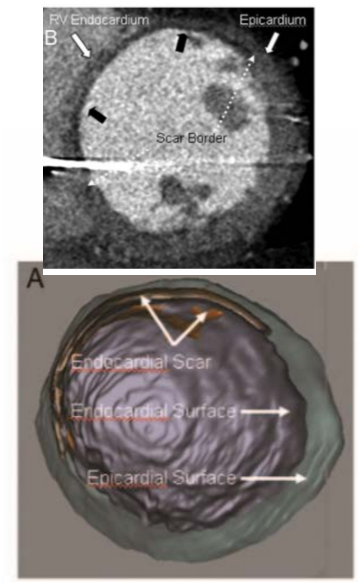
Ischemic Cardiomyopathy

Assessment of LV myocardial scar

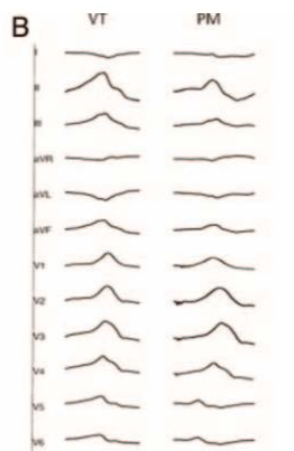


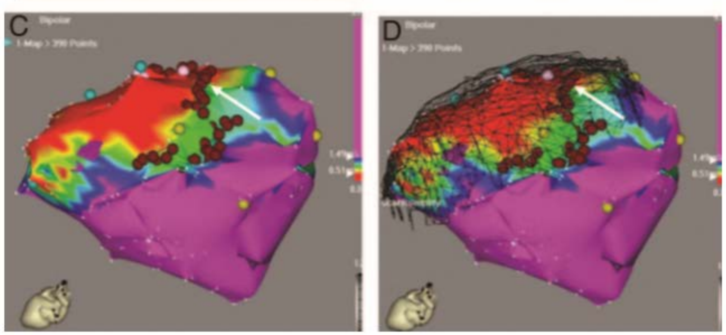
Anatomic, dynamic, and perfusion characteristics of abnormal myocardium to guide VT ablation

Fusion of 3D LV anatomy and 3D hypoperfusion reconstruction



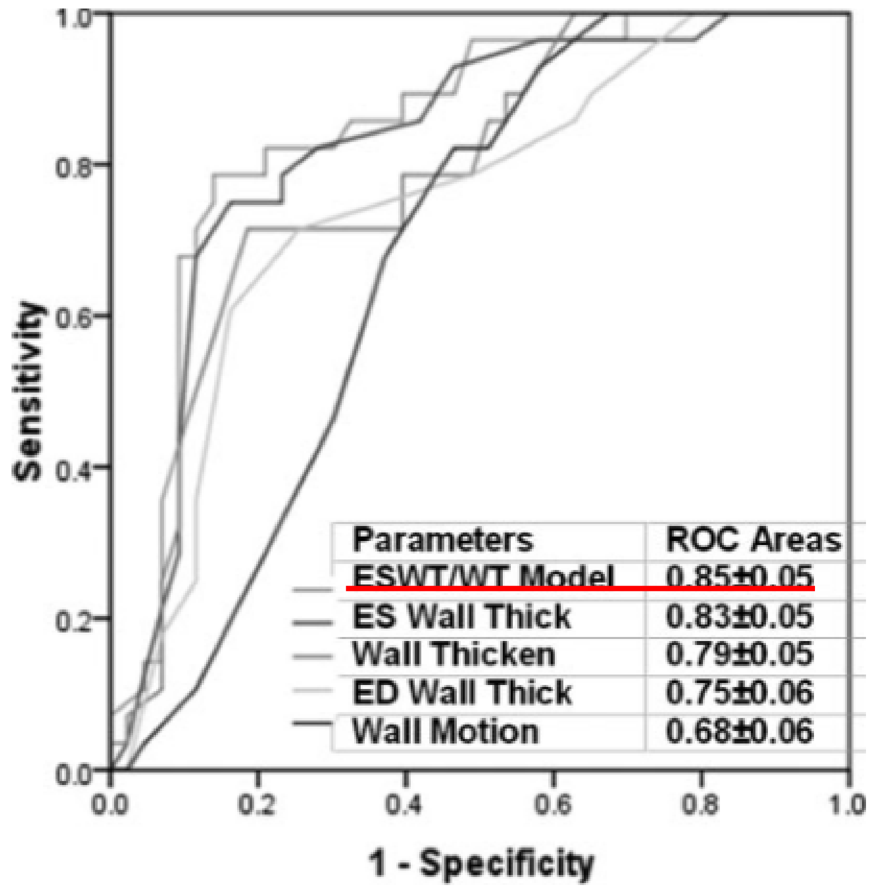
≥ 11/12 pace-mapping match





Voltage map

Abnormal voltage segment <1.5 mV

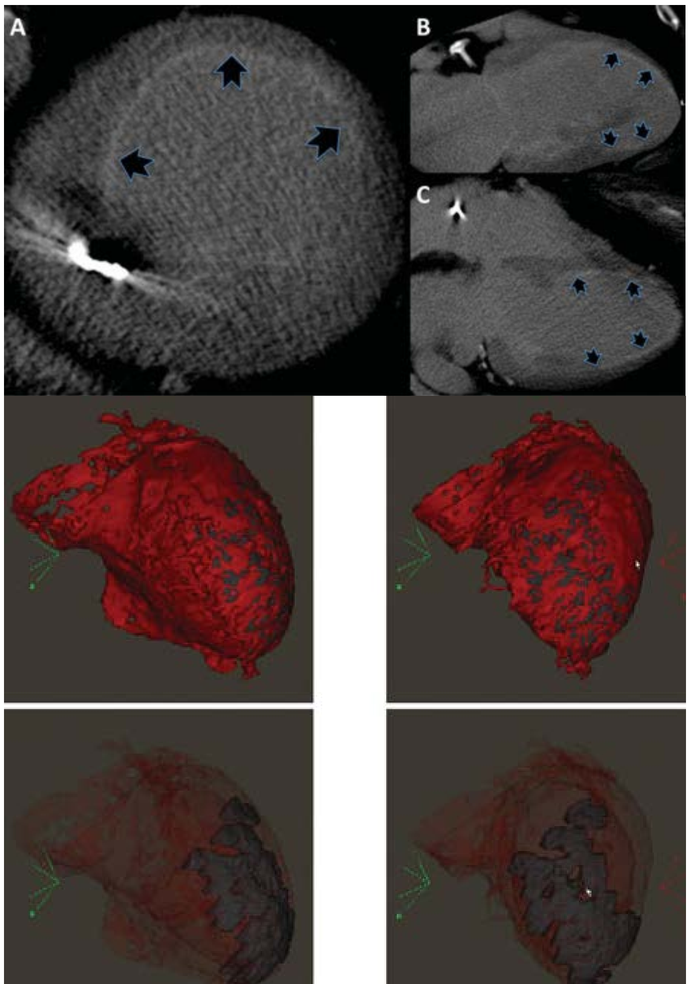


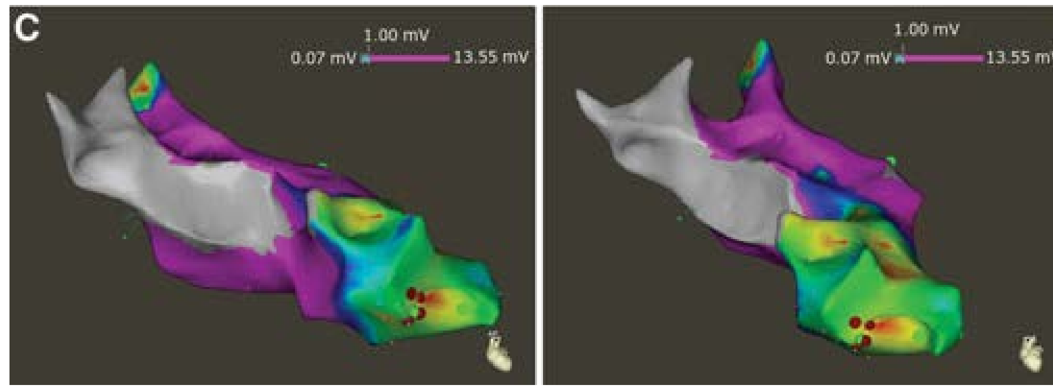
Tian J, et al. Cir Arrhythm Electrophysiol 2010;3:496-504

