بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

Advanced Imaging In Cardiac Resynchronization Therapy

Neama El-Meligy MD

Cardiology Department, Benha University

- Cardiac resynchronization therapy (CRT) is an established therapeutic option in patients with symptomatic HF.

- Large, prospective, clinical trials have demonstrated its important role in improving symptoms and reducing both hospitalization and mortality in HF patients.

- However, with the current guidelines a significant proportion of patients (30%) do not respond to CRT.

CRT is recommended for :

- **Symptomatic patients with HF** (NYHA II, III, IV) **despite OMT, sinus rhythm**
- **LVEF ≤35%**

I	A

- **LBBB QRS morphology QRS duration ≥150 msec**

ESC Guidelines of HF. European Heart Journal May 2016

So the improvement of patient selection and the achievement of optimal outcomes for CRT patients are an important area of research.


Circulation

HOME ABOUT THIS JOURNAL ALL ISSUES SUBJECTS BROWSE FEATURES RESOURCES AHA JOURN

HEART FAILURE

Results of the Predictors of Response to CRT (PROSPECT) Trial

Eugene S. Chung, Angel R. Leon, Luigi Tavazzi, Jing-Ping Sun, Petros Nihoyannopoulos, John Merlino, William T. Abraham, Stefano Ghio, Christophe Leclercq, Jeroen J. Bax, Cheuk-Man Yu, John Gorcsan, Martin St John Sutton, Johan De Sutter, Jaime Murillo

- PROSPECT (circulation 2008)

 A large, nonrandomized, multicenter trial has demonstrated that, None of 12 different echocardiographic measures of dyssynchrony proved to be sensitive or specific enough to be clinically useful for predicting response to CRT.

Advanced Imaging

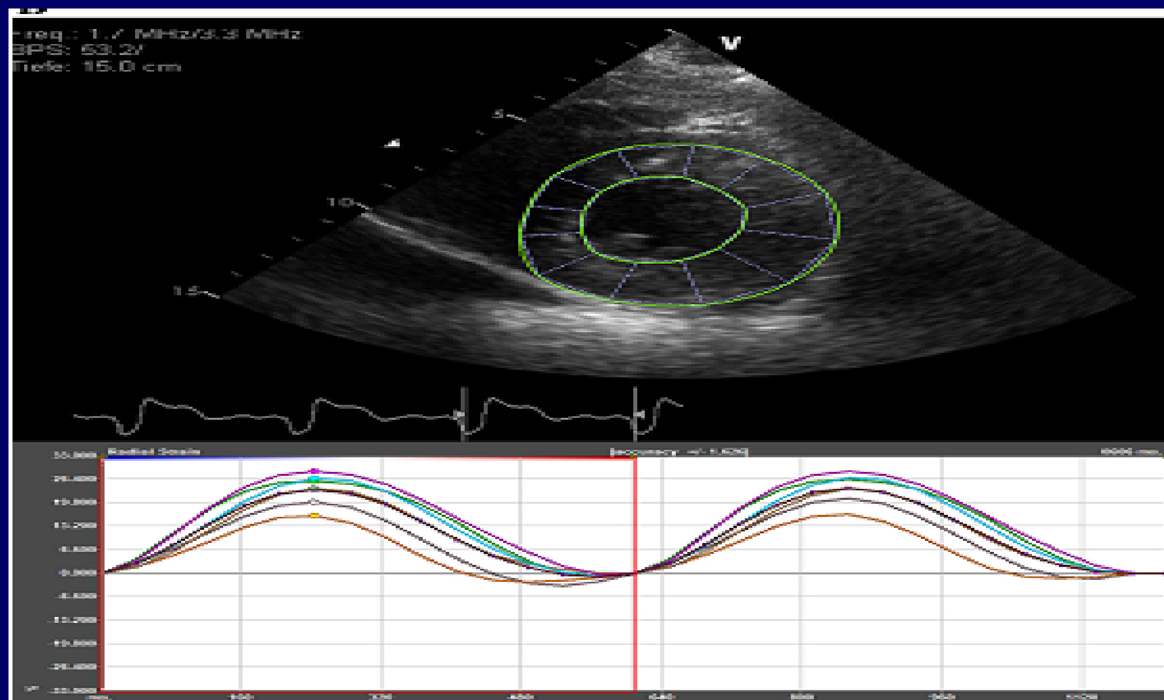
- Echo modalities :
  Speckle Tracking Imaging
  Three-Dimensional Echocardiography(3DE)
  Stress Echocardiography
- Cardiac Magnetic Resonance Imaging (CMRI)
- CCT
- Radionuclide Imaging

