Advanced Imaging in Cardiovascular Medicine:
A personal perspective

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The Cardiovascular Center

Center for Ischemic and Structural Heart Disease

Vascular Medicine Center

Heart Failure & Cardiac Transplant Center

Cardiac Arrhythmia Center

Women's Heart Center

Preventive Cardiology Center

Hypertrophic Cardiomyopathy Center

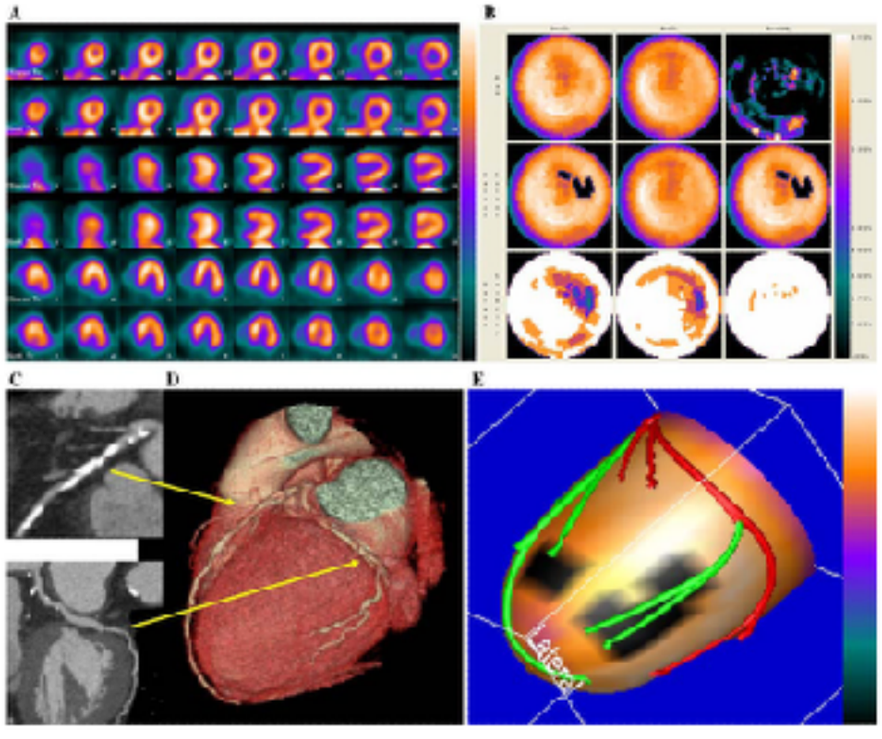
Cardiology

CT Surg

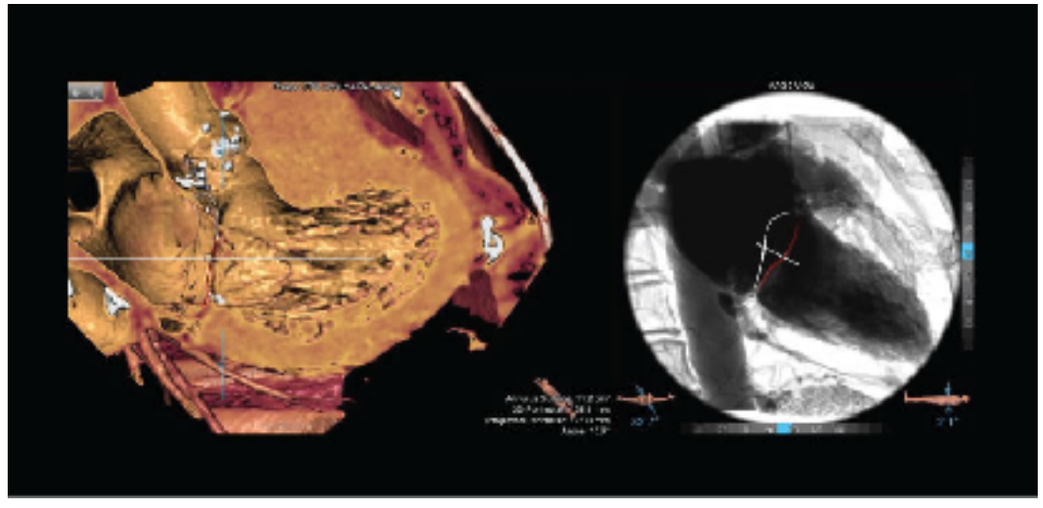
Vasc Surg

Int Rad

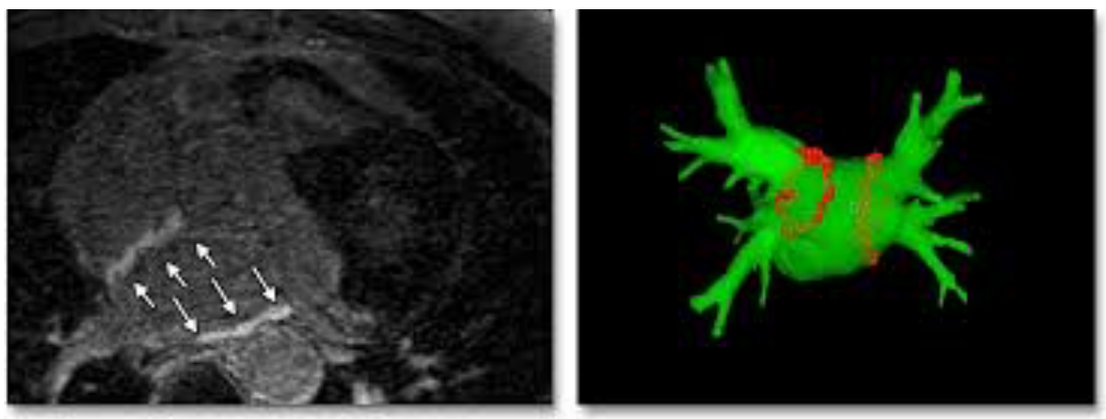