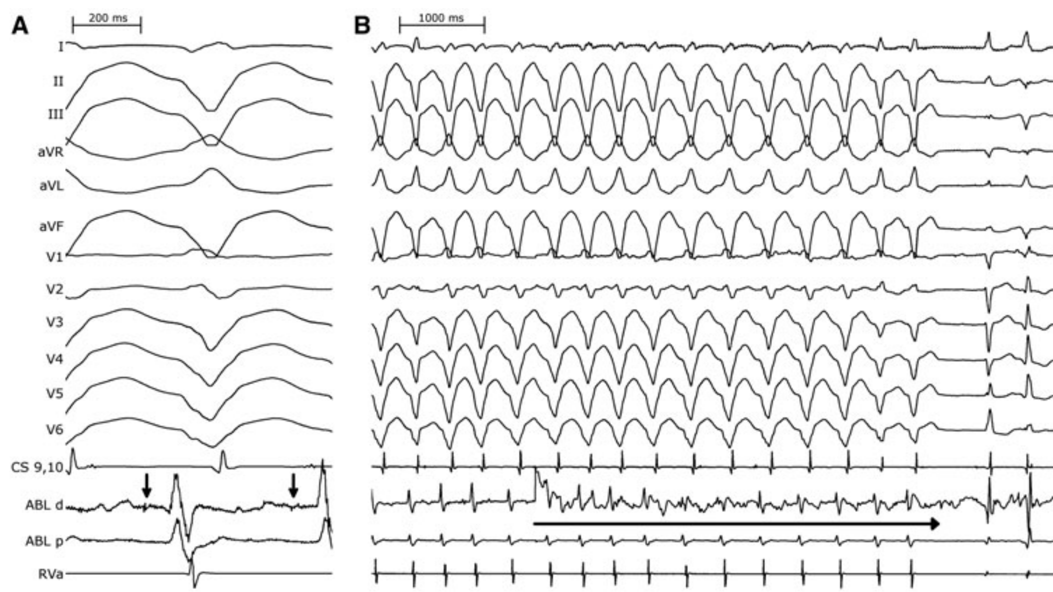
3D Scar Imaging Using a DE-CT to Guide VT Catheter Ablation

J Cardiovasc Electrophysiol 2013;24:708-710

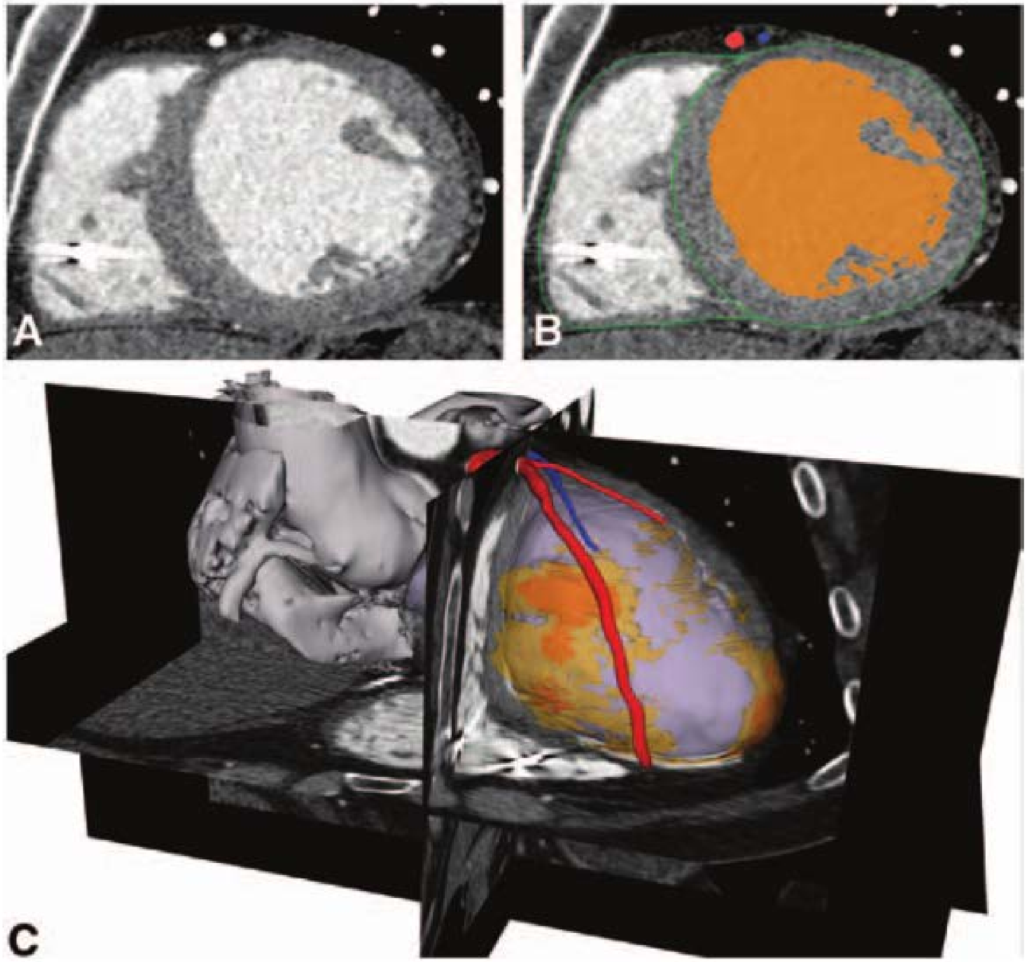
69/M with ischemic cardiomyopathy







Regional myocardial wall thinning correlates to arrhythmogenic substrates in post MI VT

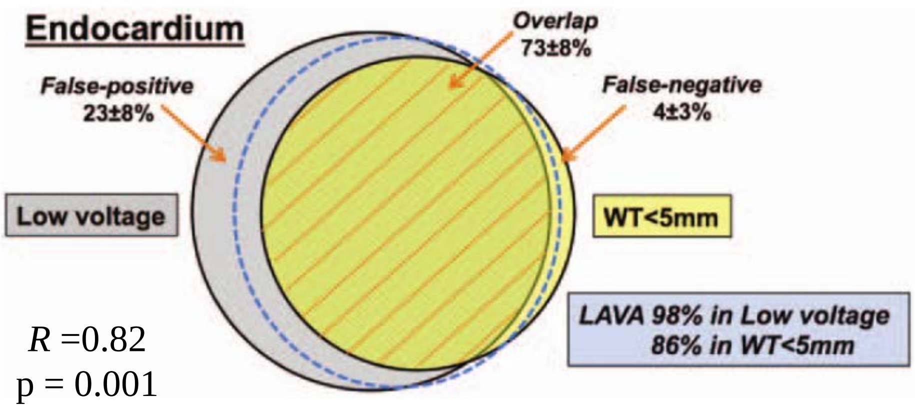


N=13

Orange , WT <3 mm
Yellow , WT <5 mm

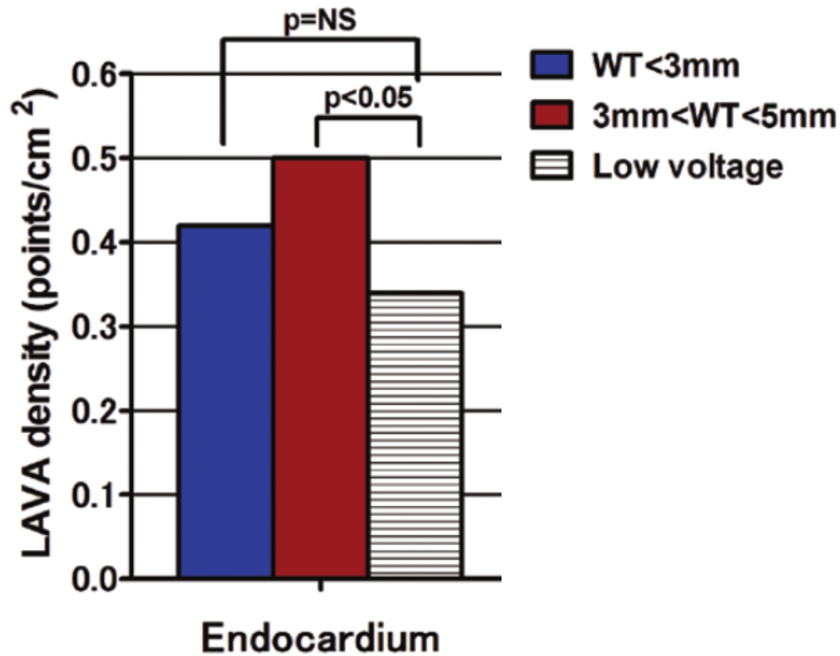
Komatsu Y et al. Circ Arrhythm Electrophysiol. 2013; 6:342-50.