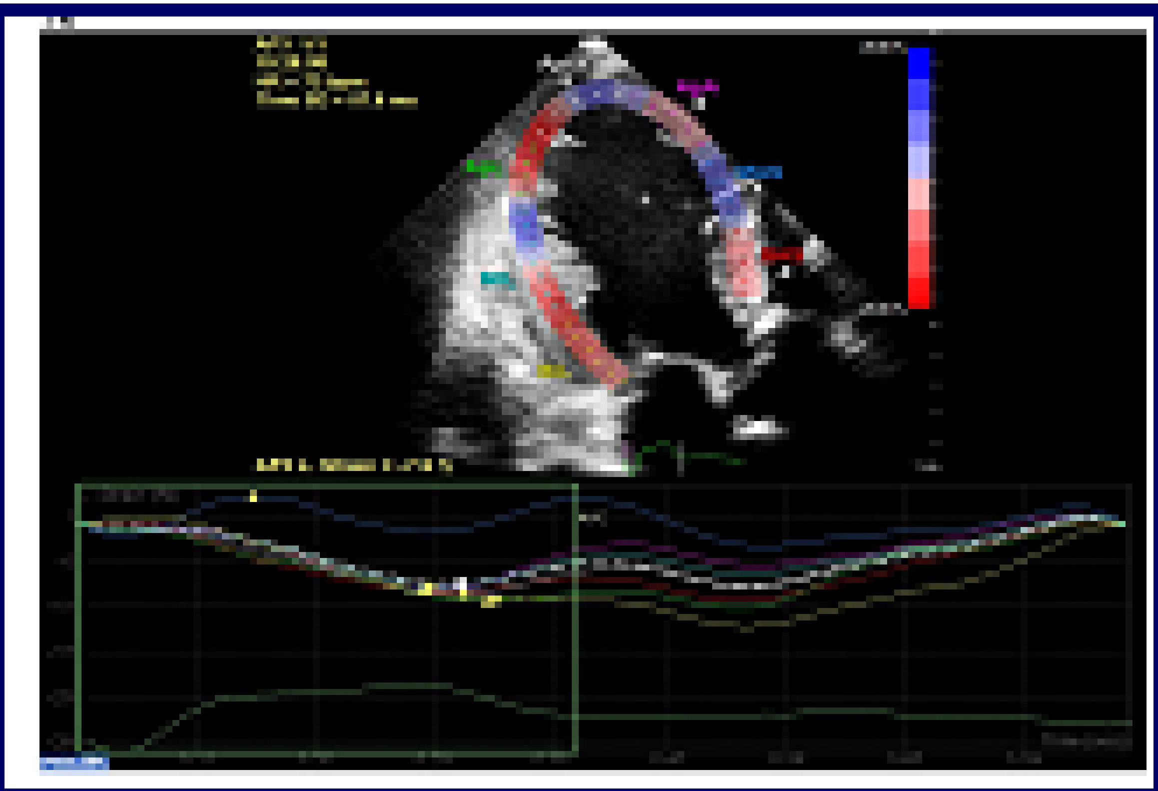
Speckle Tracking Imaging

- STI allows the assessment of deformation and dysynchrony in longitudinal, radial, circumferential and rotational axes.

- The advantages over TDI :
  - Less angle dependence
  - Lower inter-observer variability
  - Less time-consuming analysis.

Studies have identified speckle-tracking radial strain dyssynchrony as a predictor of clinical benefit in patients with ischaemic cardiomyopathy undergoing CRT





Longitudinal strain dyssynchrony is also an independent predictor of response to CRT

Longitudinal strain is able to distinguish ischaemic from non-ischaemic HF

- The TARGET trial (2011) used speckle-tracking radial strain to guide LV lead positioning and to identify sites of scar, with beneficial effects on clinical outcomes at 6 months.