Ischaemic heart disease



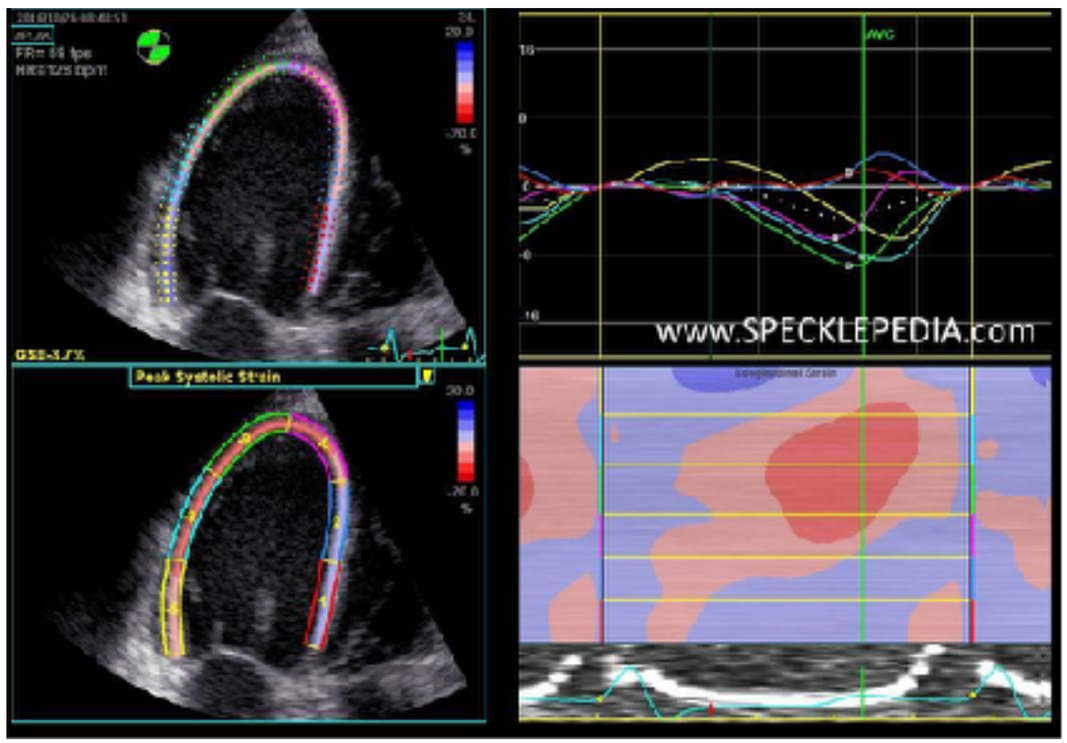
Structural heart disease



Electrophysiology



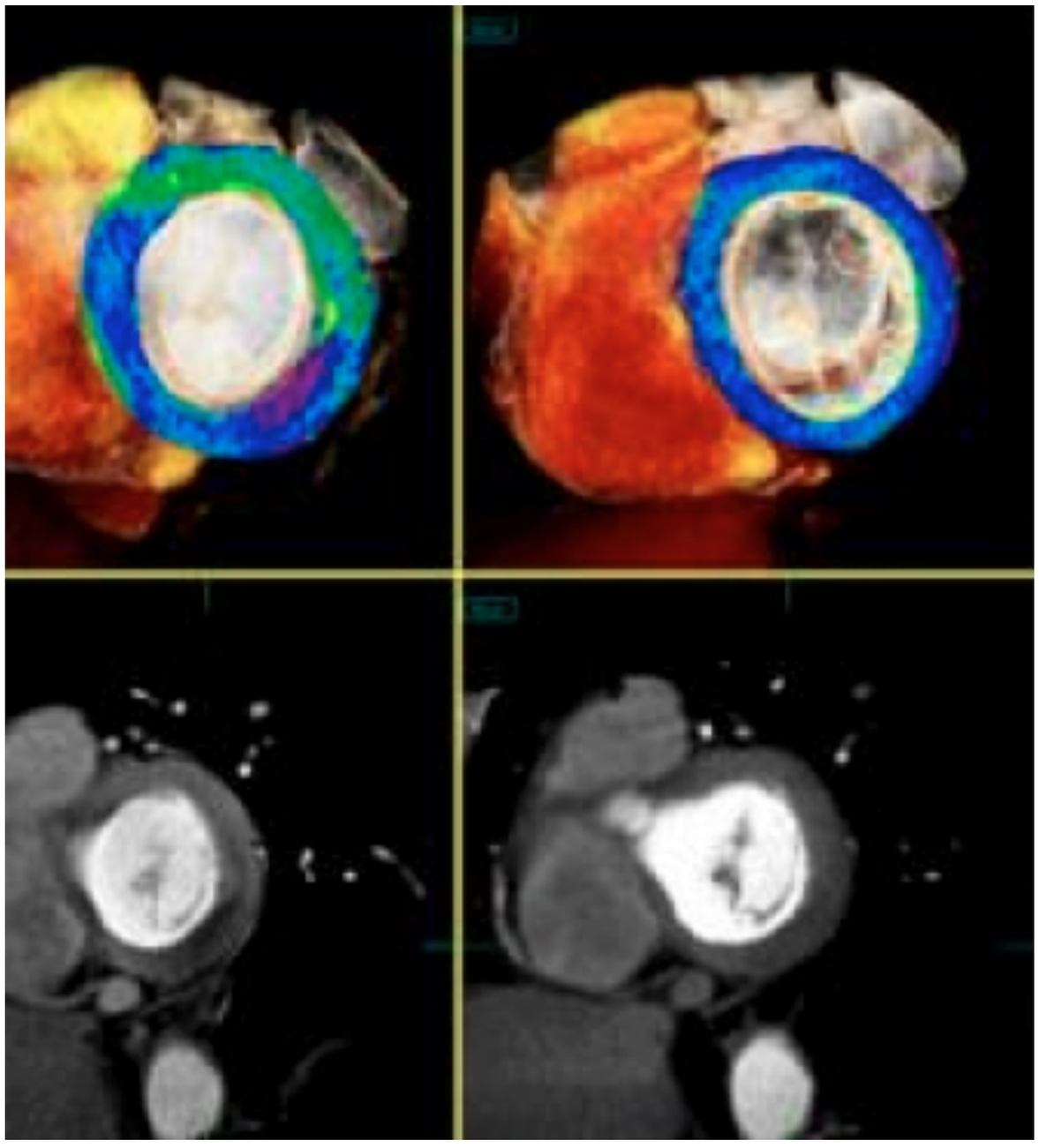
Heart failure



Advances Could Make Cardiac CT a One-Stop-Shop Imaging Modality

Experts say CT-FFR, perfusion imaging, plaque characterization, spectral imaging may tip the balance in favor of cardiac CT

Anatomy
CT-FFR
Perfusion
Plaque characterisation
Spectral imaging

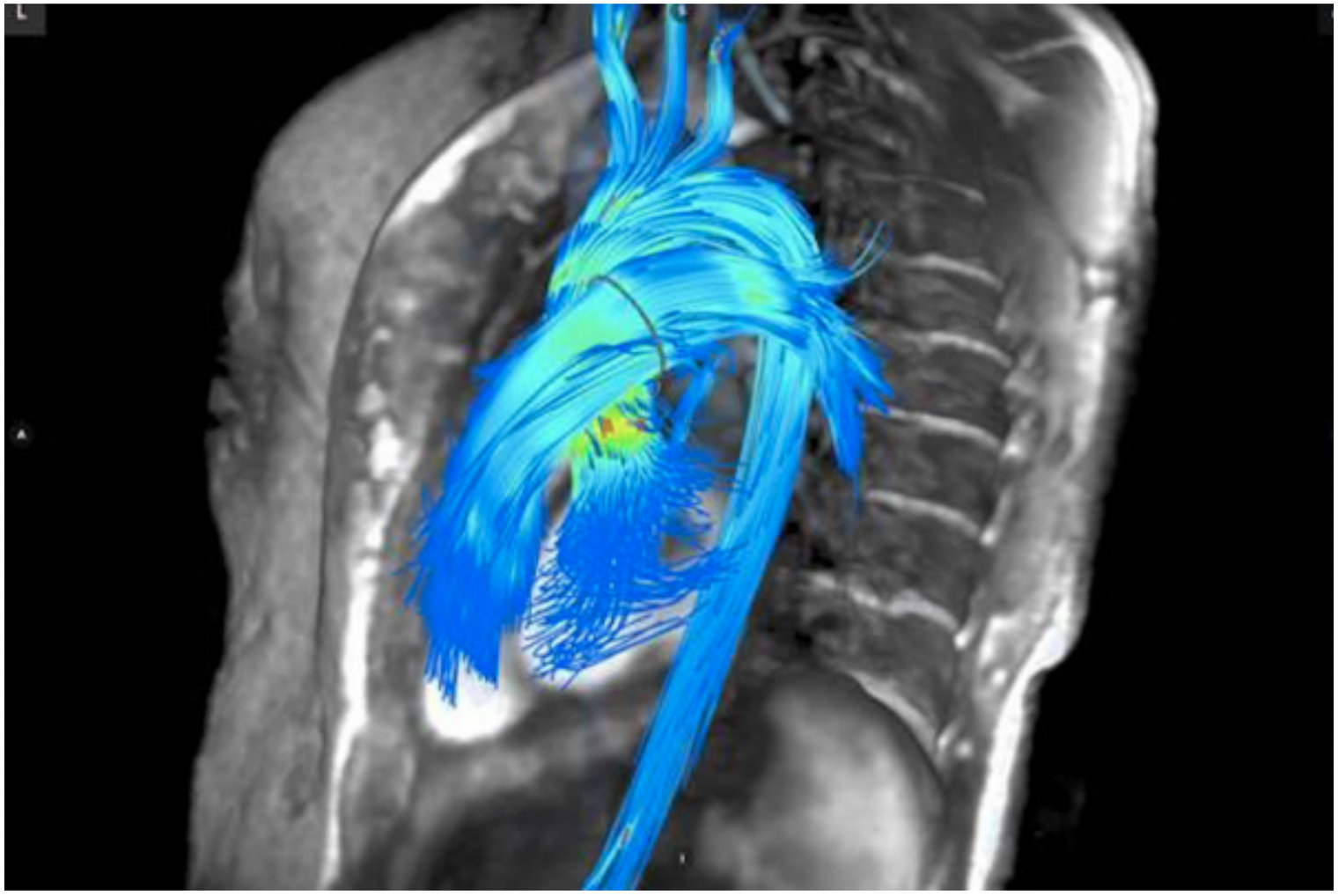


Source: DAIC 2014

Will Cardiac MRI Expand?

