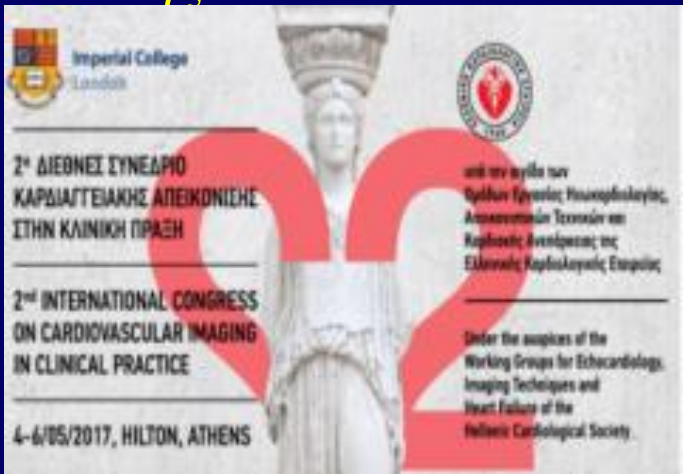
Ο Ρόλος της απεικόνησης: Αξιολόγηση προς θεραπεία με συσκευές καρδιακής ανεπάρκειας(CRT-D).

Ευαγγελία Χριστοφοράτου

Καρδιολόγος

Επιστημονικός Συνεργάτης Α΄ Πανεπιστημιακής Καρδιολογικής Κλινικής ΙΓΝΑ

Επιστημονικά Υπεύθυνη Υπερηχοκαρδιογραφικού Τμήματος και Τμήματος Βηματοδοτών- Απινιδωτών Βιοκλινικής



RCTs in NYHA III/IV pts

Trial (ref)	No.	Design	NYHA	LVEF	QRS	Primary endpoints	Secondary endpoints	Main Findings
MUSTIC-SR[52]	58	Single-blinded, crossover, randomized CRT vs. OMT, 6 months	III	<35%	≥150	6MWD	NYHA class, QoL, peak VO_2LV volumes, MR hospitalizations, mortality	CRT-P improved 6MWD, NYHA class, QoL, peak VO_2, reduced LV volumes and MR and reduced hospitalizations
PATH-CHF[51]	41	Single-blinded, crossover, randomized RV vs. LV vs. BiV, 12 months	III–IV	NA	≥150	Peak VO_2, 6MWD	NYHA class, QoL hospitalizations	CRT-P improved NYHA class, QoL and 6MWD and reduced hospitalizations
MIRACLE[49]	453	Double-blinded, randomized CRT vs. OMT, 6 months	III–IV	≤35%	≥130	NYHA class, 6MWD , QoL	Peak VO_2 LVEDD, LVEF, MR clinical composite response	CRT-P improved NYHA class, QoL and 6MWD and reduced LVEDD, MR and increased LVEF
MIRACLE-ICD[54]	369	Double-blinded, randomized CRT-D vs. ICD, 6 months	III–IV	≤35%	≥130	NYHA class, 6MWD , QoL	Peak VO_2 LVEDD, LVEF, MR clinical composite response	CRT-D improved NYHA class, QoL, peak VO_2
CONTAK-CD[53]	490	Double-blinded randomized CRT-D vs. ICD, 6 months	II–III–IV	≤35%	≥120	NYHA class, 6MWD , QoL	LV volume, LVEF composite of mortality, VT/VF, hospitalizations	CRT-D improved 6MWD, NYHA class, QoL, reduced LV volume and increased LVEF

Cazeau S. N Engl J Med 2001;344:873–80.

Auricchio A. J Am Coll Cardiol 2002;39:1895–8

Abraham W et al. N Engl J Med 2002;346:1845–53

Young J et al. JAMA 2003;289:2685–94.

Higgins et al. J Am Coll Cardiol 2003;42:1454–9

RCTs in NYHA III/IV pts (hard clinical endpoints)

Trial (ref)	No.	Design	NYHA	LVEF	QRS	Primary endpoints	Secondary endpoints	Main Findings
COMPANION[55]	1520	Double-blinded randomized OMT vs. CRT-P / or vs. CRT-D, 15 months	III–IV	≤35%	≥120	All-cause mortality or hospitalization	All-cause mortality, cardiac mortality	CRT-P and CRT-D reduced all-cause mortality or hospitalization
CARE-HF[56]	813	Double-blinded randomized OMT vs. CRT-P 29.4 months	III–IV	≤35%	≥120	All-cause mortality or hospitalization	All-cause mortality, NYHA class, QoL	CRT-P reduced all-cause mortality and hospitalization and improved NYHA class and QoL

Bristow M et al. N Engl J Med 2004;350:2140–50

Cleland J et al. N Engl J Med 2005;352:1539–49

RCTs in NYHA I/II pts

Trial (ref)	No.	Design	NYHA	LVEF	QRS	Primary endpoints	Secondary endpoints	Main Findings
REVERSE[61]	610	Double-blinded, randomized CRT-ON vs. CRT-OFF, 12 months	I–II	≤40%	≥120	% worsened by clinical composite endpoint	LVESV index, heart failure hospitalizations and all-cause mortality	CRT-P/CRT-D did not change the primary endpoint and did not reduce all-cause mortality but reduced LVESV index and heart failure hospitalizations.
MADIT-CRT[50]	1820	Single-blinded, randomized CRT-D vs. ICD, 12 months	I–II	≤30%	≥130	All-cause mortality or heart failure hospitalizations	All-cause mortality and LVESV	CRT-D reduced the endpoint heart failure hospitalizations or all-cause mortality and LVESV. CRT-D did not reduced all-cause mortality
RAFT[62]	1798	Double-blinded, randomized CRT-D vs. ICD 40 months	II–III	≤30%	≥120	All-cause mortality or heart failure hospitalizations	All-cause mortality and cardiovascular death	CRT-D reduced the endpoint all-cause mortality or heart failure hospitalizations. In NYHA III, CRT-D only reduced significantly all-cause mortality