First author	Design	Subjects (n)	Parameter and cut-off	Response prediction (≥15% ΔESV)	Outcome	Strengths and/or limitations
De Boeck [4]	Prospective single centre	62	SRSsept >4.7%	Sens/spec: 81%/81%, AUC: 0.938±0.035, B: 2.41, p=0.005		Relatively high inter- and intra-observer variability (COV: 14.2 and 15.6%)
Leenders [31]	Prospective single centre	101	SRSsept >4.7%	Multivariate analysis, B: 3.78, p<0.001	Survival (death, LVAD or transplant) with HR: 5.8 (2.3–14.3)	No HF hospitalisation or morbidity
Chan [38]	Prospective single centre	43	SRSsept >4.7%	AUC: 0.862±0.061[a]		No multivariate analysis
van 't Sant [21]	Retrospective single centre	227	SRSsept (continuous)	Multivariate analysis, B: 1.191		SRSsept assessed as continuous variable. No specific cut-off used
Ghani [32]	Retrospective single centre	138	SRSsept >4.0%	Sens/spec: 66%/66%, AUC: 0.70	Data on outcome not published (although registered)	Analysis on AP4CH instead of septal single wall
Leenders [33]	Retrospective single centre	132	Septal deformation patterns (3 types)	Type 1 and 2 predict response vs type 3 ΔESV: 37±20 & 24±24 vs 5±20 ml, p<0.001		Validated by mechanistic computer model
Marechaux [34]	Prospective single centre	101	Septal deformation patterns (3 types)	Responders: pattern 1&2 vs 3: 92 vs. 59%, p<0.0001, Sens/spec: 74%/74%	18 months event-free survival (death or HF hospitalisation): Pattern 1&2 vs. 3: 95 vs 75%, p=0.01	Relatively short follow-up
Risum [37]	Prospective single centre	67	LBBB deformation pattern	Sens/spec: 91%/95%		Complex pattern description
Risum [35]	Prospective multicentre	208	LBBB deformation pattern		Absence of LBBB-pattern increases 4 year risk of death, HF hospitalisation, LVAD or HTx HR 3.1 (1.64–5.88)	Complex pattern description

Studies on septal dyssynchrony parameters, derived from speckle tracking echocardiography, predicting response to cardiac resynchronization therapy. All studies are single centre, prospective trials.

- Single-center, limited study populations, absence of control arms, and controversial end points different threshold cutoffs for the same technique, short follow-up, and lack of randomization, blinding, or reporting of intraobserver and interobserver variability.

Stress Echocardiography

- Myocardial viability is assessed as both global and regional contractile reserve
- Global LV contractile reserve is an independent predictor of the clinical and echocardiographic response to CRT.
- Regional contractile reserve detect the target myocardial segments for the LV lead (latest activated segments).

In patients with a >20% increase in LVEF during low-dose dobutamine stress echo (LDDSE) and LV lead positioning in the most delayed mechanical segment,