Recent MRI technological advances have opened up the possibilities for greater cardiac use of the costly imaging modality

Anatomy
Perfusion
&
Ischaemic /scarred tissue
Plaque characterisation
Wall motion
MRI Guided procedures



Source: DAIC 2018

The future “CV Medicine Essentials”

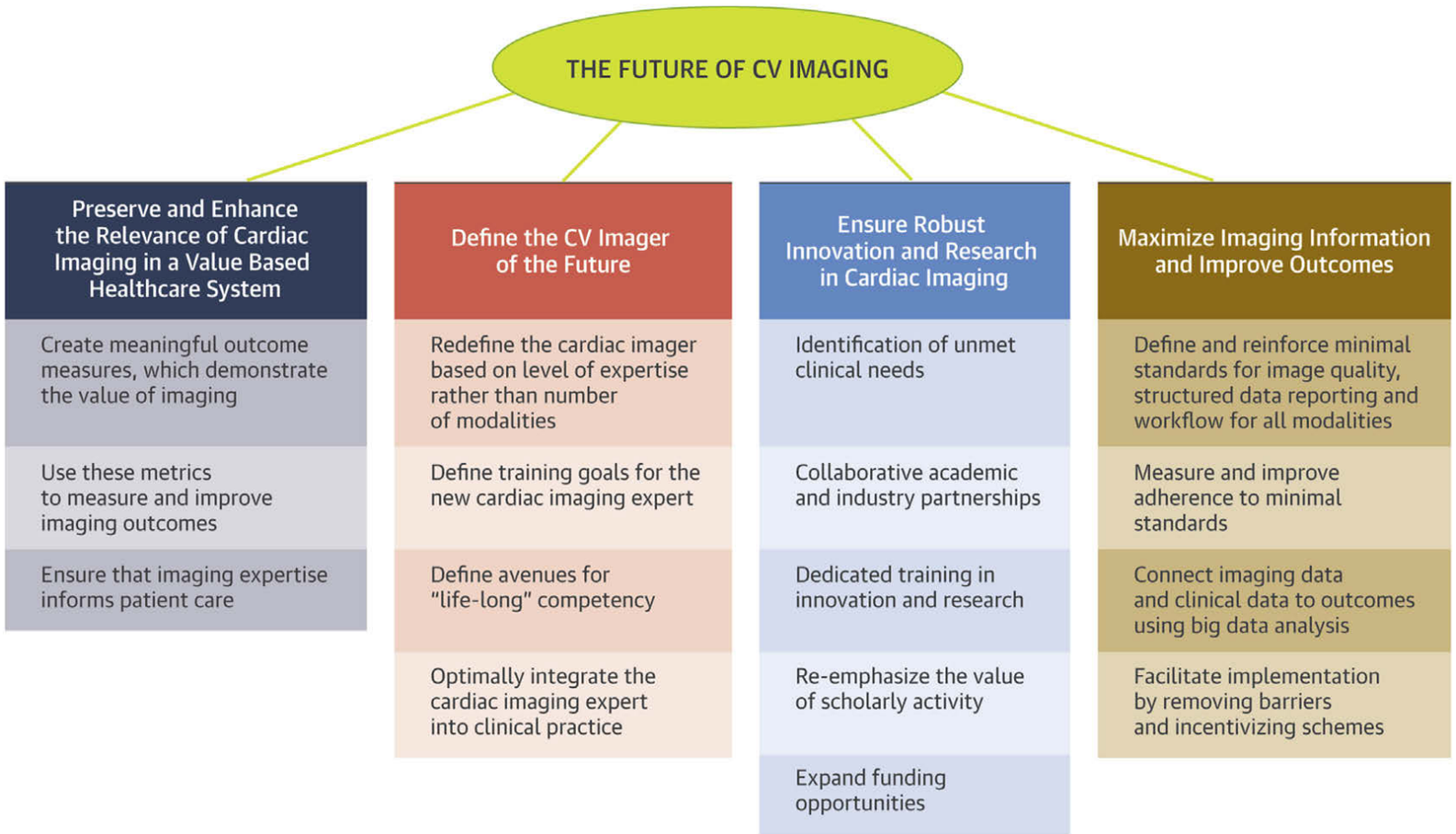
- A huge amount of data - do we really need all of this?

STATE-OF-THE-ART PAPER

The Future of Cardiac Imaging

Report of a Think Tank Convened by the American College of Cardiology

CENTRAL ILLUSTRATION Goals and Strategies Recommended by The Future of Cardiac Imaging Think Tank



Douglas, P.S. et al. J Am Coll Cardiol Img. 2016;9(10):1211–23.

The Think Tank deliberations were structured into 4 areas or goals. Within each goal, 3 to 5 key strategies were identified.

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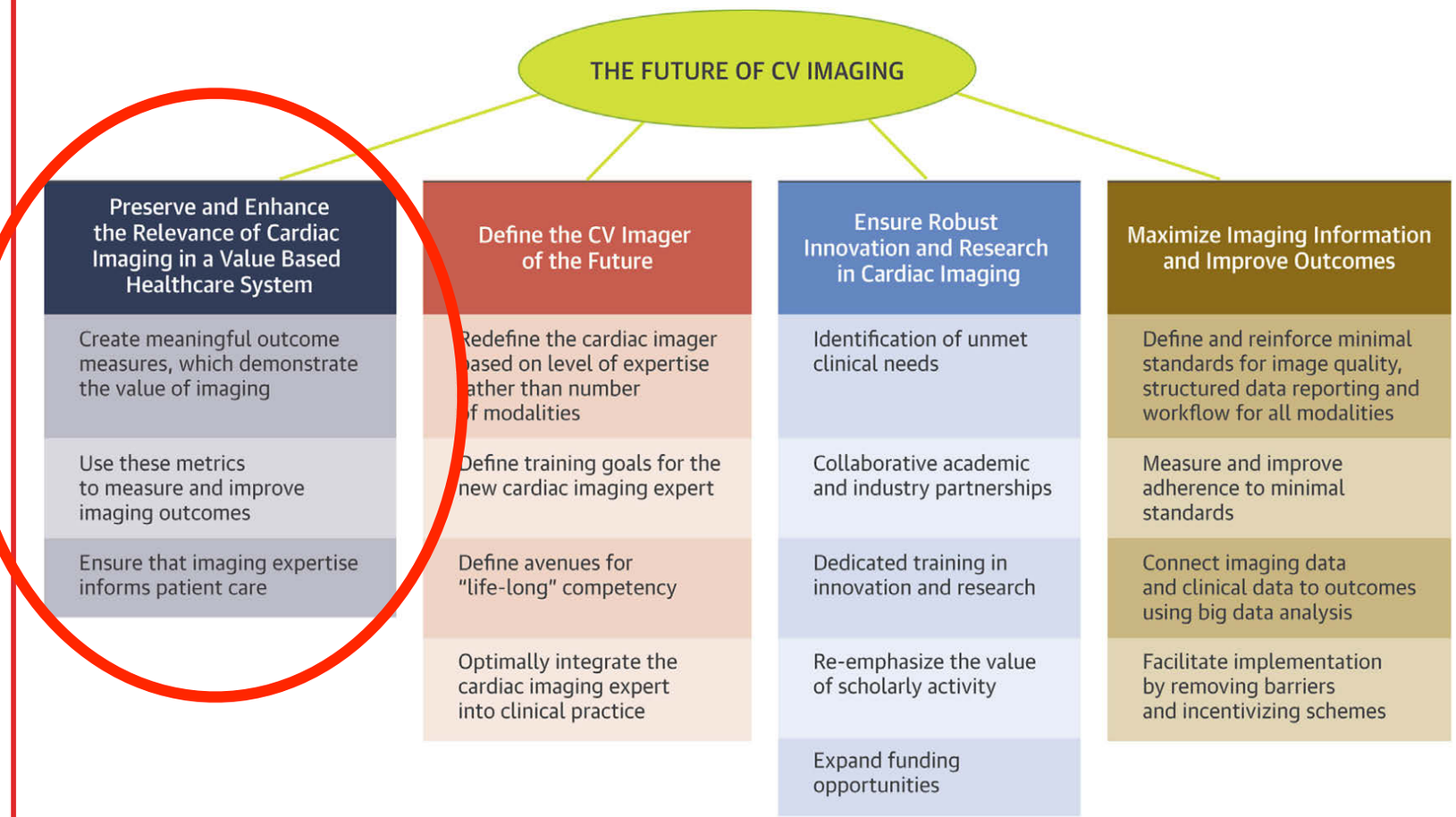