The regional wall thinning area vs low-voltage area



R =0.82
p = 0.001

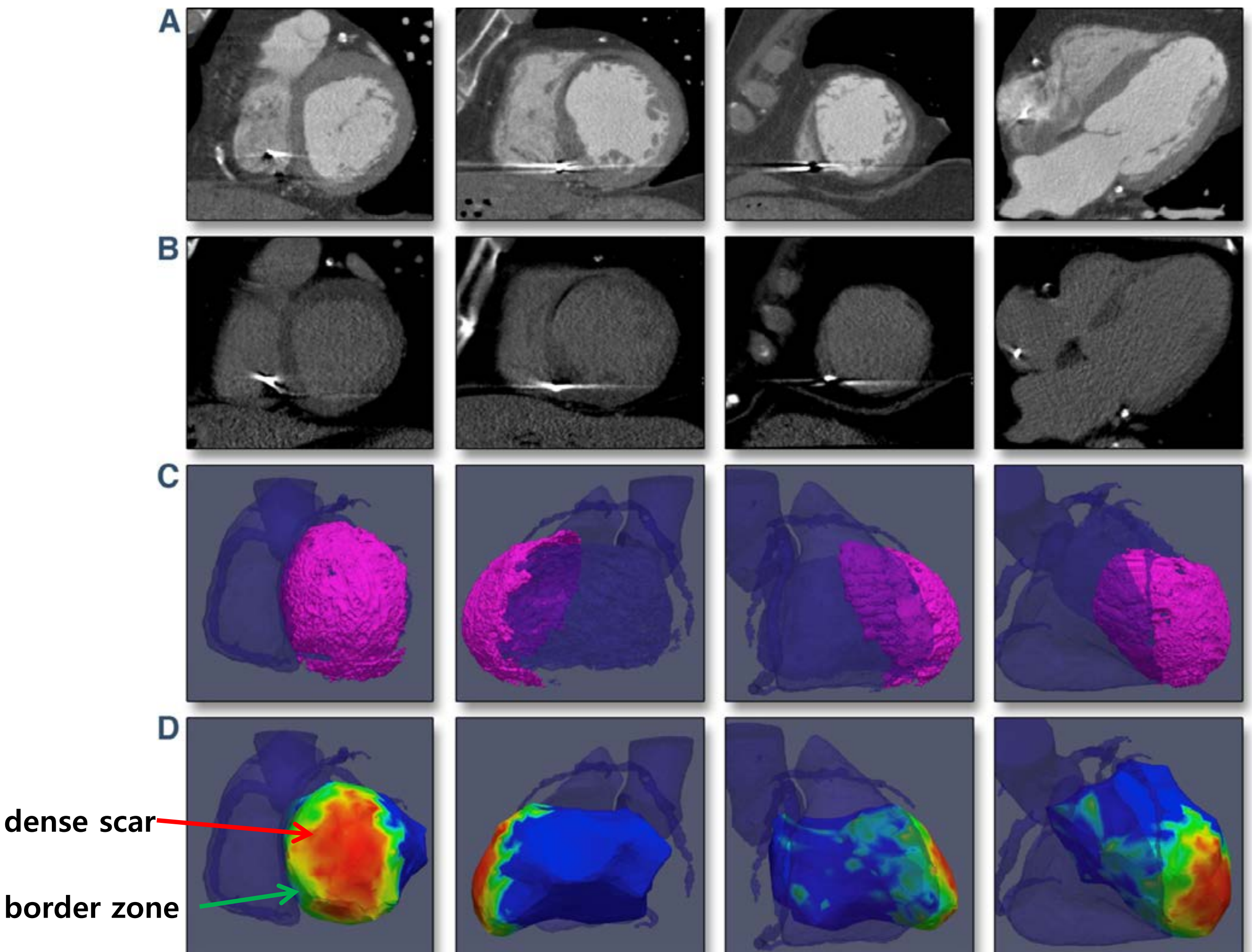
Distribution and characteristics of local abnormal ventricular activities



- WT area is substantially smaller than the low-voltage area.
- 87% of LAVA are located within the WT <5 mm.
- **The integration of cardiac CT WT with 3D EAVMs can help focus mapping and ablation on the culprit regions.**

DE-Cardiac CT in the characterization of VT structural substrate

CT vs. EAM Scar in a Patient with ICM



42 patients
(35 had ICD)

3D reconstruction of CT with scar segmentation

Bipolar endocardial EAM

J Am Coll Cardiol Img 2016;9:822–32

TABLE 2 Segmental Comparison Between Scars at CT and Low Voltages at EAM

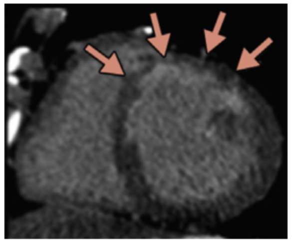
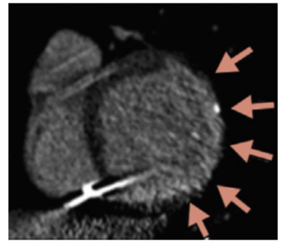
EAM Approach	EAM Voltages	Scars With Subendocardial Distribution at CT 	Scars With Transmural Distribution at CT 
Endo-EAM	BV <1.5 mV	(n = 527; scar = 109) Average K = 0.565	(n = 374; scar = 88) Average K = 0.598
	UV <8 mV	(n = 170; scar = 33) Average K = 0.411	(n = 119; scar =24) Average K = 0.434
Epi-EAM	BV <1.5 mV	(n = 204; scar = 26) Average K = 0.432	(n = 136; scar = 24) Average K = 0.828
	UV <8 mV	(n = 85; scar = 17) Average K = 0.772	(n = 68; scar = 15) Average K = 0.912

TABLE 3 Diagnostic Performance of CT in the Detection of Myocardial Substrate of VT, as Identified at EAM

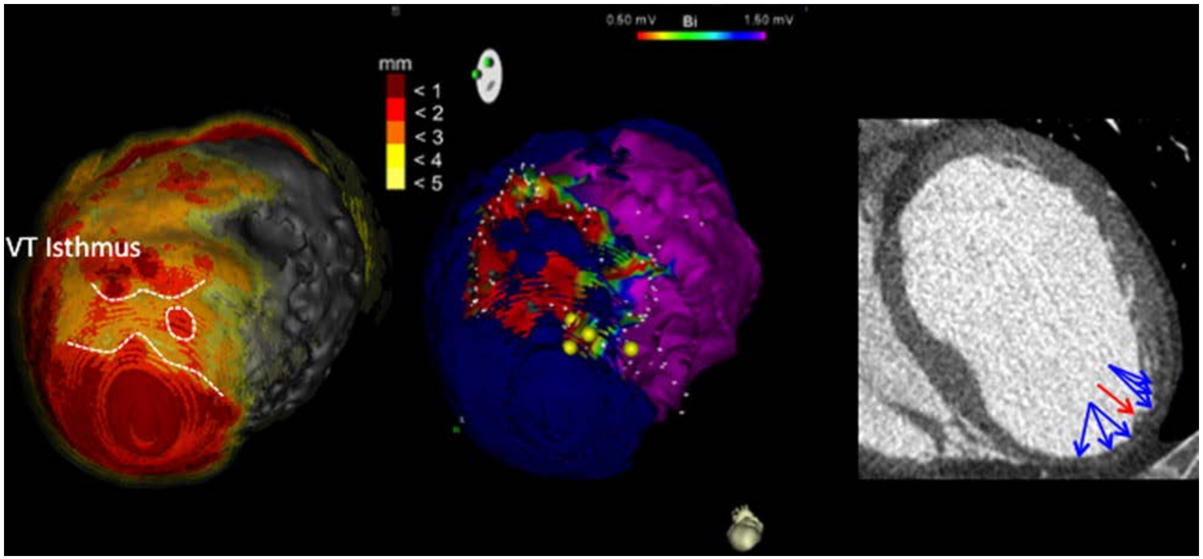
		Sensitivity	Specificity	PPV	NPV
All Patients	DE	75 (84)	88 (88)	57 (80)	95 (93)
	WTN	47 (41)	92 (91)	56 (62)	87 (77)
	DE + WTN	76 (82)	86 (82)	56 (72)	95 (92)
ICM	DE	78 (90)	86 (88)	61 (86)	95 (95)
	WTN	55 (51)	89 (89)	63 (73)	87 (79)
	DE + WTN	79 (89)	85 (85)	63 (80)	95 (96)
NICM	DE	78 (77)	91 (88)	54 (73)	95 (91)
	WTN	29 (32)	95 (93)	55 (69)	87 (75)
	DE + WTN	77 (74)	87 (79)	47 (62)	95 (89)

Values are % (%). Values in parentheses represent diagnostic performance of CT calculated excluding segments with a low prevalence of scars (<20%). Sensitivity, specificity, PPV, and NPV of each CT parameter considering the entire population, ICM, and NICM patients.

DE = delayed enhancement; ICM = ischemic cardiomyopathy; NICM = nonischemic cardiomyopathy; NPV = negative predictive value; PPV = positive predictive value; VT = ventricular tachycardia; WTN = wall thinning; other abbreviations as in Tables 1 and 2.

- Good overall concordance (κ = 0.536) between CT and EAM in the detection of scar
- Delayed enhancement and wall thinning – sensitivity 76%, specificity 86% and NPV 95% for identifying segments characterized by low voltages
- **Delayed enhancement CT provides a 3D characterization of VT scar substrate together with a detailed anatomic model of the heart.**

Correlation between CT-derived scar topography and critical ablation sites in post MI VT



15 patients (mean age 63 ± 10 years, 86% male, LVEF 27 ± 12%) with a prior MI referred for VT ablation.

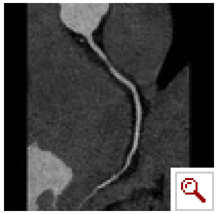
J Cardiovasc Electrophysiol. 2018;29:438–445.

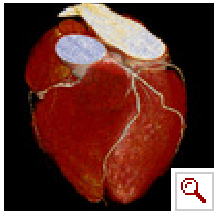
- Bipolar and unipolar voltage amplitude and bipolar electrogram width correlated with WT (correlation coefficient: 0.63, 0.65, and 0.41, respectively, $P < 0.001$).
- The ablation target sites were located on CT-defined ridges (WT: 4.2 ± 1.2 mm) bordered by areas of thinning (WT:2.6 ± 1.1 mm, $P < 0.0001$) in 14 of 15 patients.
- Ablation targets were found on ridges in 49 of 58 VTs (84%) for which target sites were identified.
- VT became noninducible postablation in 11 of 15 patients (73%).