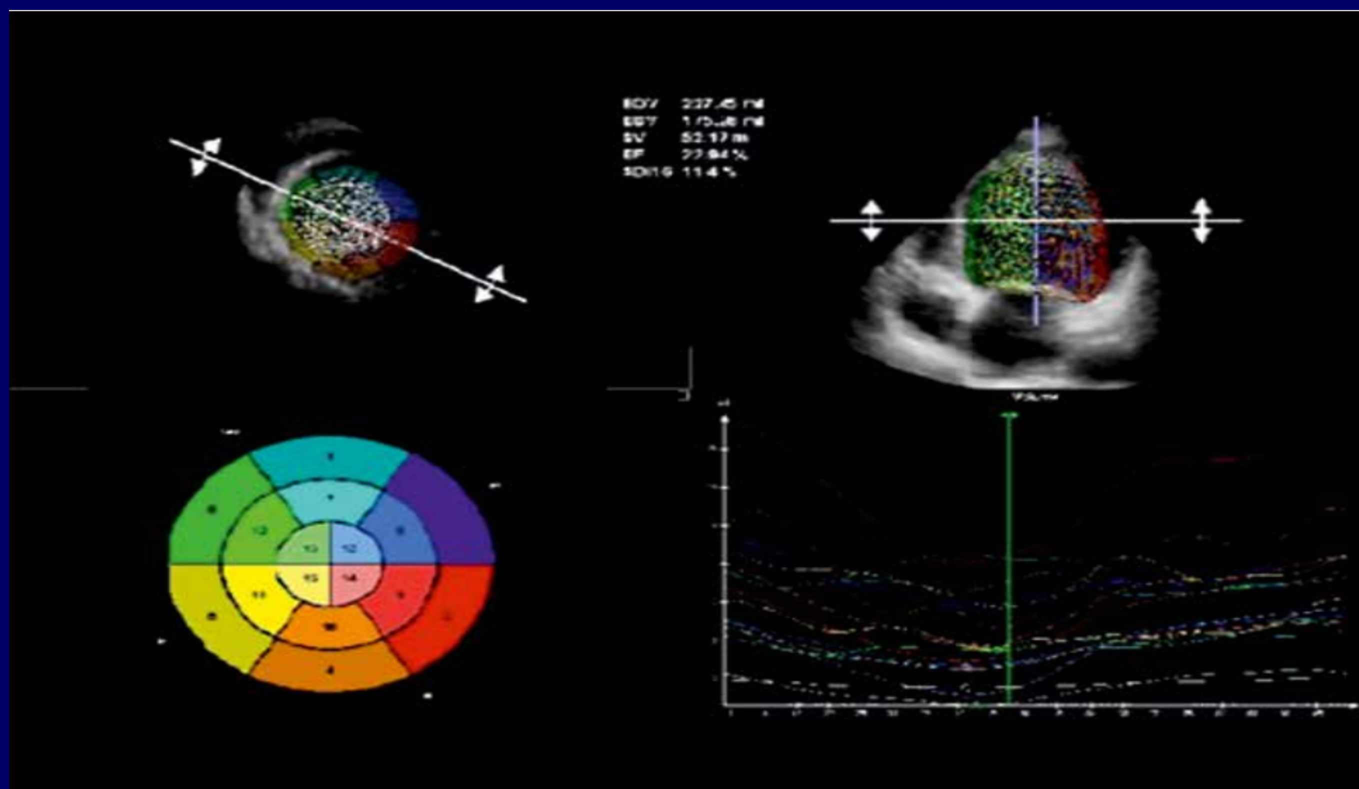
the response rates to CRT and HF hospitalization-free survival are improved,

Three-Dimensional Echocardiography

- (3DE) is a promising technique for the global assessment of LV synchronicity
- It can simultaneously evaluate global and regional ventricular volumes and contraction during the cardiac cycle
- Acquired by three methods:
  Triplane tissue Doppler (TTD)
  Regional volume-time curves (RVTC) and
  Three-dimensional speckle tracking (3DST)