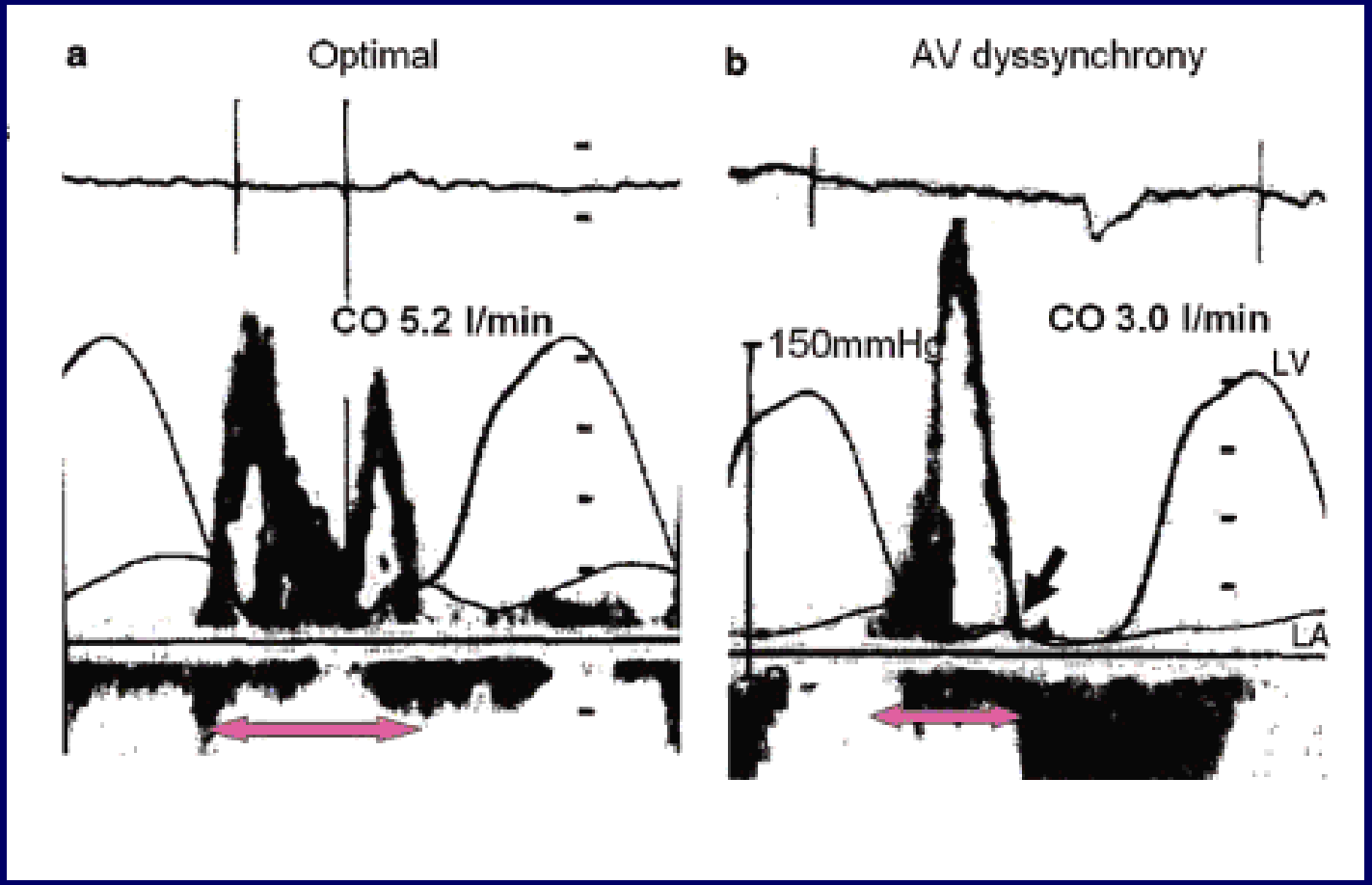
Linde C, et al. JACC 2008;52:1834-43
Daubert C, et al. JACC 2009;54(20):1837-46

Moss et al. N Engl J Med. 2009;361:1329-38.

Tang et al. NEJM 2010; 363:2385-95

Ποια η συμβολή της υπερηχοκαρδιογραφιας στην αρχική αξιολόγηση των ασθενών που εμφανίζουν δυσυγχρονισμό με σκοπό να λάβουν αμφικοιλιακή βηματοδότηση και να ωφεληθούν τα μέγιστα από αυτή;