Siemens's SOMATOM Force

Overview | Features & Benefits | Clinical Use | **Technical Specifications**

Detector	2 x Stellar^{Infinity} detector with 3D Anti-Scatter collimator
Number of acquired slices	384 (2 x 192)
Rotation time	up to 0.25 s[1]
Temporal resolution	66 ms
Generator power	240 kW (2 x 120 kW)
kV settings	70-150 kV, in steps of 10
Spatial resolution	0.24 mm
Max. scan speed	737 mm/s[1] with Turbo Flash
Table load	up to 307 kg / 676 lbs[1]
Gantry opening	78 cm





Collimation: 2 x 192 x 0.6 mm	Tube setting: 80 kV, 543 mAs
Spatial resolution: 0.24 mm	CTDIvol: 2.49 mGy
Scan time: 0.2 s	DLP: 45 mGy cm
Scan length: 139 mm	Eff. dose: 0.6 mSv
Rotation time: 0.25 s	

Cardiac CT for VT in patient with ICM

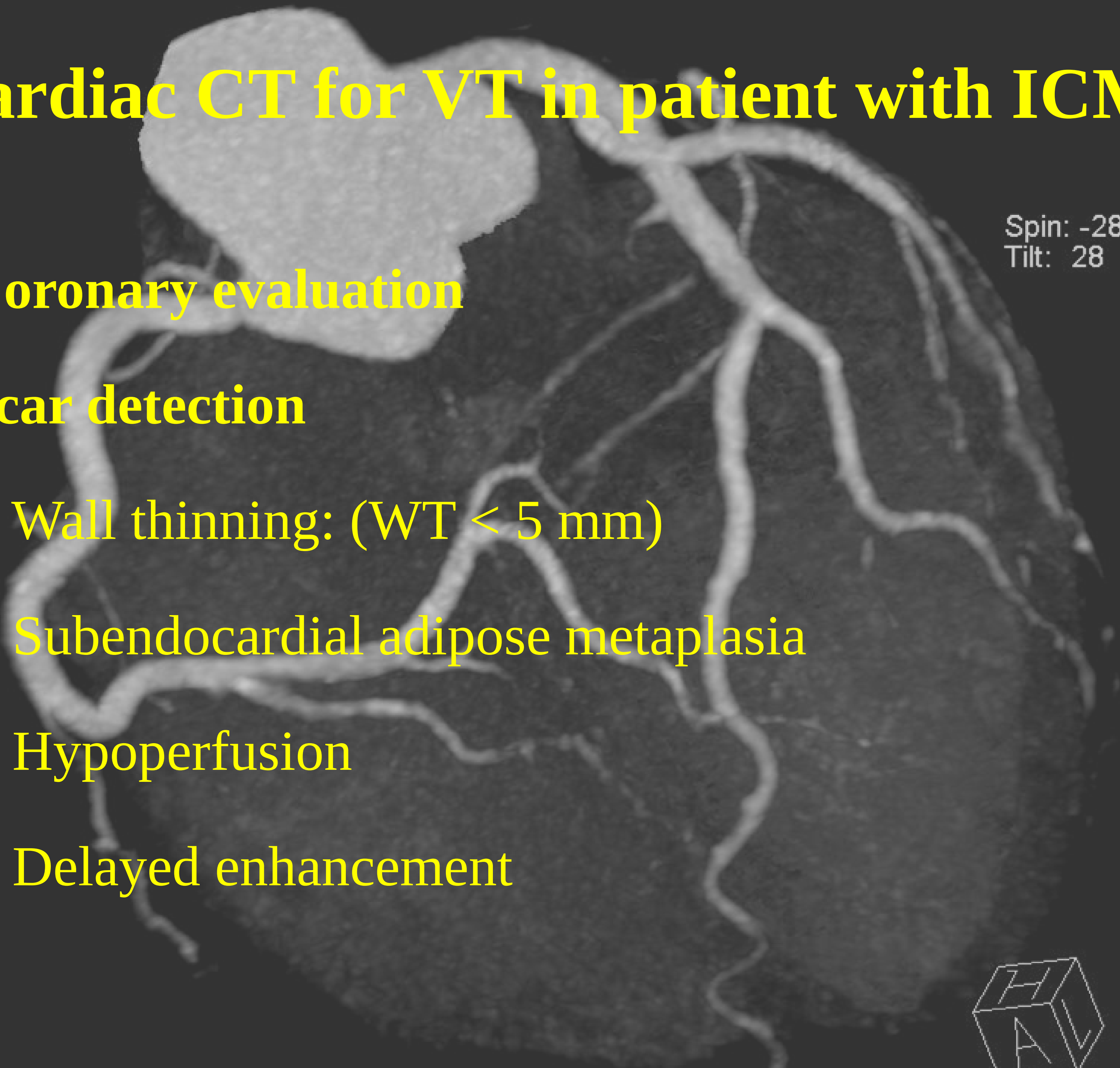
- **Coronary evaluation**
- **Scar detection**

  - Wall thinning: (WT < 5 mm)