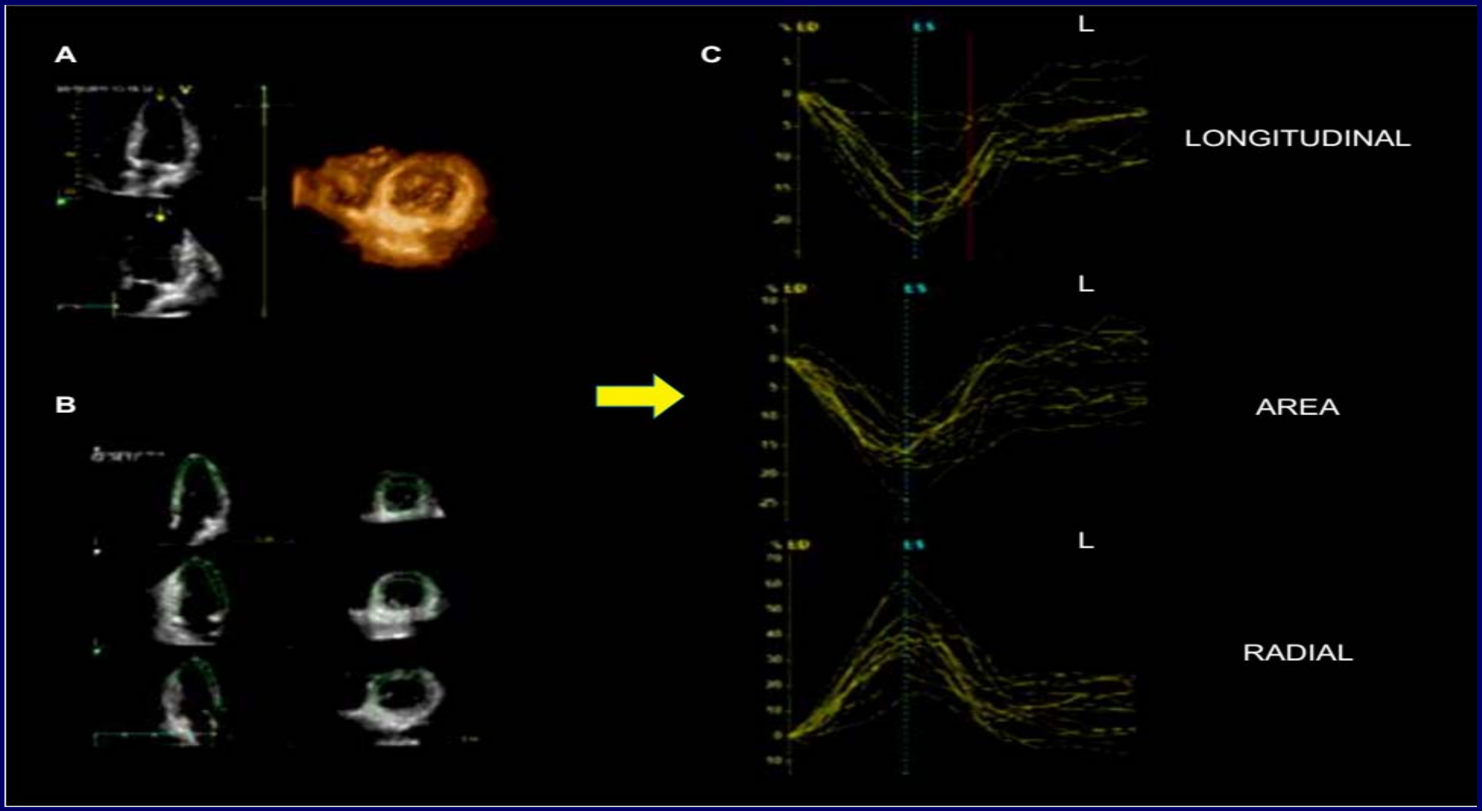
RVTC (Regional volume-time curves)

comparing the times to minimal regional volume for each segment



3DST

All the three strain vectors are analysed simultaneously



- 3DE allows the global assessment of LV synchronicity within a few minutes
- Although there are no optimal cutoff values so far, and the method still requires expertise and further study.

Cardiac Magnetic Resonance Imaging CMRI

- Accurate assessment of LV volumes and EF
- Estimates the degree of mechanical dysynchrony
- Detection of scar tissue and its relation to the site of LV pacing
- Evaluate the venous coronary anatomy, allowing the optimal guidance of LV lead deployment.

CMRI

Evaluation of asynchrony

Can be assessed by :

- Cine MRI technique
- Myocardial tagging, and
- Strain-encoded imaging (SENC).

- Cine MRI study (the LV asynchrony indices, evaluated by longitudinal strain analysis using a 4-chamber view, were significantly prolonged in CRT responders.)