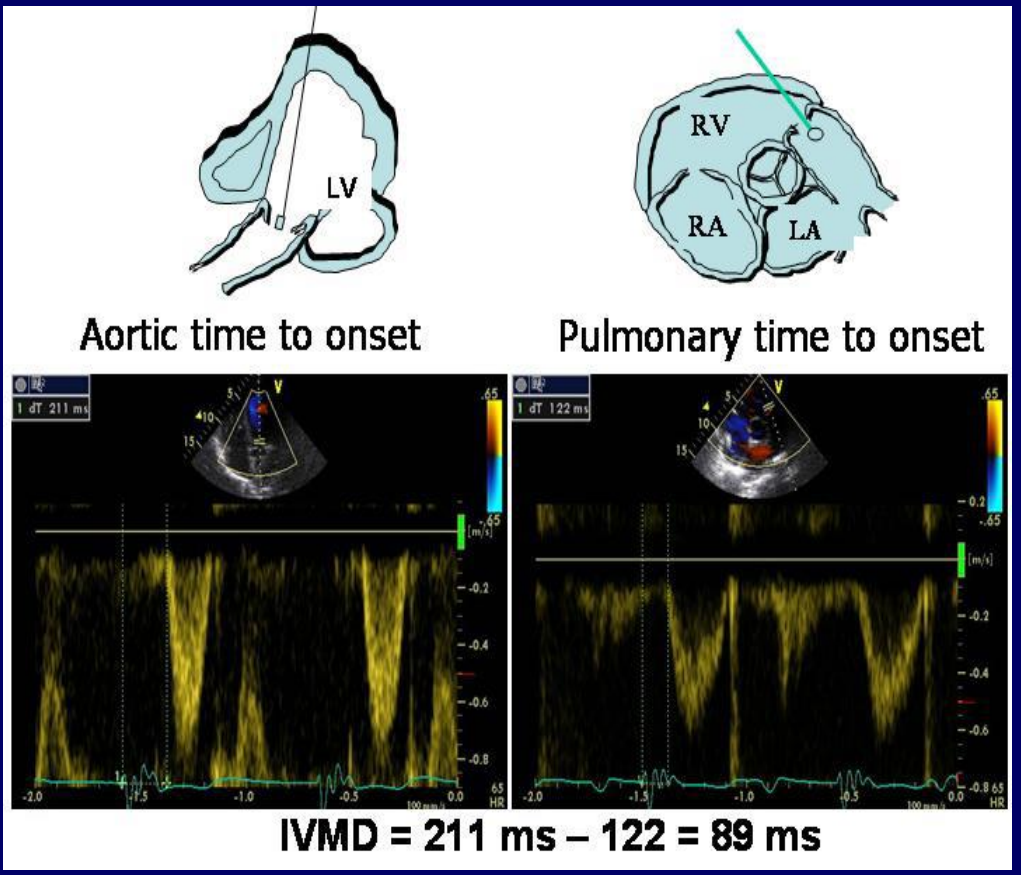
AV mechanical dyssynchrony



Demonstration of AV dyssynchrony

Intraventricular mechanical Dyssynchrony

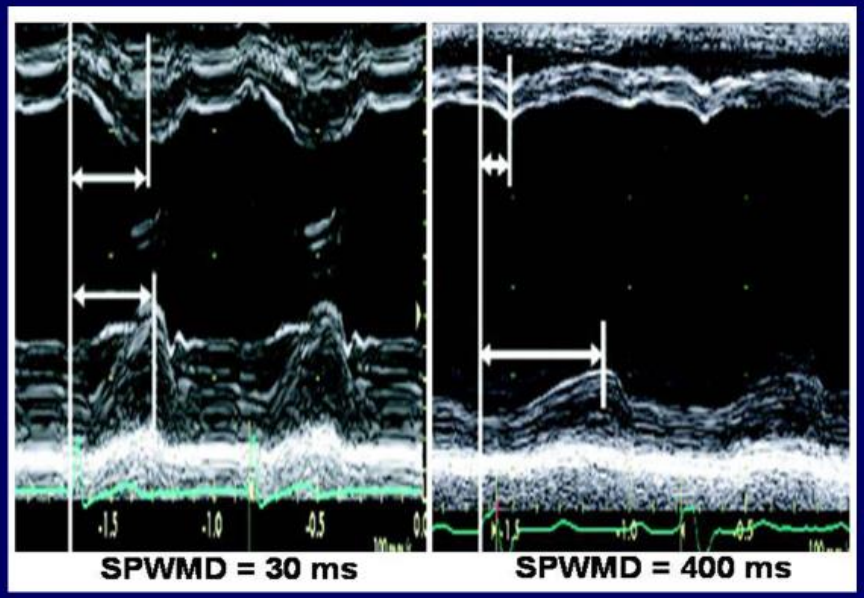
- IVMD values of > 40 ms and values of LV PEP of > 140 ms are considered pathological

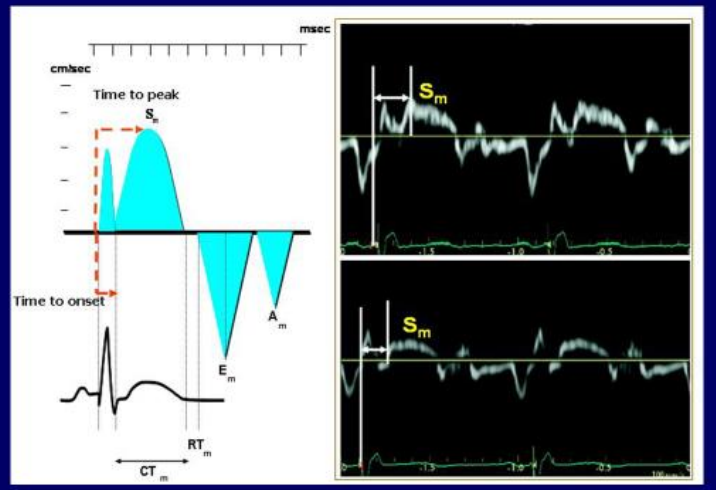


Inter-ventricular mechanical dyssynchrony

M-Mode: SPWMD> 130 ms was considered pathological

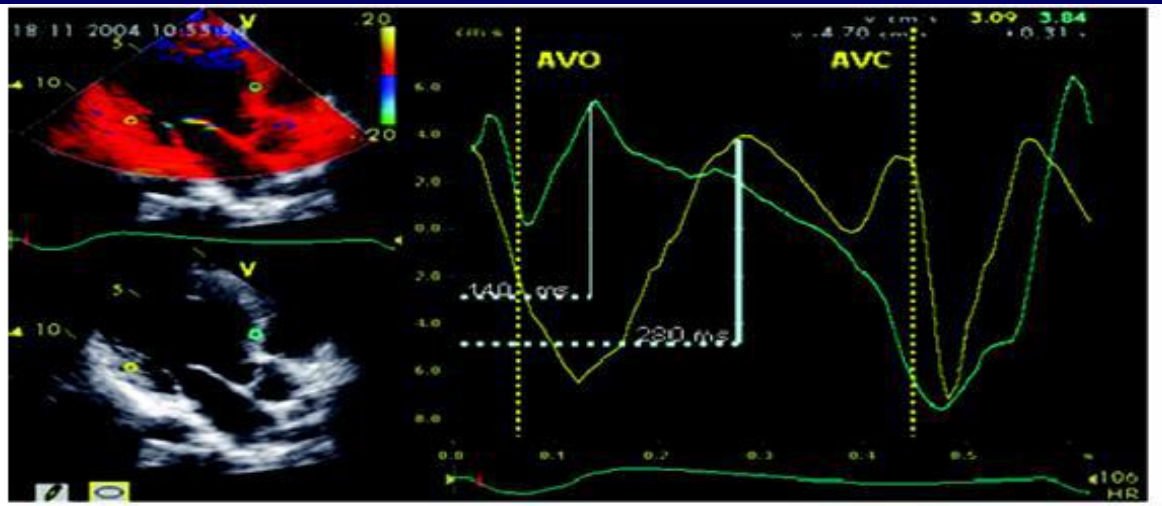
TDI> 60 ms of time to Sm Peak between LV segments