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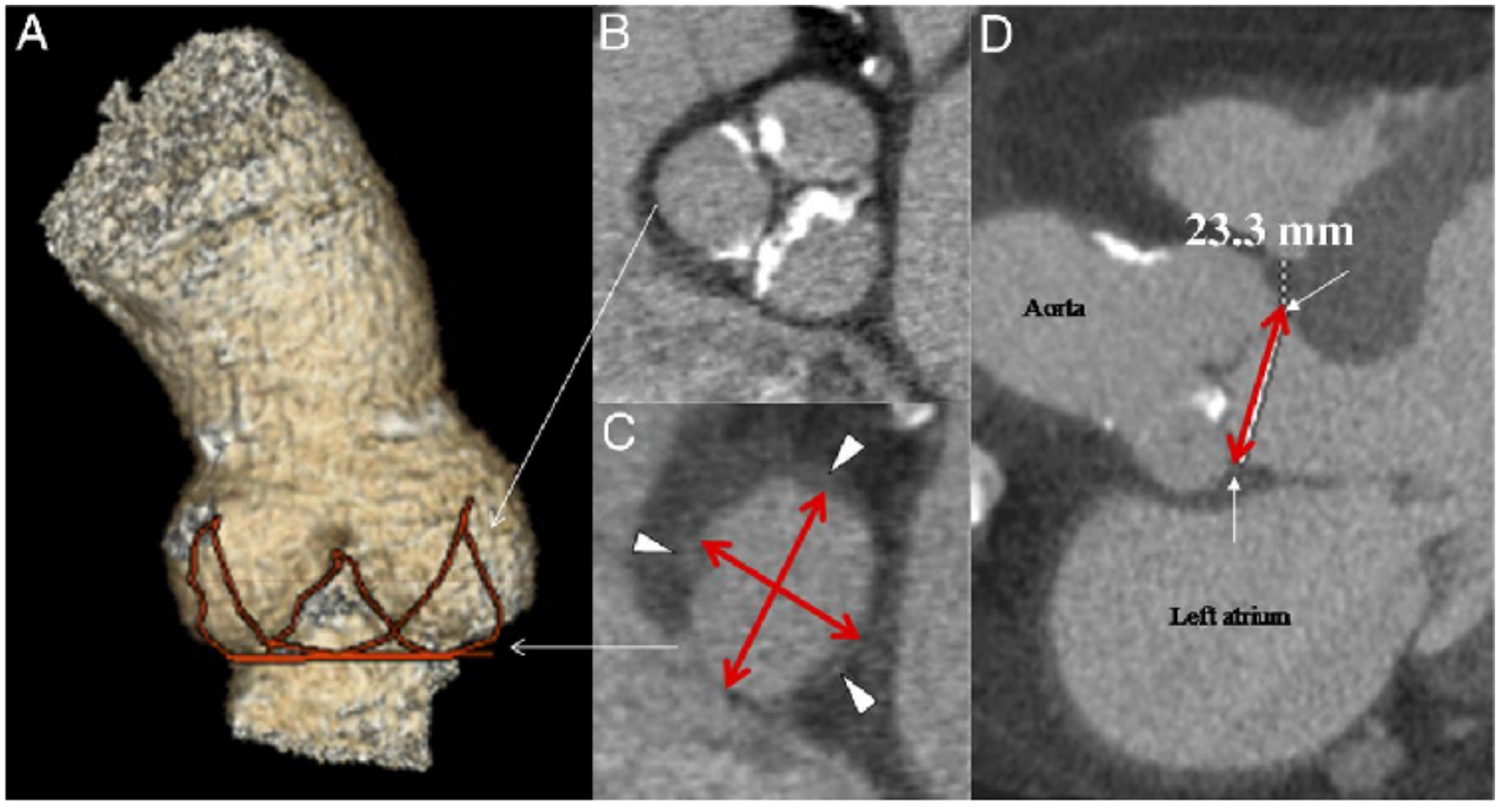
Can Imaging Change the Outcomes?



Innovation that changes the outcome (in my field…)

- One-shot anatomic + functional information in CAD

- Real time imaging during MICS / TCT for SHD

Innovation that changes the outcome (in my field…)

- **One-shot anatomic + functional information in CAD**

- Real time imaging during MICS / TCT for SHD

THE LANCET

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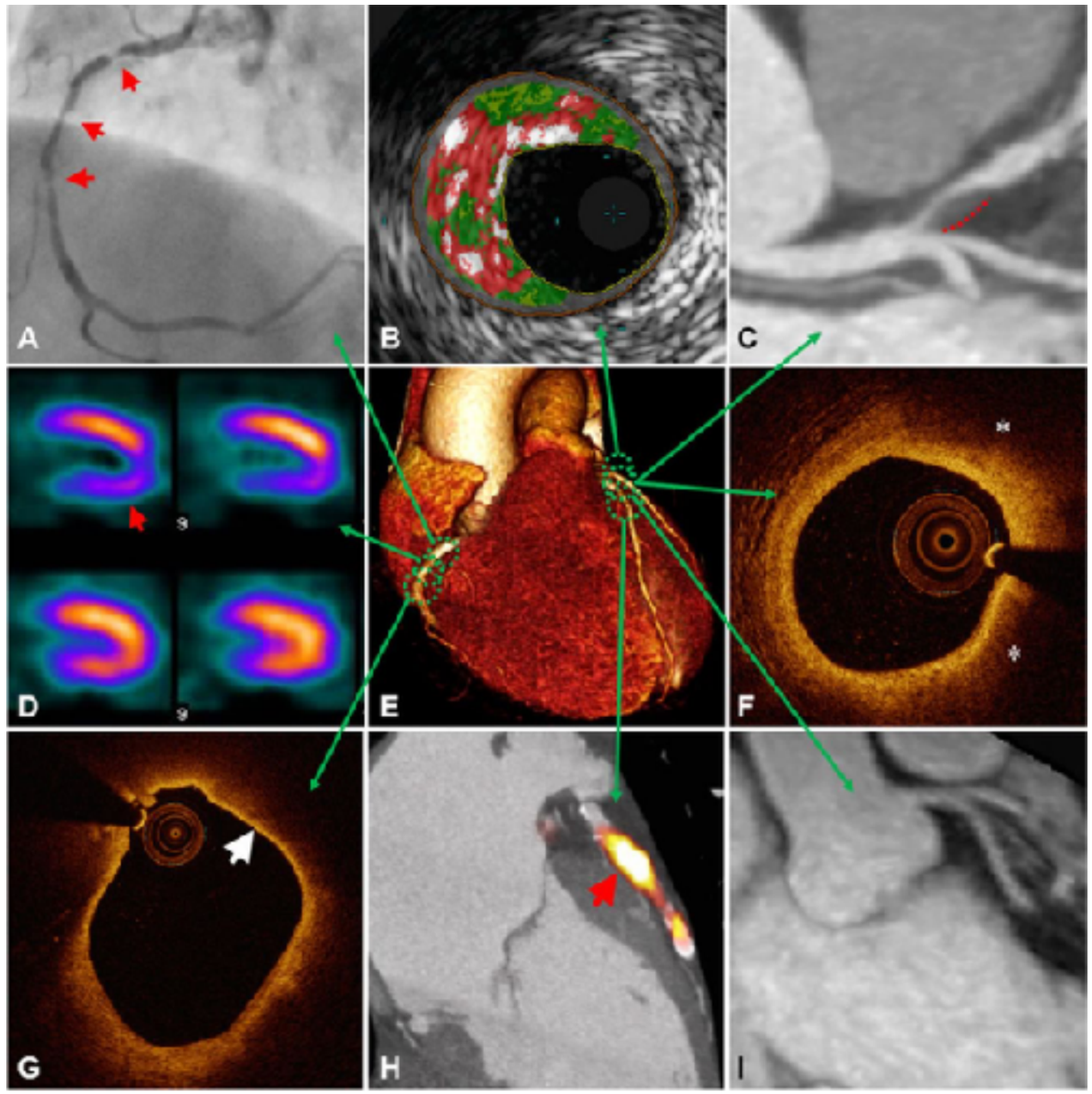
"In patients with medically treated angina and severe coronary stenosis, percutaneous coronary intervention did not increase exercise time by more than the effect of a placebo procedure."