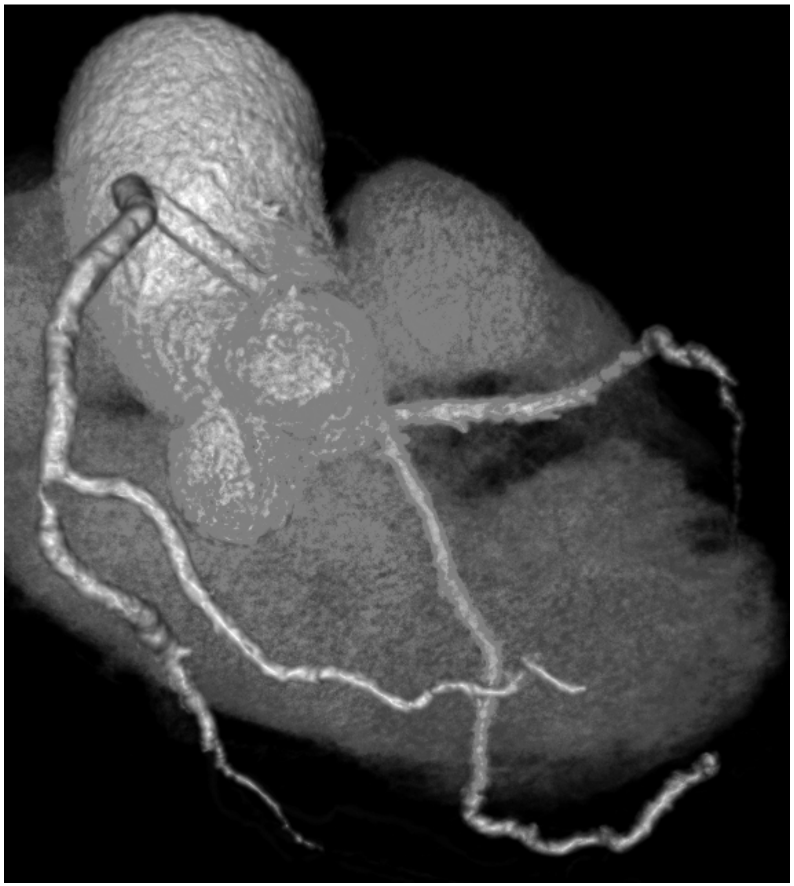
  - Subendocardial adipose metaplasia

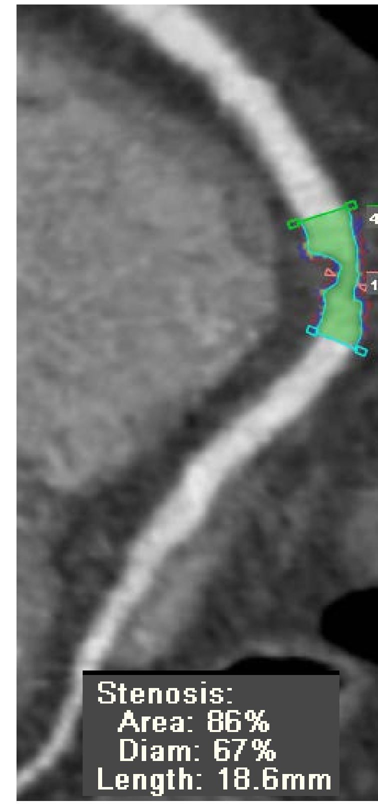
  - Hypoperfusion

  - Delayed enhancement

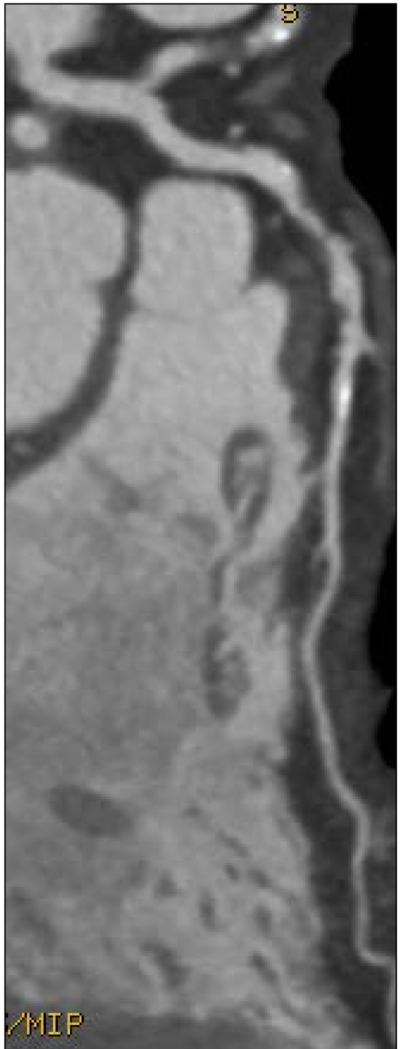


Coronary stenoses

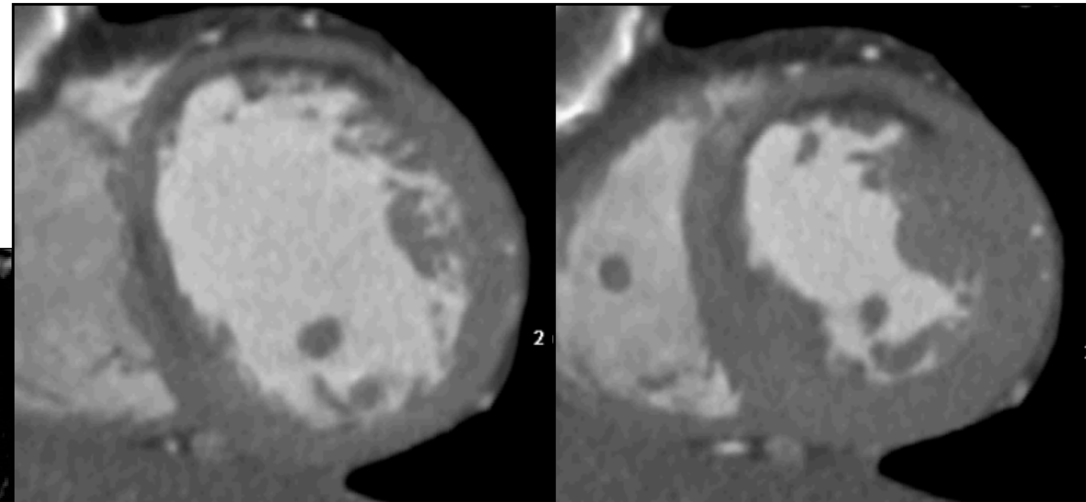


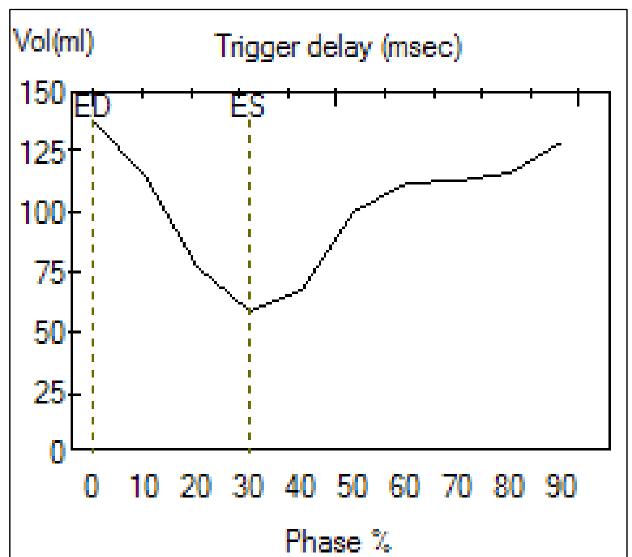


Wall thinning and adipose metaplasia



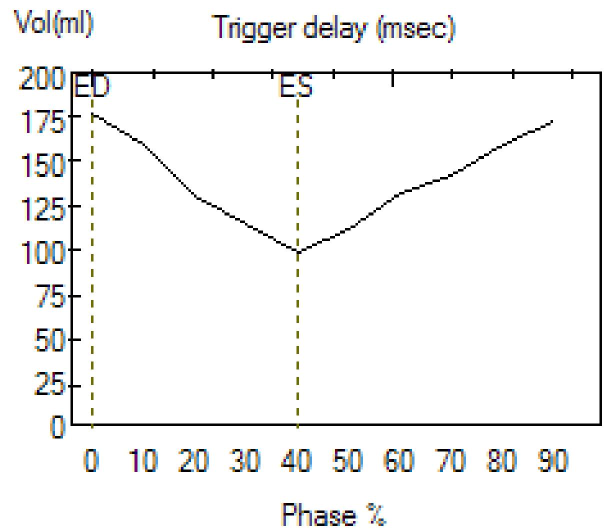
51M, old MI, chest pain





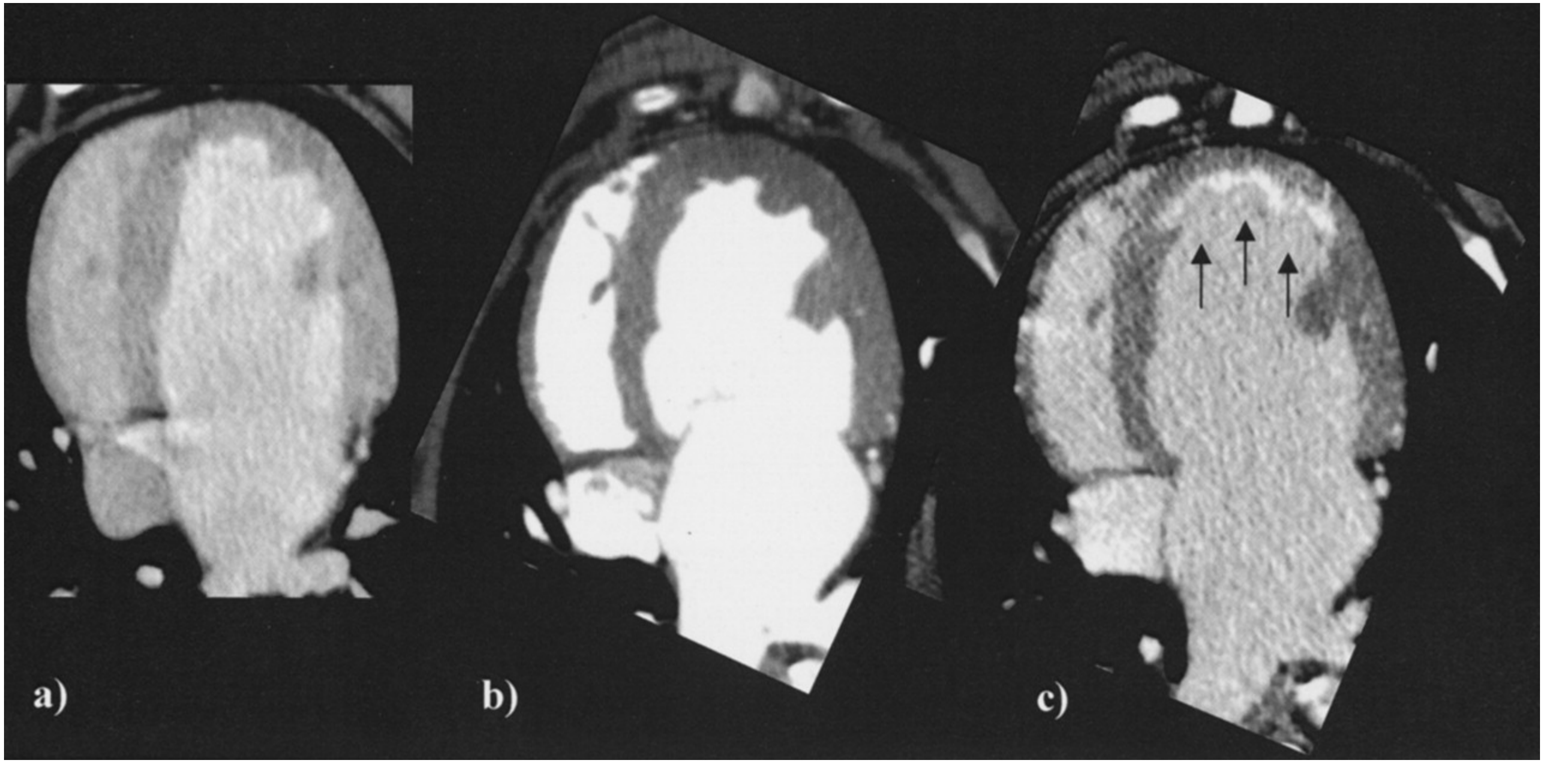
- EF 57%
- EDV 137 ml
- ESV 59 ml
- Myocardial mass 151 g