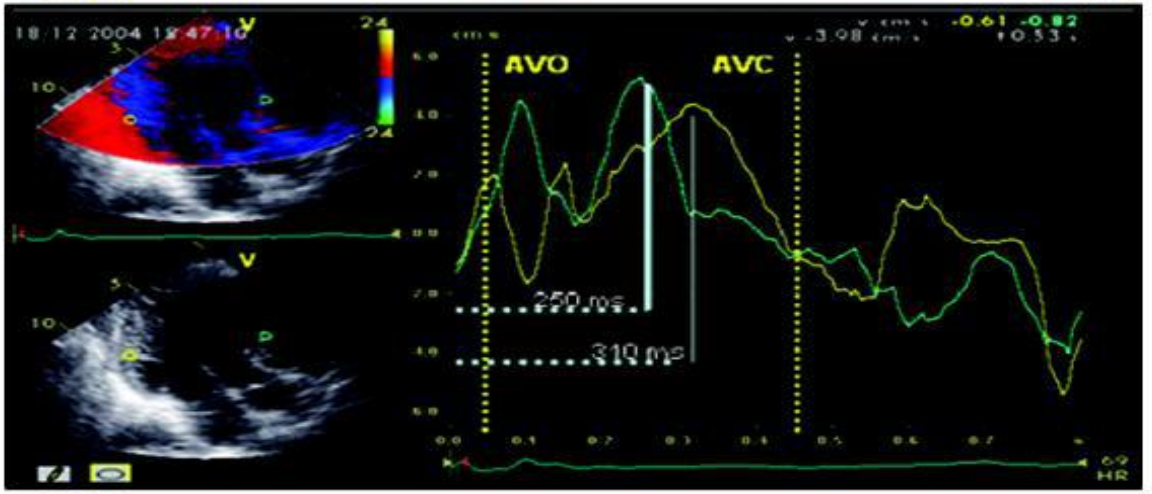


Inter-ventricular mechanical dyssynchrony

Pre CRT



Post CRT



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

Πολυκεντρική μελέτη (53): Europe, US, Hong Kong

- 467 ασθενείς , 54% ισχαιμική HF
- NYHA III ή IV
- QRS > 130ms, EF≤35%
- *Εκτίμηση δυσυγχρονισμού:*12 παράμετροι
- 5 +7 TDI
- *Response to CRT*: 0, 3, 6 months
- Κλινικά
- Επιβίωση
- NYHA CCS
- Νοσοκομειακή νοσηλεία
- Γενικότερη εκτίμηση ασθενούς
- Υπερηχογραφικά
- ↓LVESV ≥15%

SPWMD[10]	Septal-posterior wall motion delay; M mode measured by parasternal short-axis view	M mode
IVMD[14]	Interventricular mechanical delay defined as the difference between left and right ventricular preejection intervals	Pulsed Doppler
LVFT/RR[14]	Left ventricular filling time (LVFT) in relation to cardiac cycle length (RR) as measured by transmitral Doppler echo expressed as percentage	Pulsed Doppler
LPEI[14]	Left ventricular preejection interval defined as the time interval between the beginning of QRS and beginning of left ventricular ejection by Doppler	Pulsed Doppler
LLWC[14]	Intraventricular dyssynchrony left lateral wall contraction defined as the presence of overlap between the end of lateral wall contraction (via M mode) and onset of LV filling (by Doppler echocardiography)	M mode and pulsed Doppler
Ts-(lateral-septal)[15]	Delay between time to peak systolic velocity in ejection phase at basal septal and basal lateral segments	TDI
Ts-SD[11,12]	SD of time from QRS to peak systolic velocity in ejection phase for 12 left ventricular segments (6 basal and 6 middle)	TDI
PVD[16]	Peak velocity difference derived from subtracting the maximal from the minimal difference of time to peak velocity (excluding velocities occurring during isovolumic contraction time) for 6 segments at basal level	TDI
DLC[17,18]	Delayed longitudinal contraction measured in the 6 basal left ventricular segments with a systolic contraction component in early diastole by TDI and confirmed with strain rate imaging	TDI+SRI
Ts-peak displacement	Maximum difference of time to peak systolic displacement for 4 segments	TDI
Ts-peak (basal)	Maximum difference of time to peak systolic velocity for 6 segments at basal level	TDI
Ts-onset (basal)	Maximum difference of time to onset of systolic velocity for 6 segments at basal level	TDI

Chung et al Circulation 2008;117: 2608-2616

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

Results

CCS end point

5 non-TDI parameters , 1 TDI έδειξαν *μέτρια* στατιστική συσχέτιση με το κλινικό αποτέλεσμα που θεωρείται επιτυχής ανταπόκριση στη CRT.

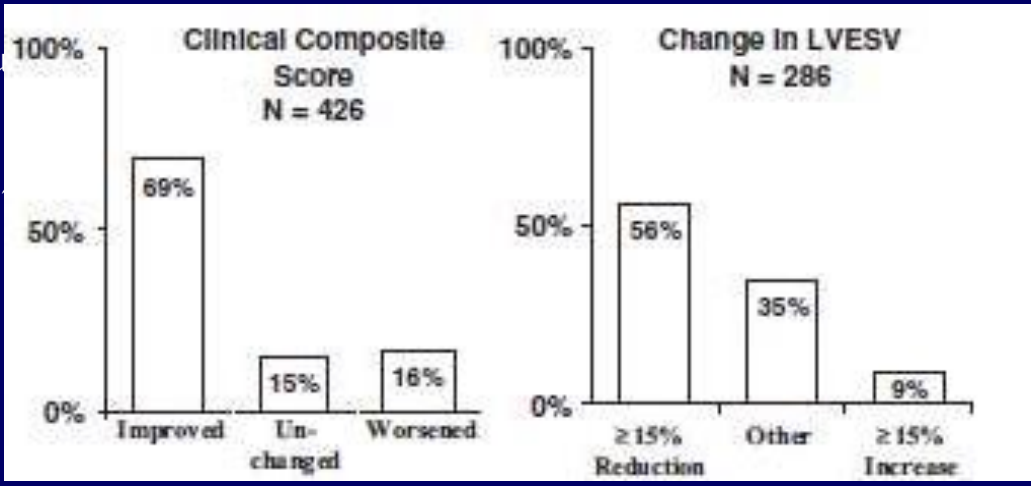
LVESV end point

4 non-TDI parameters, 1 TDI έδειξαν στατιστική συσχέτιση μ
υπερηχογραφικό αποτέλεσμα που θεωρείται επιτυχής CRT.

*Η ευαισθησία και ειδικότητα των μελετηθέντων παραμέτρων ή
χαμηλή.*

Η μελέτη δεν καταδεικνύει κάποιο από τους πολλούς υπερηχογραφικούς παράγοντες ως αξιόπιστο ώστε να χρησιμοποιηθεί στην κλινική πράξη για εκτίμηση του δυσυγχρονισμού.

Πιθανόν η κλινική βελτίωση να έρχεται γρηγορότερα από την ηχοκαρδιογραφική σε κάποιους ασθενείς.