See Articles page 31

Imaging Coronary Atherosclerosis



Imaging Coronary Atherosclerosis

- Quantitative measure of lumen reduction - angio

- Plaque morphology - IVUS, OCT

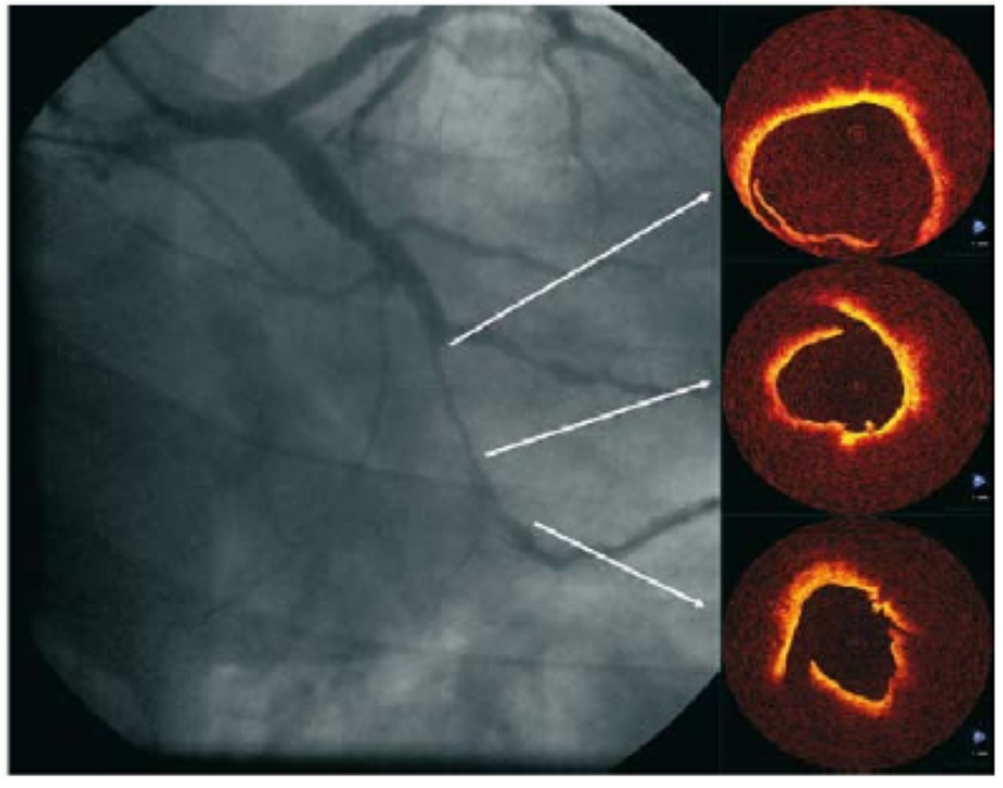
Table 1. Summary of potential advantages of hybrid catheters.