Wall thinning and motion abnormality



DE-CT viability imaging after MI

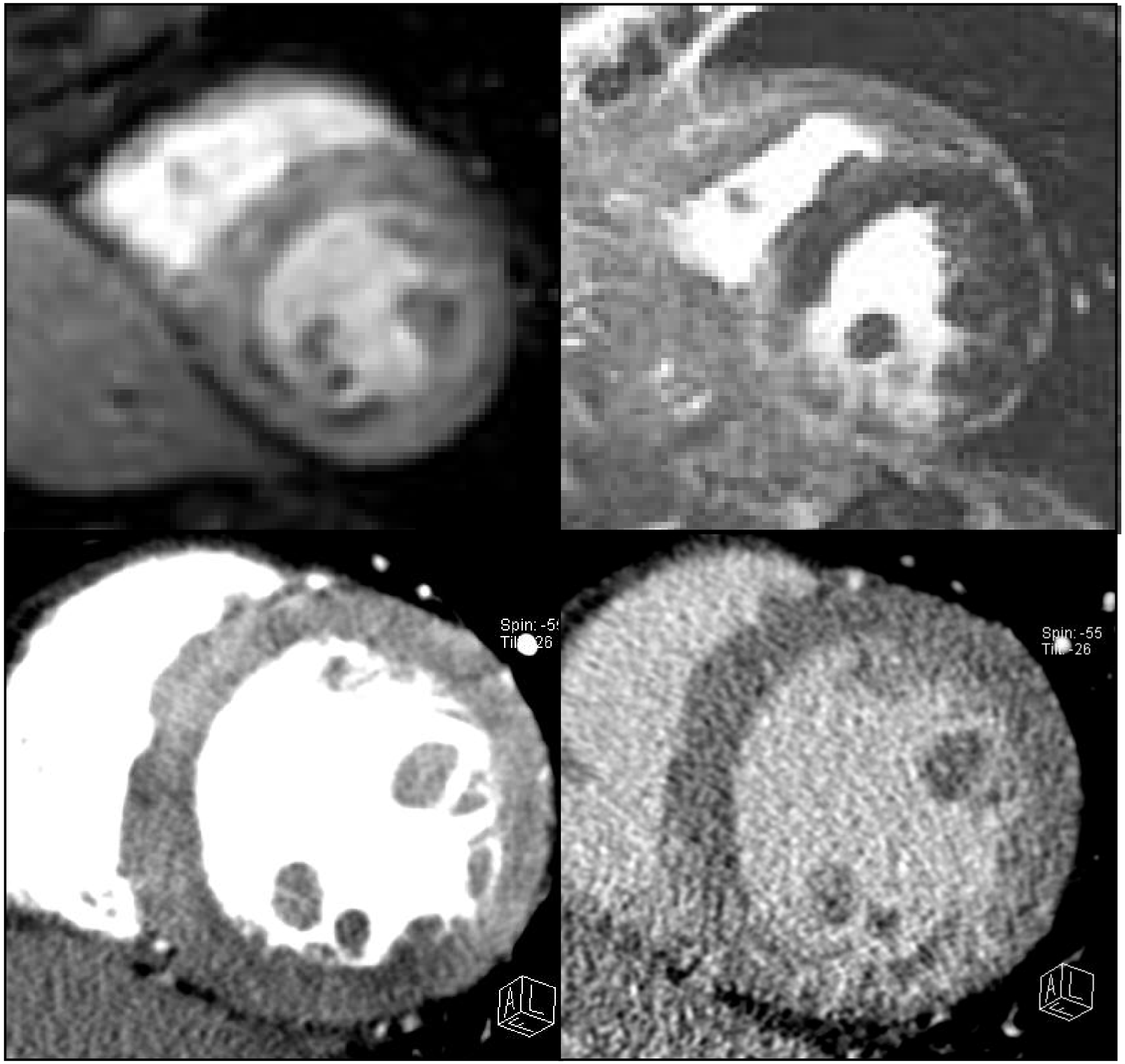
preinfarct 5 minutes after contrast	postinfarct during first-pass contrast injection	postinfarct 5 minutes after contrast injection