Chung et al Circulation 2008;117: 2608-2616

Indications for cardiac resynchronization therapy in patients in sinus rhythm

Recommendations	Class [a]	Level [b]	Ref. [c]
1) LBBB with QRS duration >150 ms. CRT is recommended in chronic HF patients and LVEF ≤35% who remain in NYHA functional class II, III and ambulatory IV despite adequate medical treatment. [d]	I	A	48–64
2) LBBB with QRS duration 120–150 ms. CRT is recommended in chronic HF patients and LVEF ≤35% who remain in NYHA functional class II, III and ambulatory IV despite adequate medical treatment. [d]	I	B	48–64
3) Non-LBBB with QRS duration >150 ms. CRT should be considered in chronic HF patients and LVEF ≤35% who remain in NYHA functional class II, III and ambulatory IV despite adequate medical treatment. [d]	IIa	B	48–64
4) Non-LBBB with QRS duration 120–150 ms. CRT may be considered in chronic HF patients and LVEF ≤35% who remain in NYHA functional class II, III and ambulatory IV despite adequate medical treatment. [d]	IIb	B	48–64
5) CRT in patients with chronic HF with QRS duration <120 ms is not recommended.	III	B	65, 66

2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy
Brignole et al Europace 2013;15:1070-118 / Eur Heart J 2013;34:2281-329

Cardiac-Resynchronization Therapy in Heart Failure with a Narrow QRS Complex

Frank Ruschitzka, M.D., William T. Abraham, M.D., Jagmeet P. Singh, M.D., Ph.D., Jeroen J. Bax, M.D., Ph.D., Jeffrey S. Borer, M.D., Josep Brugada, M.D., Ph.D., Kenneth Dickstein, M.D., Ph.D., Ian Ford, M.D., Ph.D., John Gorcsan III, M.D., Daniel Gras, M.D., Henry Krum, M.B., B.S., Ph.D., Peter Sogaard, M.D., D.M.Sc., and Johannes Holzmeister, M.D., for the EchoCRT Study Group*

BACKGROUND

Cardiac-resynchronization therapy (CRT) reduces morbidity and mortality in chronic systolic heart failure with a wide QRS complex. Mechanical dyssynchrony also occurs in patients with a narrow QRS complex, which suggests the potential usefulness of CRT in such patients.

METHODS

We conducted a randomized trial involving 115 centers to evaluate the effect of CRT in patients with New York Heart Association class III or IV heart failure, a left ventricular ejection fraction of 35% or less, a QRS duration of less than 130 msec, and echocardiographic evidence of left ventricular dyssynchrony. All patients underwent device implantation and were randomly assigned to have CRT capability turned on or off. The primary efficacy outcome was the composite of death from any cause or first hospitalization for worsening heart failure.

RESULTS

On March 13, 2013, the study was stopped for futility on the recommendation of the data and safety monitoring board. At study closure, the 809 patients who had undergone randomization had been followed for a mean of 19.4 months. The primary outcome occurred in 116 of 404 patients in the CRT group, as compared with 102 of 405 in the control group (28.7% vs. 25.2%; hazard ratio, 1.20; 95% confidence interval [CI], 0.92 to 1.57; P=0.15). There were 45 deaths in the CRT group and 26 in the control group (11.1% vs. 6.4%; hazard ratio, 1.81; 95% CI, 1.11 to 2.93; P=0.02).

CONCLUSIONS

In patients with systolic heart failure and a QRS duration of less than 130 msec, CRT does not reduce the rate of death or hospitalization for heart failure and may increase mortality. (Funded by Biotronik and GE Healthcare; EchoCRT ClinicalTrials.gov number, NCT00683696.)

Ruschitzka et al. N Engl J Med 2013;369:1395-405

Cardiac-Resynchronization Therapy in Heart Failure with a Narrow QRS Complex

Frank Ruschitzka, M.D., William T. Abraham, M.D., Jagm

Table 2. Protocol-Specified Cardiovascular Outcomes.*

Outcome	Control Group (N=405)	CRT Group (N=404)	Adjusted Hazard Ratio (95% CI)	P Value
	no. of patients with event (%)			
Primary composite outcome				
Death from any cause or hospitalization for heart failure	102 (25.2)	116 (28.7)	1.20 (0.92–1.57)	0.15
Components of primary outcome				
Hospitalization for heart failure	90 (22.2)	99 (24.5)	1.16 (0.87–1.55)	0.25
Death from any cause	26 (6.4)	45 (11.1)	1.81 (1.11–2.93)	0.02
Other cardiovascular outcomes				
Hospitalization for cardiovascular event	137 (33.8)	147 (36.4)	1.11 (0.88–1.40)	0.36
Death				
Cardiovascular event	17 (4.2)	37 (9.2)	2.26 (1.27–4.01)	0.004
Heart failure	10 (2.5)	17 (4.2)	1.74 (0.80–3.81)	0.15
Follow-up data censored				
Owing to LVAD implantation	10 (2.5)	7 (1.7)	—	—
Owing to heart transplantation	5 (1.2)	3 (0.7)	—	—
Death after data were censored owing to LVAD implantation or heart transplantation†	4 (1.0)	1 (0.2)	—	—