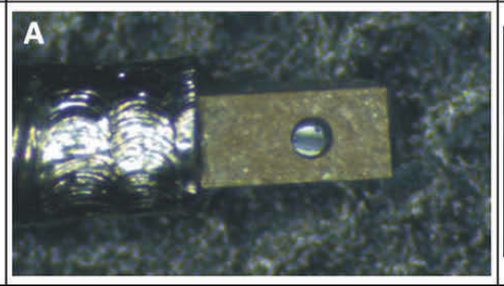
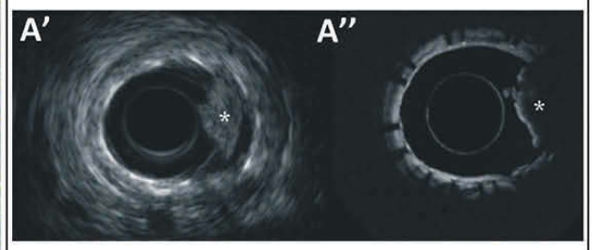
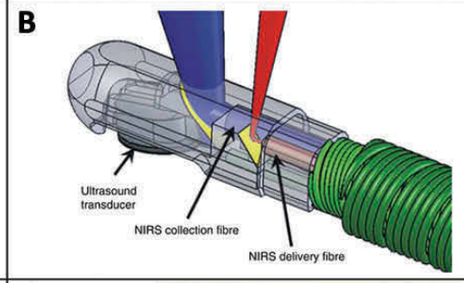
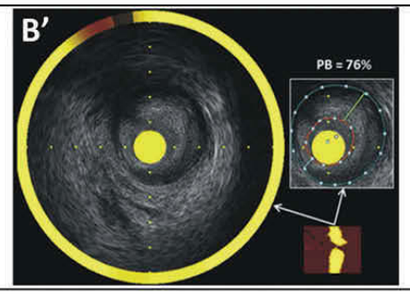
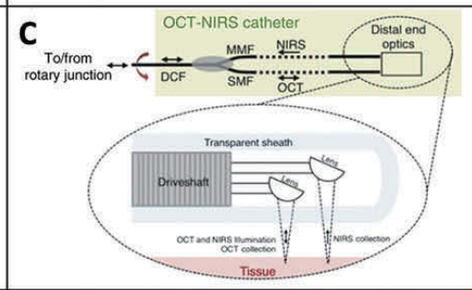
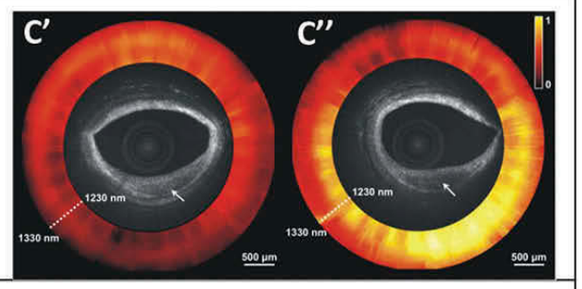
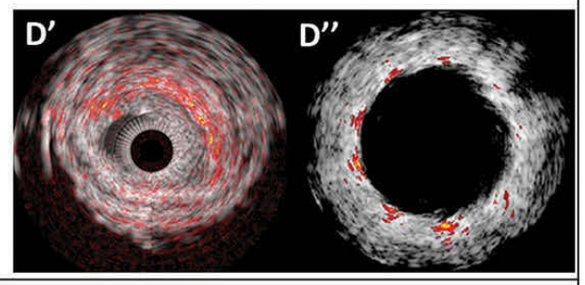
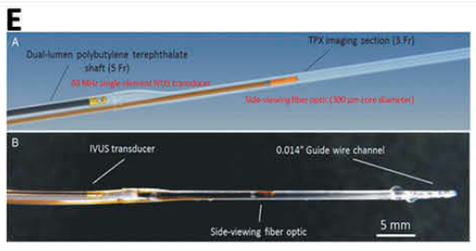
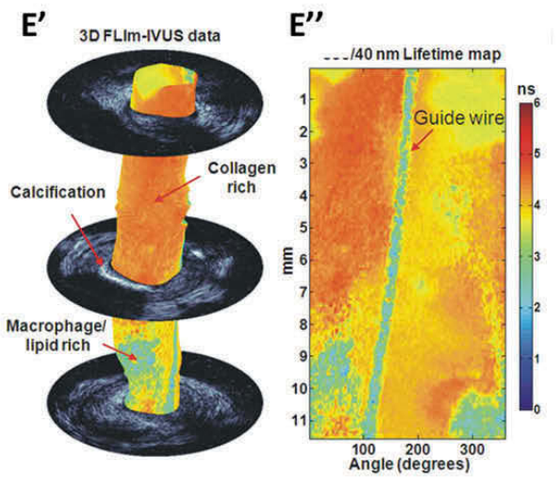
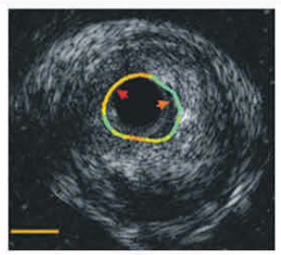
		IVUS (intravascular ultrasound)	OCT (optical coherent tomography)
	Axial Resolution	20 µm	8 µm [12]
OCT	8 µm [12]	IVUS-OCT: Detailed plaque characterization with vessel size (remodeling) assessment.	
NIRS (near-infrared spectroscopy)	NA	NIRS-IVUS: Simultaneous assessment of lipid component and vessel structure (plaque burden, remodeling).	NIRS-OCT: Differentiating deep tissue (i.e. deeply embedded calcific tissue and lipid tissue).
NIRF (near-infrared fluorescence imaging)	NA	NIRF-IVUS: Simultaneous assessment of inflammation and vessel structure.	NIRF-OCT: Correlates inflammation and detailed morphological assessment.
IVPA (intravascular photoacoustic imaging)	100 µm [13]	IVPA-IVUS: Simultaneous assessment of chemical composition (i.e. lipid, inflammation, stent) and structural information.	
TRFS (time-resolved fluorescence spectroscopy)	160 µm [14]	TRFS-IVUS: Simultaneous assessment of compositional characteristics (i.e. lipid, collagen, elastin) of the superficial plaque and vessel structure.	

Table 2. Study phase of hybrid imaging devices.

Type of imaging devices	*Ex vivo* study	*In vivo* animal study	*In vivo* human study	Regulatory body approval
IVUS-OCT	✓[12,15–17]	✓[18,19]		
NIRS-IVUS	✓[20]	✓[21,22]	✓[23–26]	✓
NIRS-OCT	✓[27]			
NIRF-IVUS	✓[28]	✓[29]		
NIRF-OCT	✓[30]	✓[31–35]	✓[36]	
IVPA-IVUS	✓[37–40]	✓[41]		
TRFS(FLIm)-IVUS	✓[42,43]	✓[14,44,45]		

FLIm: fluorescence life time imaging; IVPA: intravascular photoacoustic; IVUS: intravascular ultrasound; NIRF: near-infrared fluorescence; NIRS: near-infrared spectroscopy; OCT: optical coherence tomography; TRFS: time resolved fluorescence spectroscopy.



	Catheter Tip	Cross sectional Image example
IVUS-OCT		
NIRS-IVUS		
NIRS-OCT		
IVUS-IVPA		
IVUS-FLIm		
		

Evidence

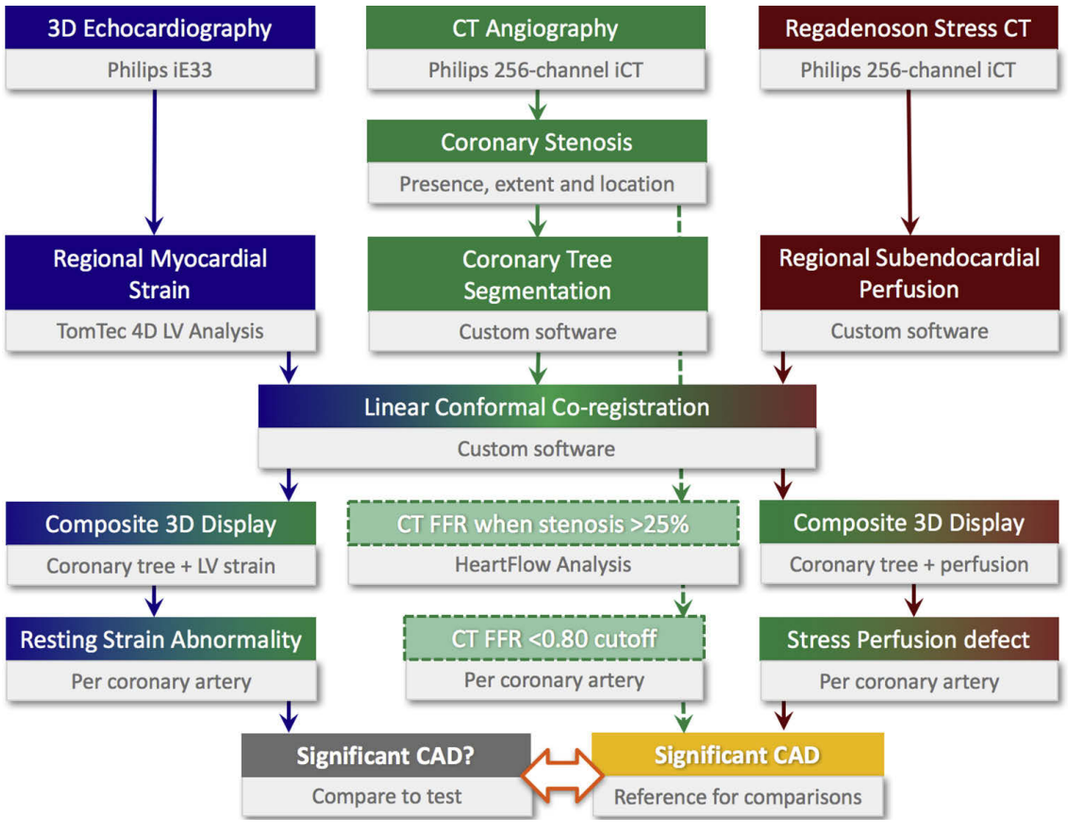
- IVUS Guided PCI
    - IVUS-XPL
    - CTO-IVUS
    - ILUMEN
- Vulnerable plaque treatment
    - SECRITT
    - PREVENT