Lardo AC, et al. Circulation 2006;113:394-404

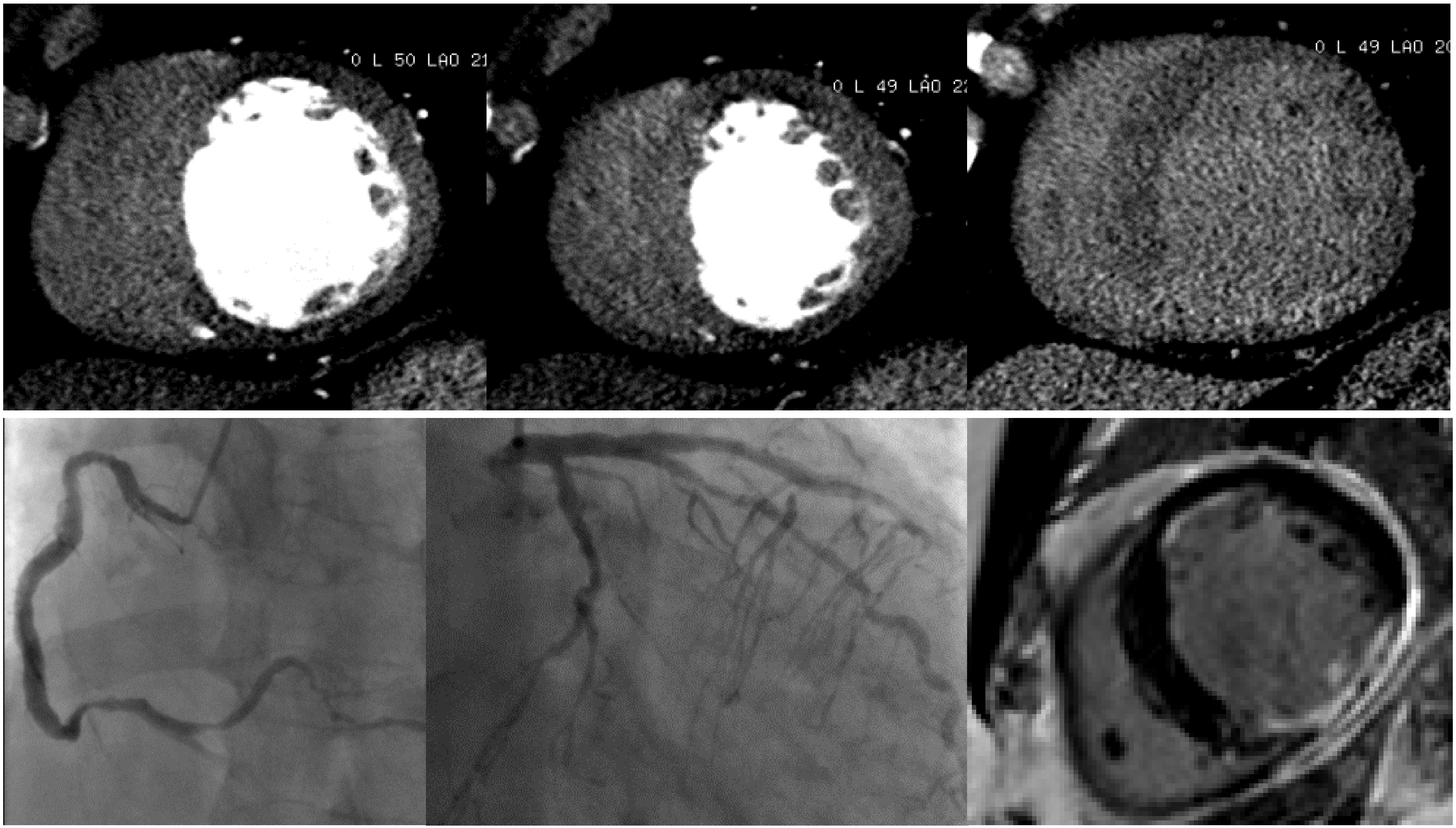
Myocardial viability with CMR and CT

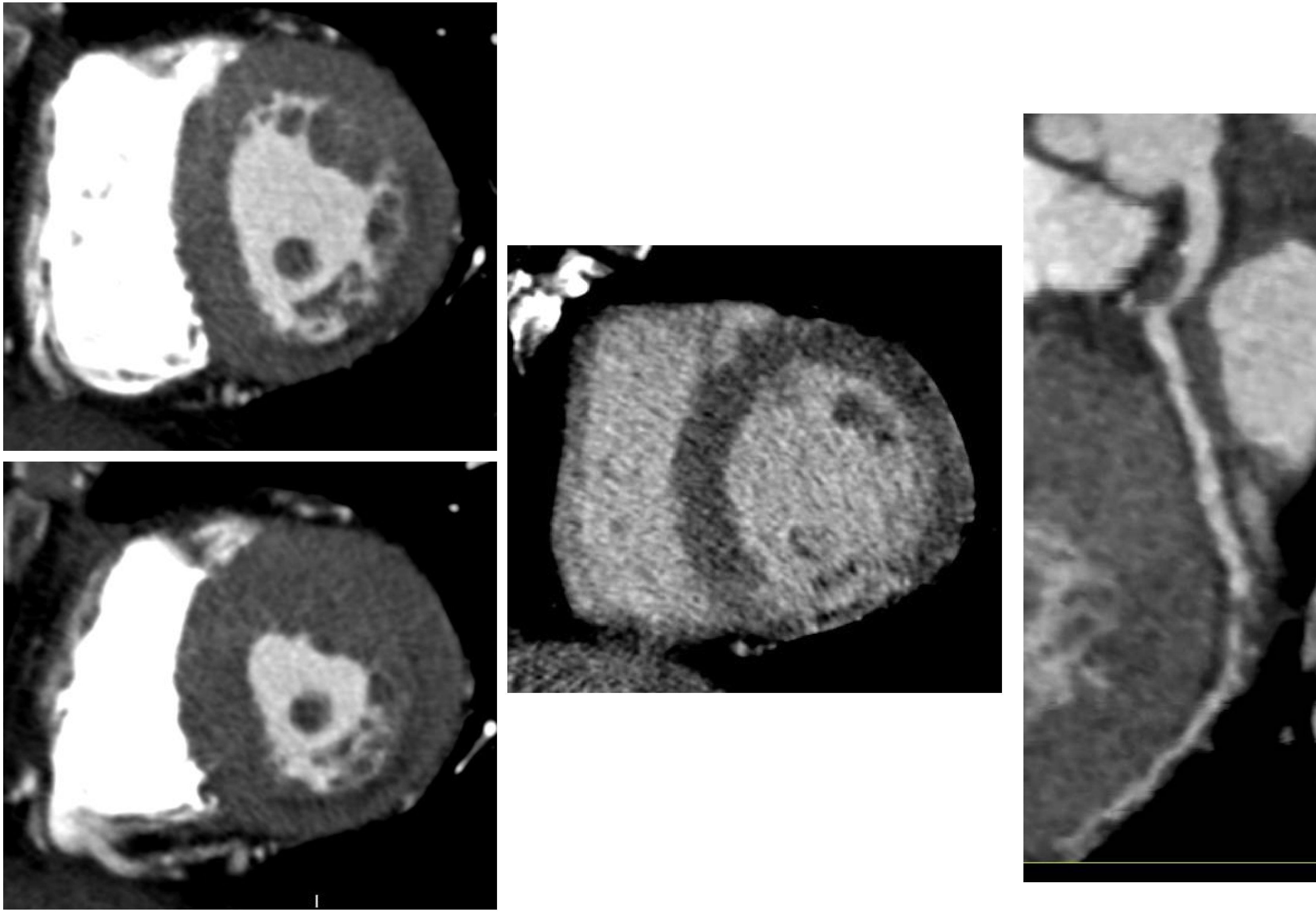
63/M, AMI



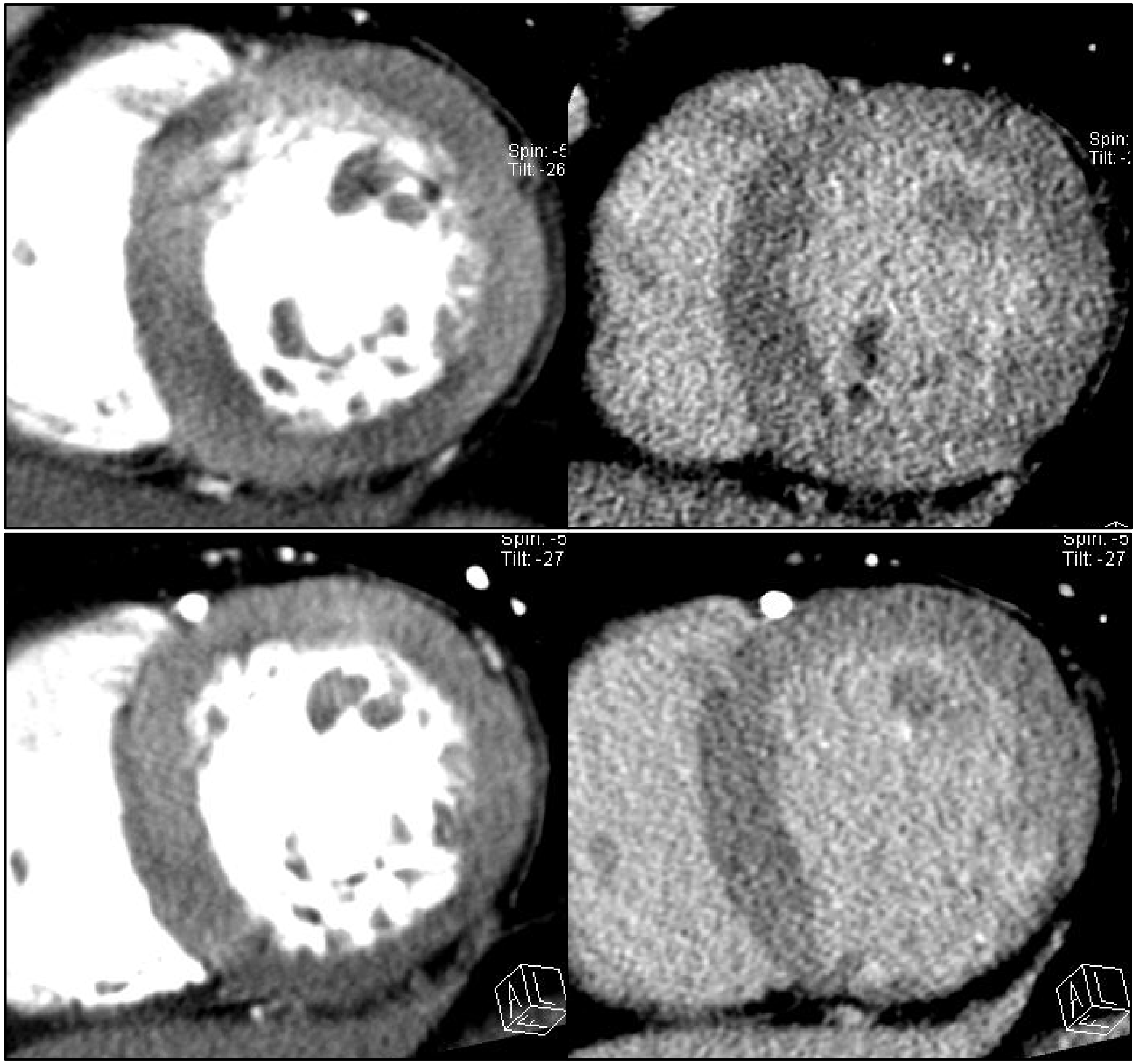
Myocardial viability with CMR and CT

73/M, OMI



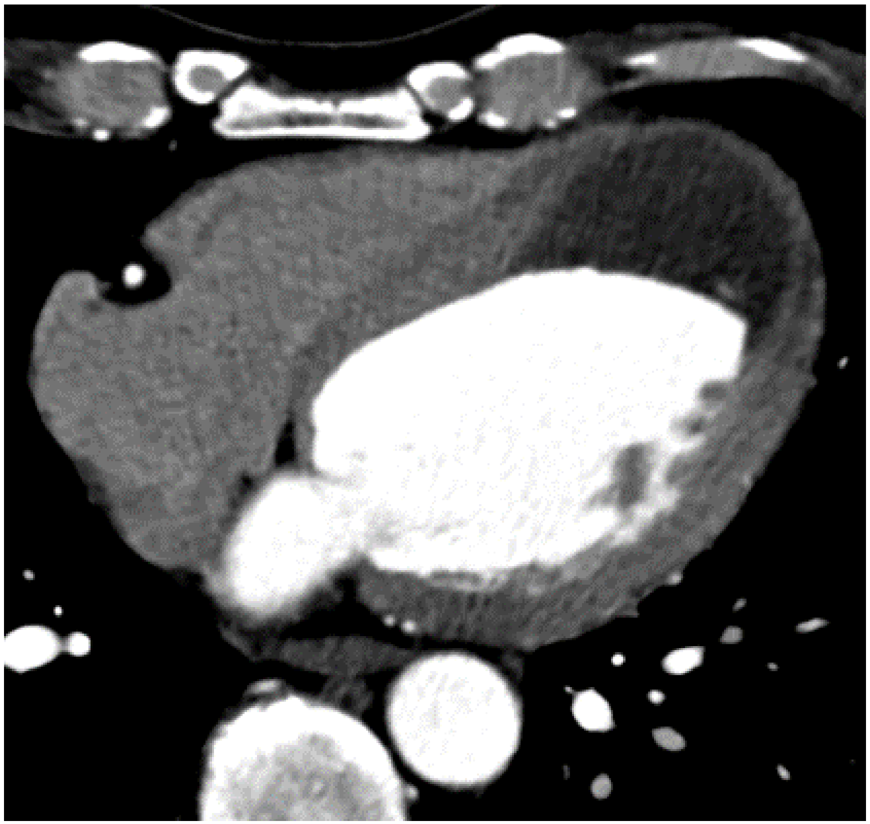


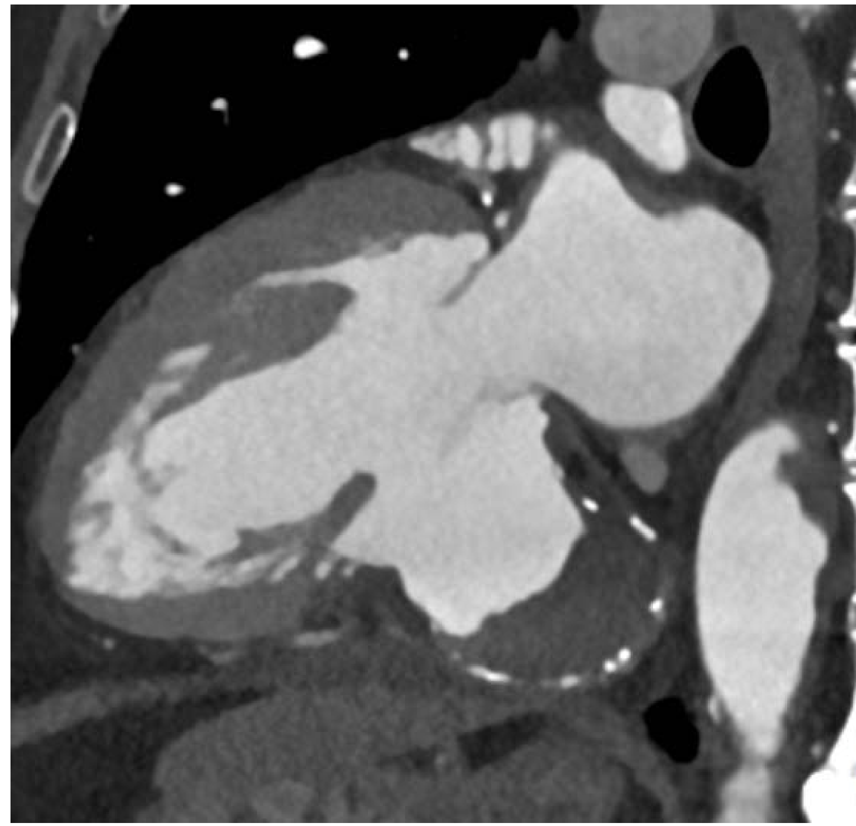
Follow-up of acute myocardial infarction