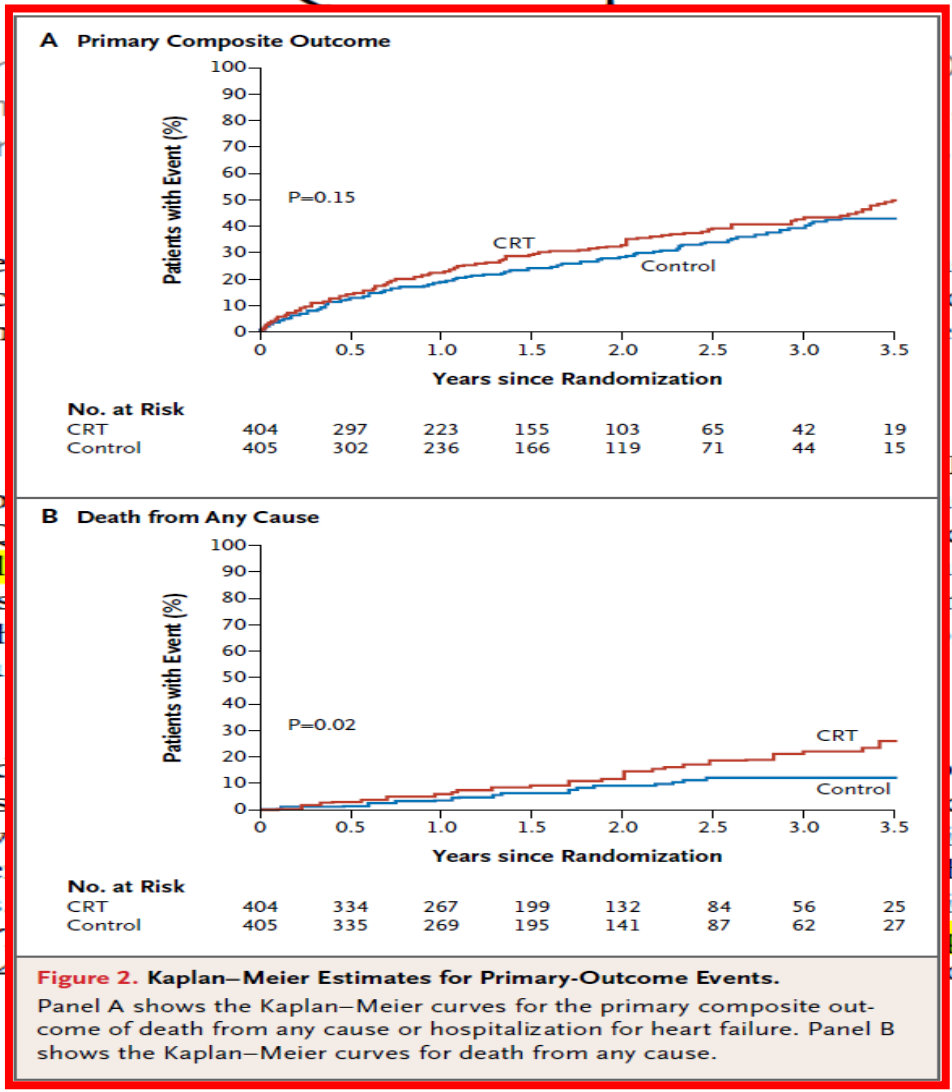


Figure 2. Kaplan–Meier Estimates for Primary-Outcome Events.
Panel A shows the Kaplan–Meier curves for the primary composite outcome of death from any cause or hospitalization for heart failure. Panel B shows the Kaplan–Meier curves for death from any cause.

CONCLUSIONS

In patients with systolic heart failure and a QRS duration of less than 130 msec, CRT does not reduce the rate of death or hospitalization for heart failure and may increase mortality. (Funded by Biotronik and GE Healthcare; EchoCRT ClinicalTrials.gov number, NCT00683696.)

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Death after data were censored owing to LVAD implantation or heart transplantation†	4 (1.0)	1 (0.2)	—	—

Reason of Death	Control Group, number (%) with event N=405	CRT Group, number (%) with event N=404
Any reason	26 (6.4%)	45 (11.1%)*
Cardiovascular	17 (4.2%)	37 (9.2%)**
Death due to heart failure	10 (2.5%)	17 (4.2%)
Death due to arrhythmic events	4 (1.0%)	14 (3.5%)*
Death due to non-ischemic dysrhythmia	0	2 (0.5%)
Death due to symptomatic heart block/bradycardia/ PEA	0	4 (1.0%)
Sudden cardiac death	4 (1.0%)	8 (2.0%)
Presumed cardiovascular death	1 (0.3%)	5 (1.2%)
Fatal stroke	1 (0.3%)	1 (0.3%)
Other vascular death	1 (0.3%)	0
Non-Cardiovascular	9 (2.2%)	8 (2.0%)
Cancer	4 (1.0%)	1 (0.3%)
Infection-pneumonia	0	2 (0.5%)
Infection-sepsis	1 (0.3%)	3 (0.7%)
Other non-cardiovascular	1 (0.3%)	0
Respiratory-exacerbation of COPD	2 (0.5%)	0
Traumatic injury	1 (0.3%)	2 (0.5%)
Death after crossover	7 (1.7%)	1 (0.3%)

Statistically significant difference of *p<0.05, **p<0.01

CONCLUSIONS

In patients with systolic heart failure and a QRS duration of less than 130 msec, CRT does not reduce the rate of death or hospitalization for heart failure and may increase mortality. (Funded by Biotronik and GE Healthcare; EchoCRT ClinicalTrials.gov number, NCT00683696.)

Ruschitzka et al. N Engl J Med 2013;369:1395-405

Recommendations for cardiac resynchronization therapy implantation in patients with heart failure

Recommendations	Class[a]	Level[b]	Ref[c]
CRT is recommended for symptomatic patients with HF in sinus rhythm with a QRS duration ≥150 msec and LBBB QRS morphology and with LVEF ≤35% despite OMT in order to improve symptoms and reduce morbidity and mortality.	I	A	261–272
CRT should be considered for symptomatic patients with HF in sinus rhythm with a QRS duration ≥150 msec and non-LBBB QRS morphology and with LVEF ≤35% despite OMT in order to improve symptoms and reduce morbidity and mortality.	IIa	B	261–272
CRT is recommended for symptomatic patients with HF in sinus rhythm with a QRS duration of 130–149 msec and LBBB QRS morphology and with LVEF ≤35% despite OMT in order to improve symptoms and reduce morbidity and mortality.	I	B	266, 273
CRT may be considered for symptomatic patients with HF in sinus rhythm with a QRS duration of 130–149 msec and non-LBBB QRS morphology and with LVEF ≤35% despite OMT in order to improve symptoms and reduce morbidity and mortality.	IIb	B	266, 273
CRT rather than RV pacing is recommended for patients with HFrEF regardless of NYHA class who have an indication for ventricular pacing and high degree AV block in order to reduce morbidity. This includes patients with AF (see Section 10.1).	I	A	274–277
CRT should be considered for patients with LVEF ≤35% in NYHA Class III–IV[d] despite OMT in order to improve symptoms and reduce morbidity and mortality, if they are in AF and have a QRS duration ≥130 msec provided a strategy to ensure bi-ventricular capture is in place or the patient is expected to return to sinus rhythm.	IIa	B	275, 278–281
Patients with HFrEF who have received a conventional pacemaker or an ICD and subsequently develop worsening HF despite OMT and who have a high proportion of RV pacing may be considered for upgrade to CRT. This does not apply to patients with stable HF.	IIb	B	282
CRT is contra-indicated in patients with a QRS duration < 130 msec.	III	A	266, 283–285

AF = atrial fibrillation; AV = atrio-ventricular; CRT = cardiac resynchronization therapy; HF = heart failure; HFrEF = heart failure with reduced ejection fraction; ICD = implantable cardioverter-defibrillator; LBBB = left bundle branch block; LVEF = left ventricular ejection fraction; NYHA = New York Heart Association; OMT = optimal medical therapy; QRS = Q, R and S waves (combination of three of the graphical deflections); RV = right ventricular.

[a]Class of recommendation.