CMRI
Evaluation of scar tissue

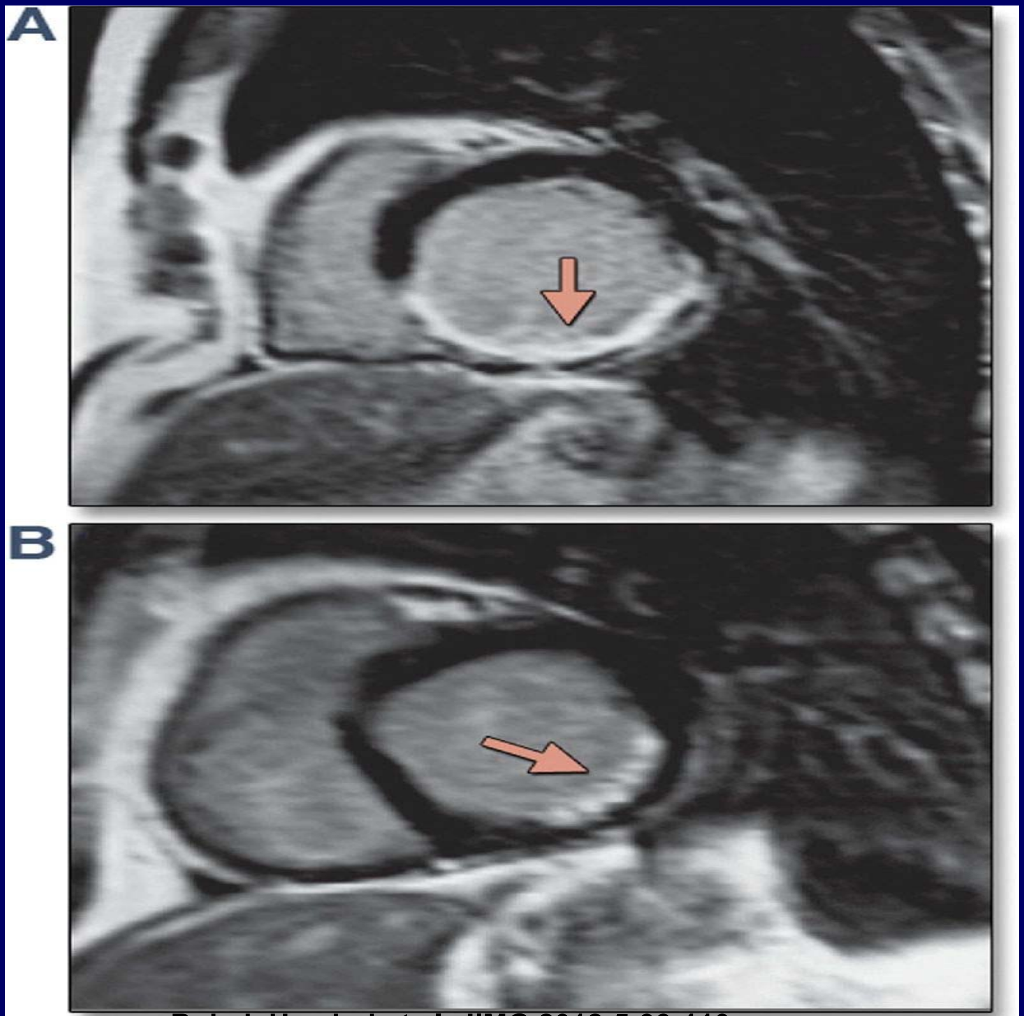
- There has been accumulating evidence that the quantity and location of scar tissue in patients with HF play an important role in the results of CRT.

- CMRI, with the use of LGE, has become the gold-standard for the assessment of myocardial scarring.

- A cutoff value of <15% for scar burden in patients with ischemic and non-ischemic cardiomyopathy was associated with clinical responders to CRT, with a sensitivity and specificity of 85% and 90%, respectively.

- Scar transmurality ≥50% is associated with a suboptimal response to CRT.

- In patients with ischemic cardiomyopathy the posterolateral scar was associated with lower response rates to CRT. Furthermore, the combination of an absence of lateral wall transmural scar and the presence of asynchrony predict favorable effects post CRT with a sensitivity and specificity of 90% and 60%



Bobak Heydari et al. JIMG 2012;5:93-110

CMRI
Optimal lead location

- CMRI seems to contribute to optimal lead placement, by the evaluation of the site and extension of the scar and by imaging the respective coronary vein.

- Allows the placement of the pacing leads in an area with the greatest electrical and mechanical activation delay, while the area of extensive scarring can be avoided.