16 months later

Post MI aneurysm and pseudoaneurysm

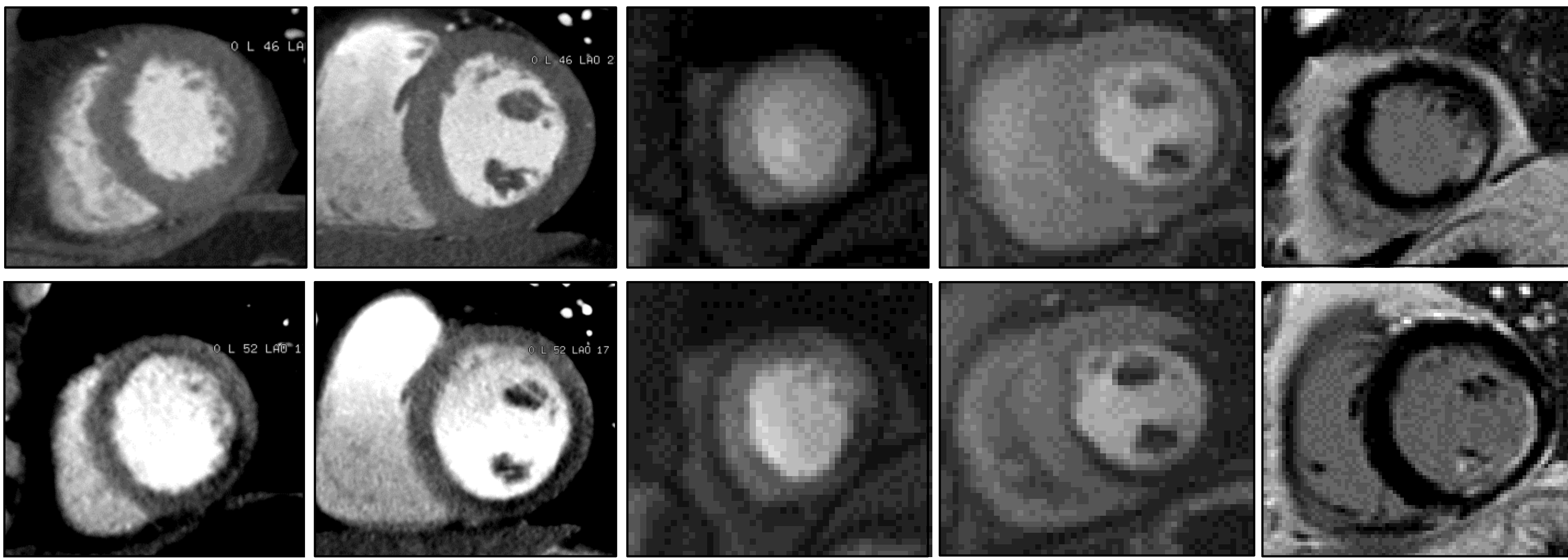


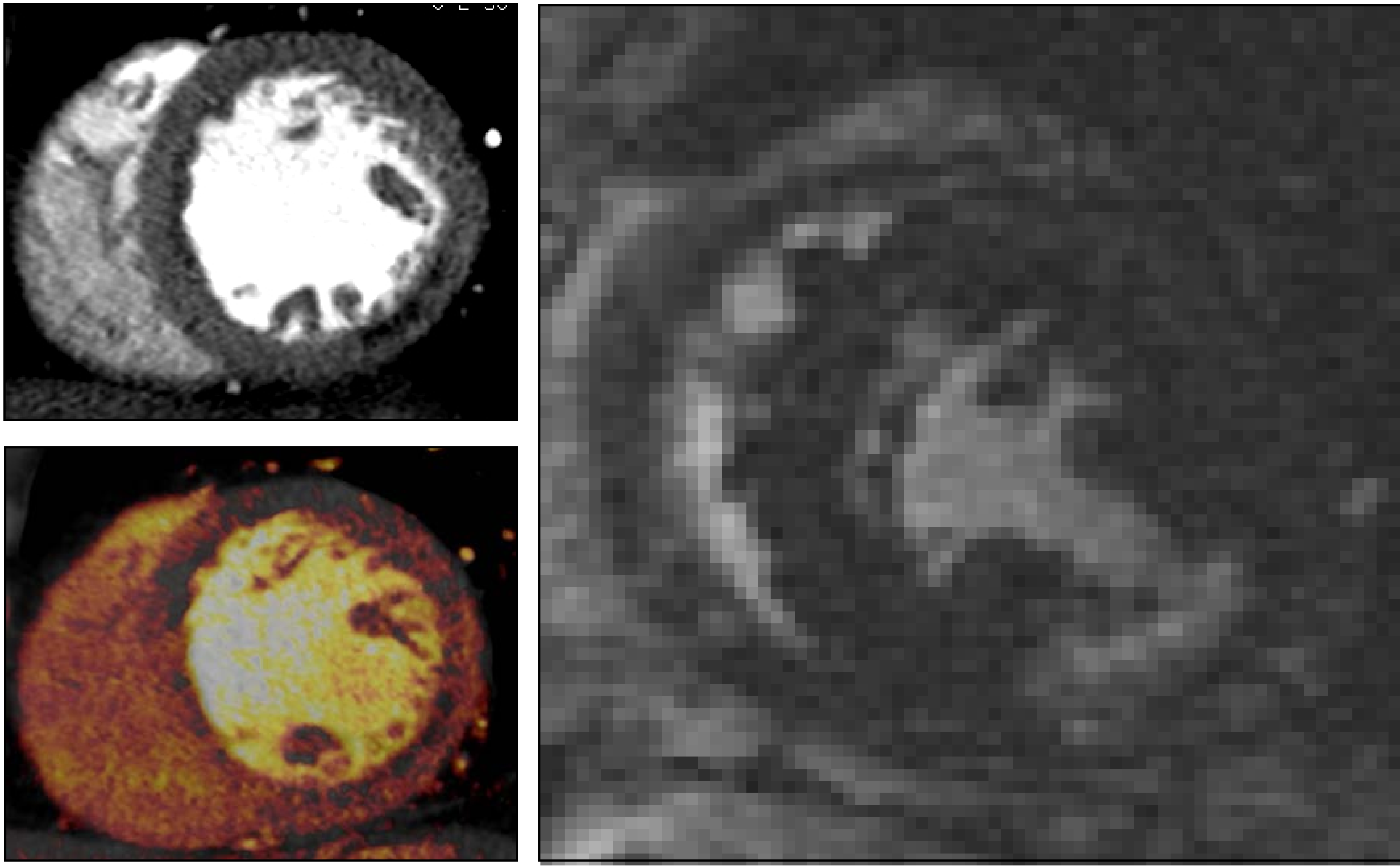


Perfusion: CT vs. CMR

40M,
chest discomfort
No medication for DM
& hyperlipidemia

CTP **CMR** **DE-CMR**





Summary

- The role of cardiac CT as a diagnostic tool in patients presenting with VT is relatively limited.
- Compared with CMR (near-isotropic spatial resolution of 1 to 2 mm^3), a major advantage of cardiac CT (close to 0.5 mm^3 on most systems) is a significantly higher spatial resolution.
- Cardiac CT lends itself to noninvasive assessment of the coronary arteries, particularly in patients with low to intermediate probability of coronary artery disease.
- Cardiac CT may also be considered as an alternative modality for detailed assessment of myocardial structure and function if CMR and TTE imaging is unavailable or suboptimal.

Circulation 2017;136:2491–2507

Summary

- Cardiac CT can also be used for detailed characterization of scar (wall thinning, fatty metaplasia, decreased perfusion, and delayed hyperenhancement).
- Good agreement between scar defined by cardiac CT and that defined by EAM systems in patients with ICM.
- However, cardiac CT is associated with a lower contrast-to-noise ratio within myocardial tissue, which contributes to inferior scar characterization relative to LGE-CMR.
- Cardiac CT-based scar imaging, and indeed structural imaging, are currently largely limited to an adjunctive role during VT ablation procedures.

Circulation 2017;136:2491–2507


Thank you for
your attention!