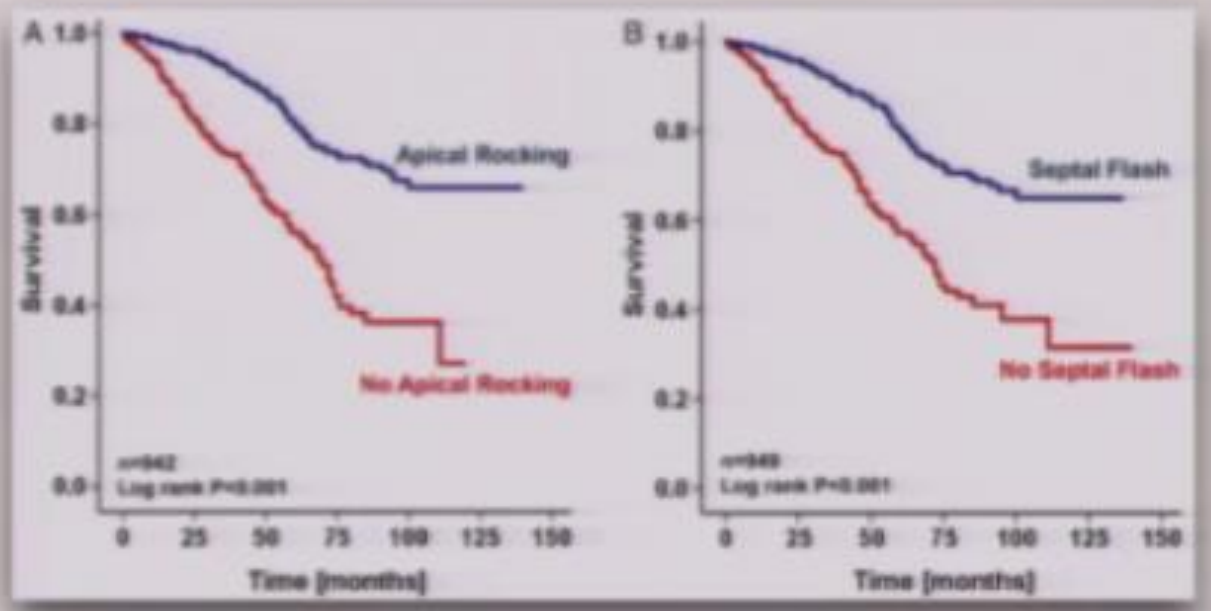
[b]Level of evidence.

[c]Reference(s) supporting recommendations.

[d]Use judgement for patients with end-stage HF who might be managed conservatively rather than with treatments to improve symptoms or prognosis.