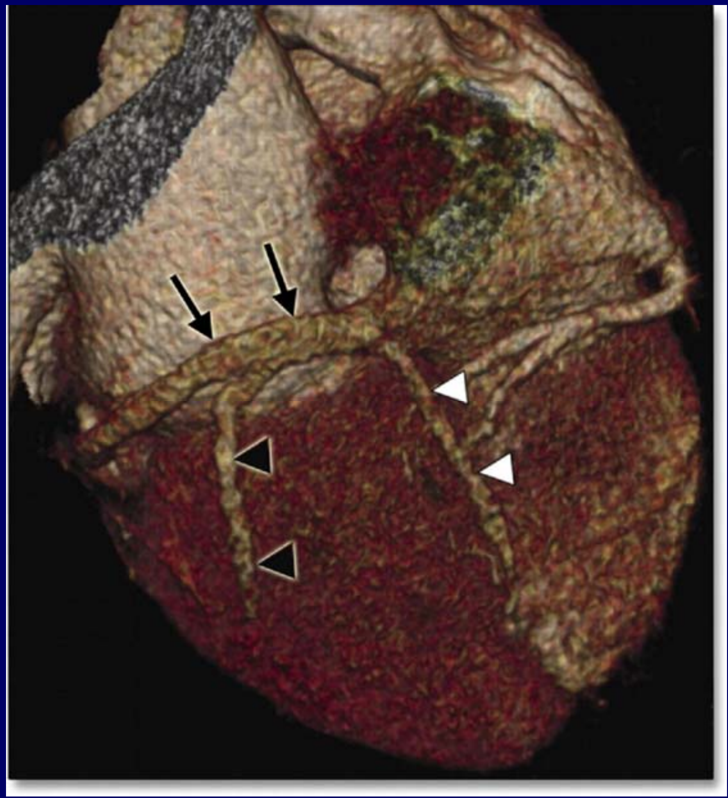
Limitations

- Time-consuming
- MT and SENCE are complex post-processing techniques
- Cannot be used for bedside assessment
- Contraindicated in patients with many implanted cardiac devices.

CCT

- CCT could be a useful technique, in combination with echocardiography and CMRI, for the assessment of asynchrony, quantification of scar, and evaluation of venous anatomy, assisting in determining the optimal LV lead placement

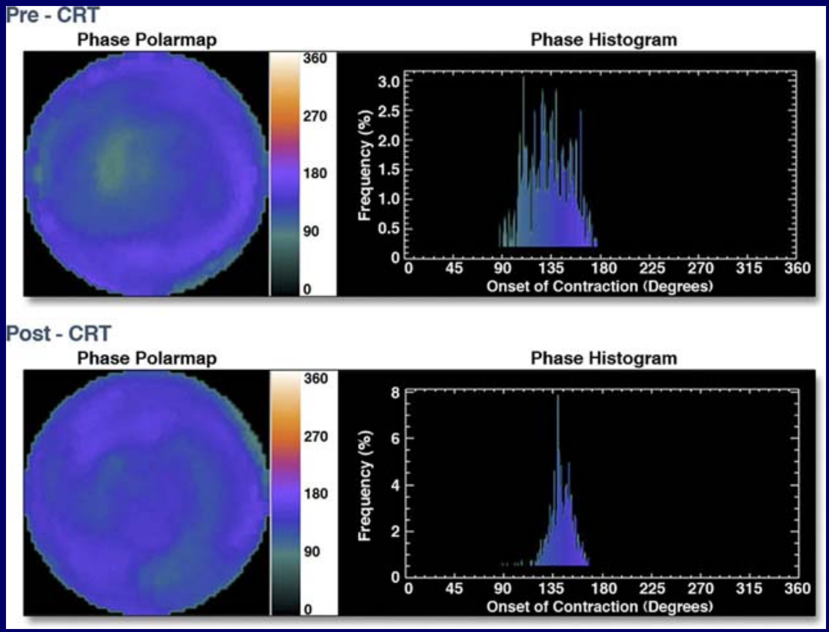
- The two major disadvantages: radiation exposure and the prolonged time of the procedure



Radionuclide Imaging

- The degree of LV dyssynchrony as assessed by GMPS was also shown to correlate with response to CRT in a study
- A recent study evaluated the use of GMPS to determine the site of latest LV activation for LV lead placement and found a significantly higher response rate for patients with GMPS-guided LV lead placement

Gated myocardial perfusion single-photon emission computed tomography (GMPS)



- limitations of nuclear dyssynchrony assessment, including sophisticated post-processing techniques, potentially hazardous radiation exposure, and limited spatial resolution

Conclusions

- Despite advances in cardiac imaging over the past decade, there are still no imaging parameters that are routinely indicated to guide CRT therapy .
- Novel imaging methods have shown great promise in assessing mechanical dyssynchrony.
- Future randomized control trials are required to determine whether imaging studies can provide more targeted CRT selection to reduce nonresponsiveness and complications related to CRT.

Thank You