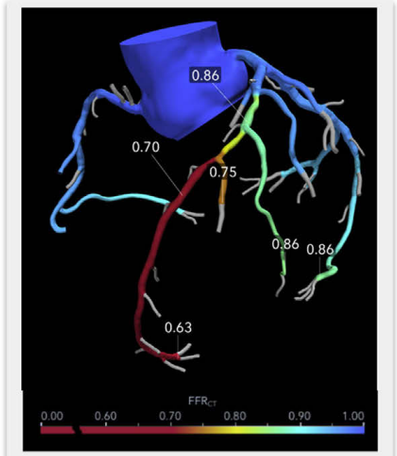
Imaging Coronary Atherosclerosis

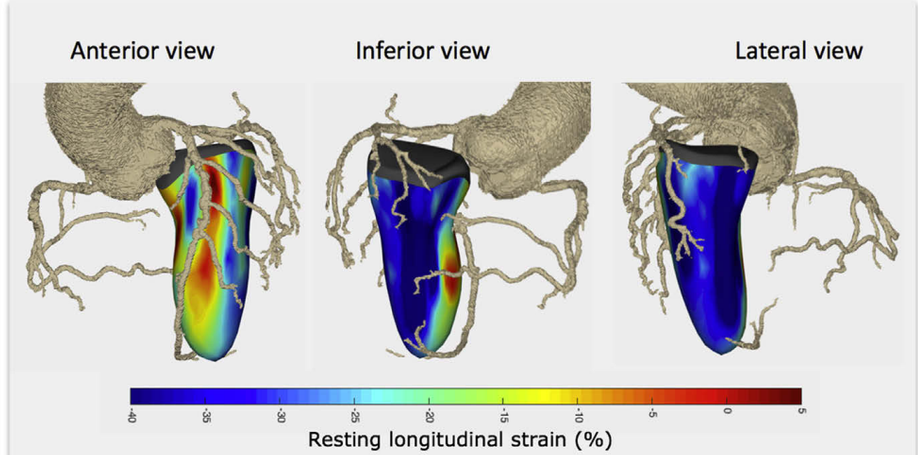
- Quantitative measure of lumen reduction - angio

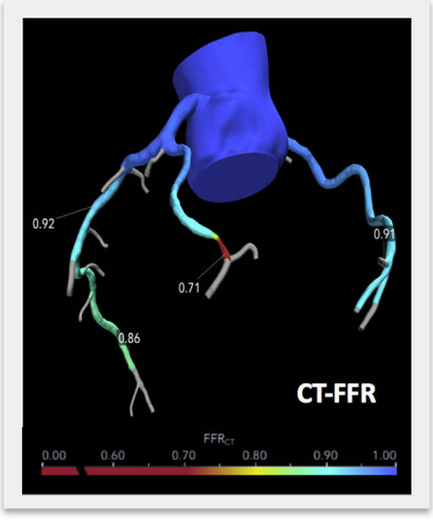
- Demonstration of specific, lesion-induced, metabolic abhormality (Ischaemia)

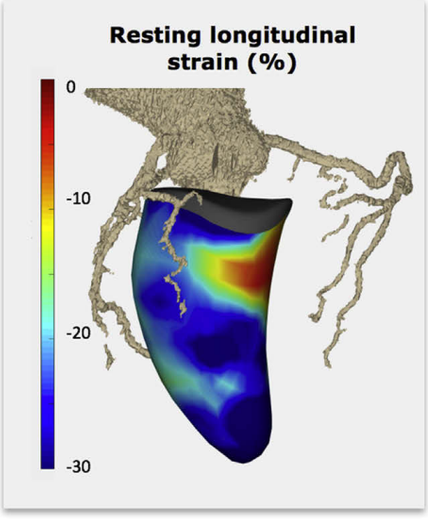
Echo-CT fusion imaging

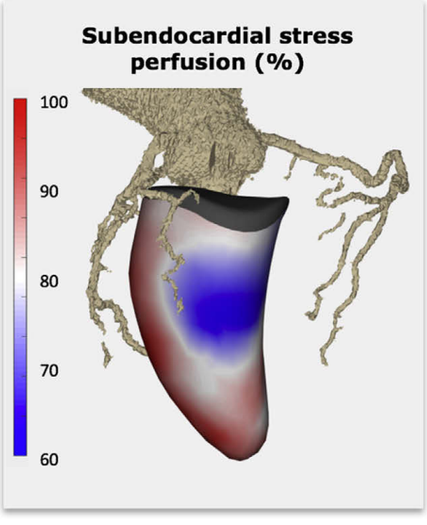




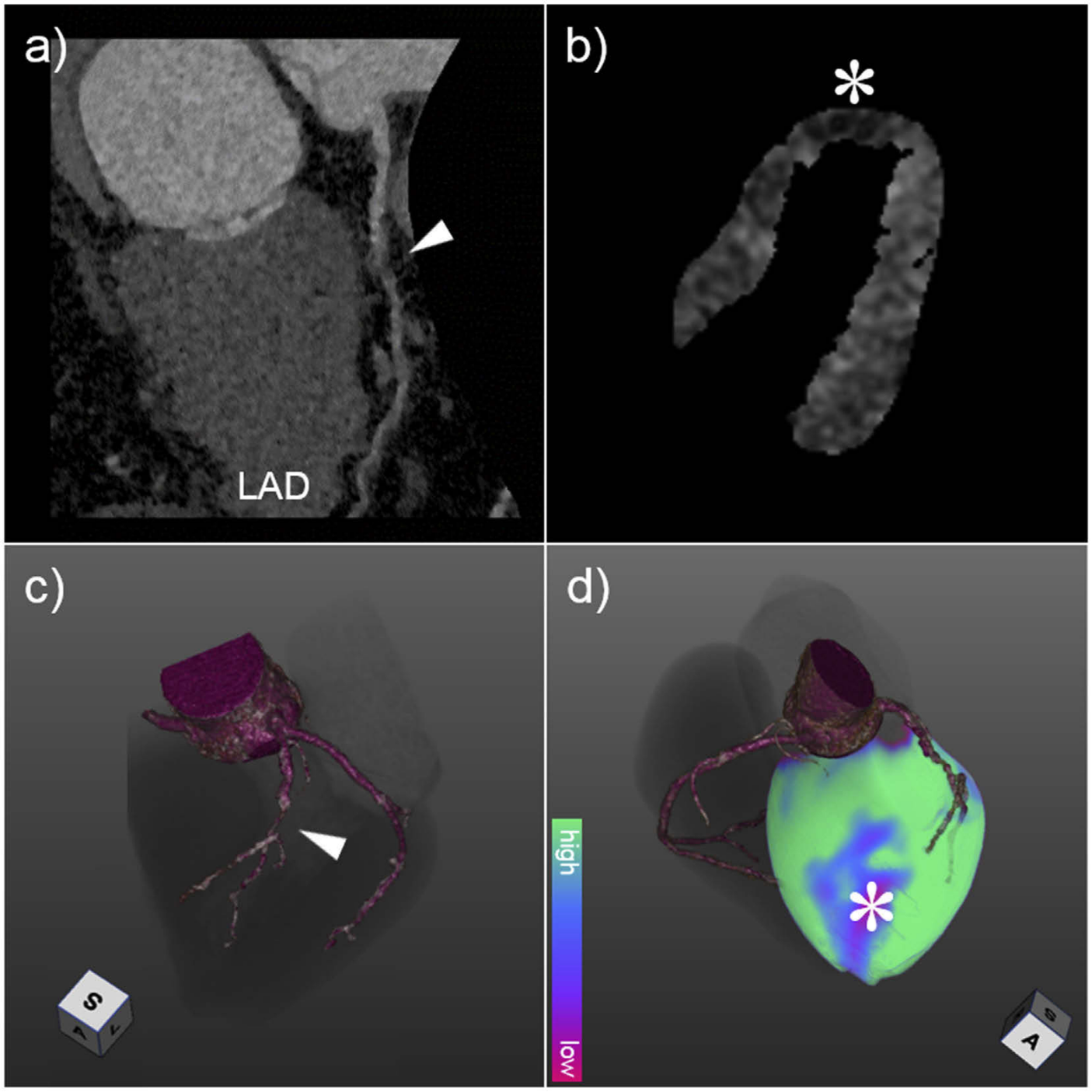




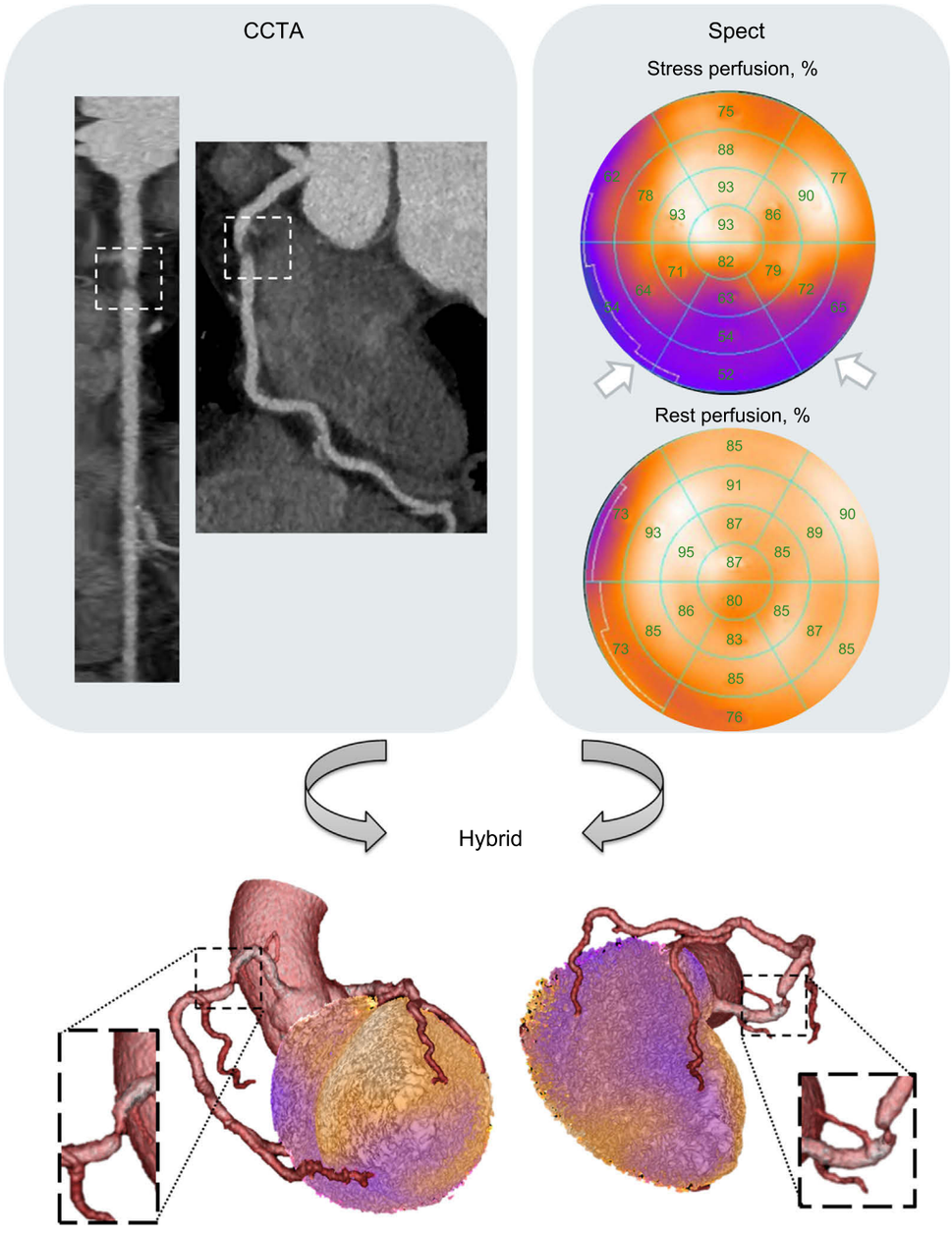




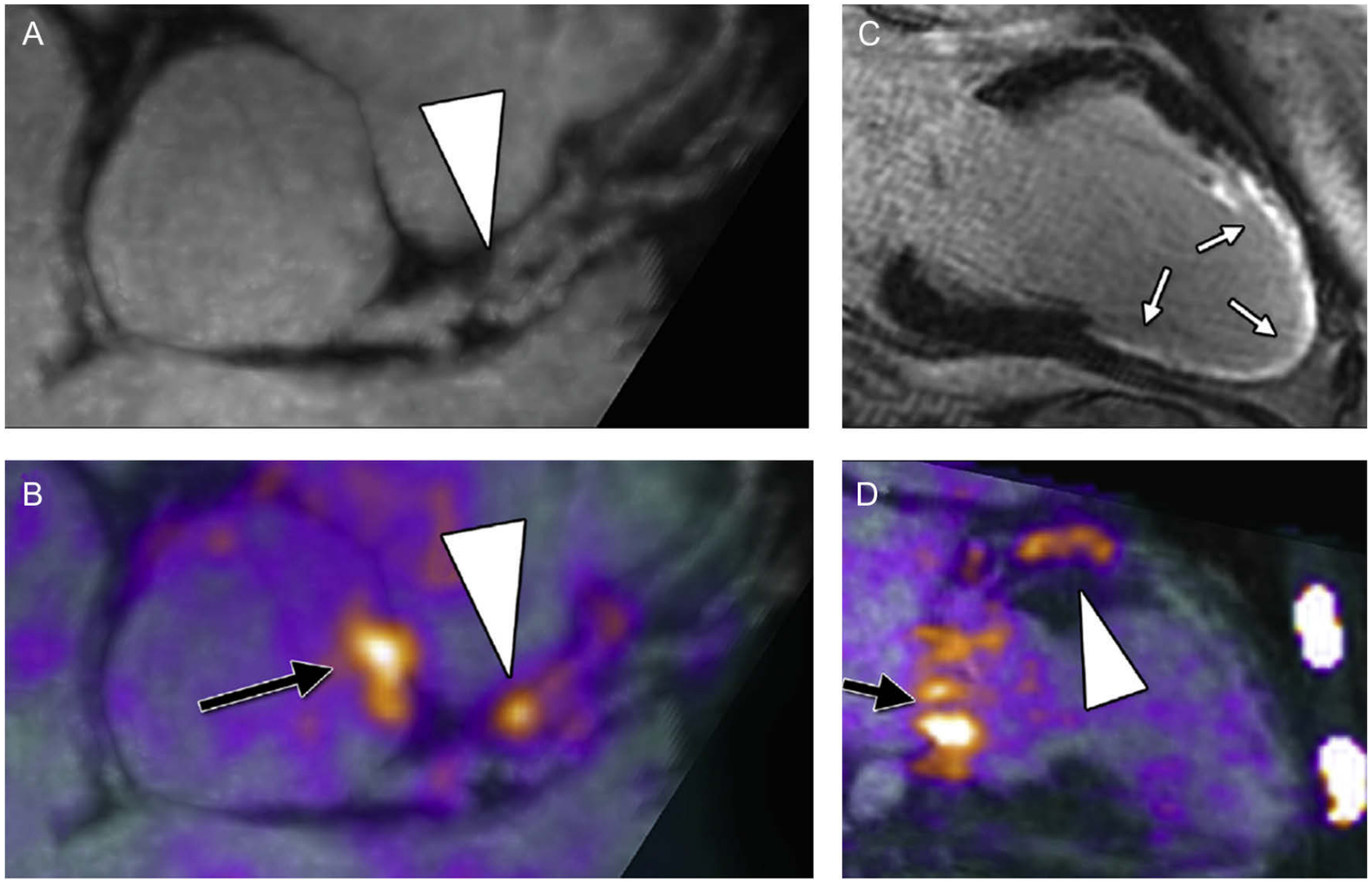
CT-CT fusion imaging



CT-Spect fusion imaging



PET-MRI fusion imaging



CTA-MRI fusion imaging