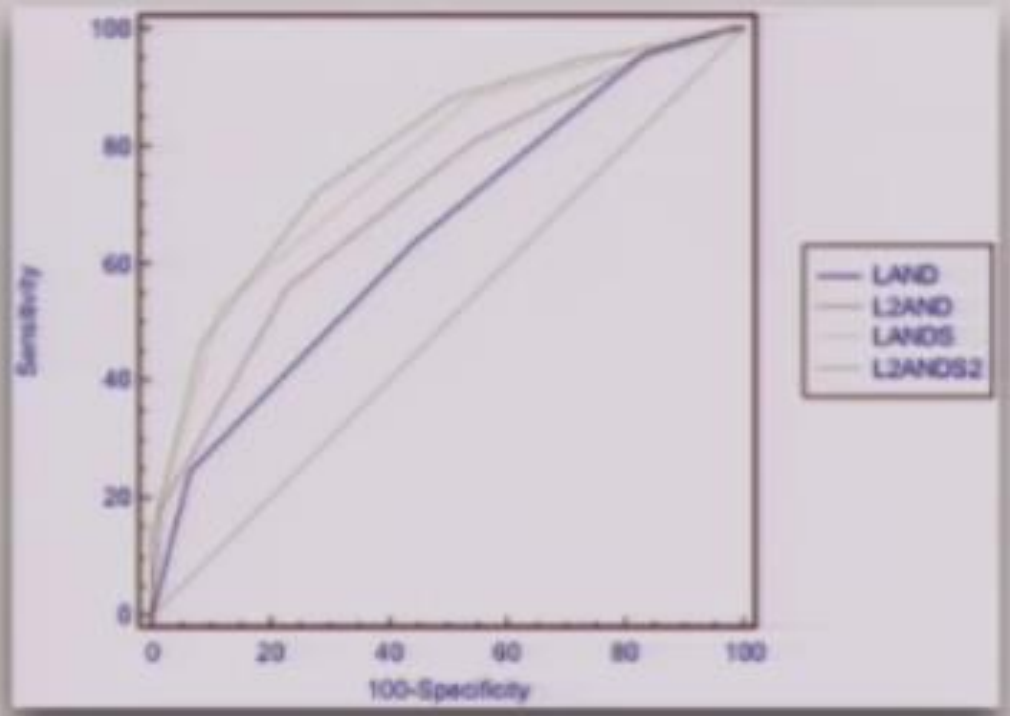
Septal Flash-Apical Rocking

- QRS > 120ms
- LVEF < 35%
- NYHA III-IV



Stankovic I et al. Eur Heart J Cardiovasc Imaging. 2016;17:262–69

Scores

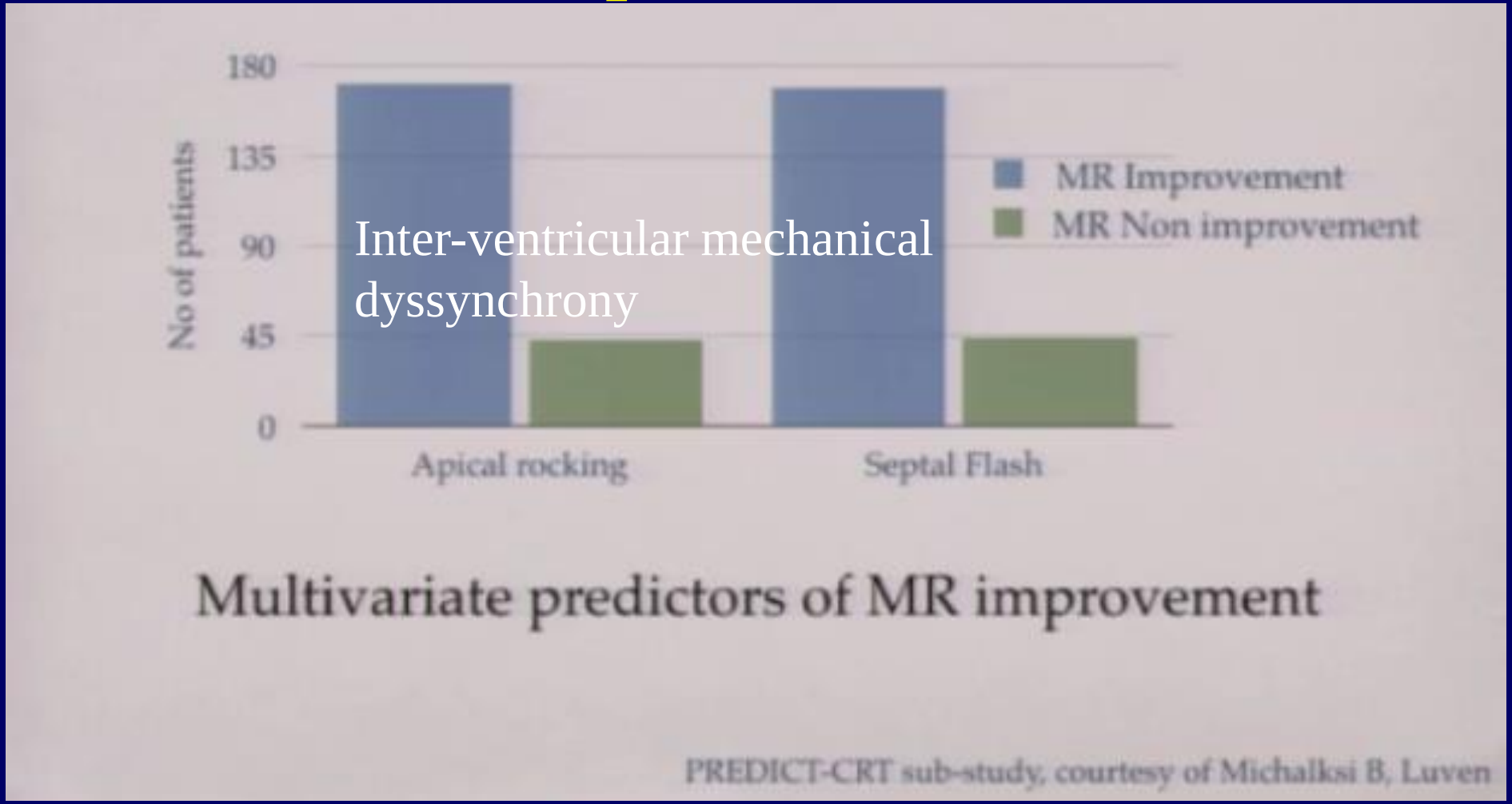


LBBB
AGE
NON ISCHAEMIC
DIAMETER LV
SEPTAL FLASH

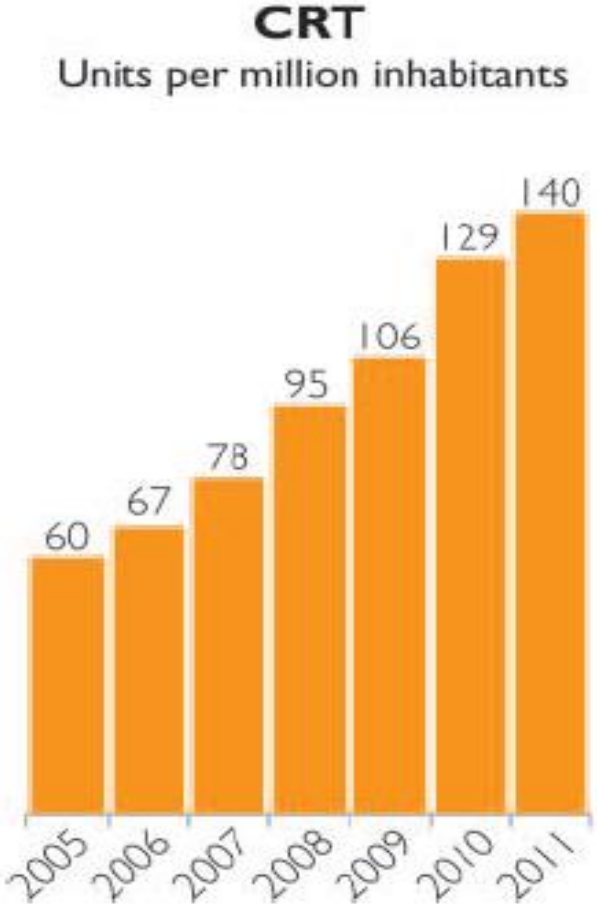
- Septal flash improved predictive value of clinical and echocardiographic scores

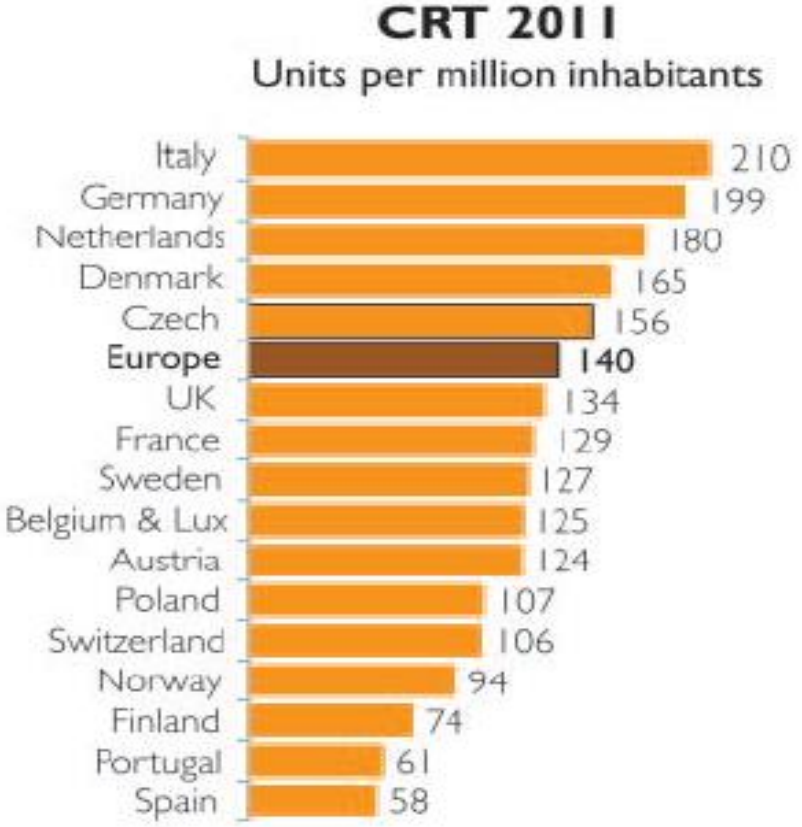
Brunet-Bernard A et al. Am J Cardiol. 2014;113:2045–51

Prediction of secondary MR improvement



CRT implantation rate in Europe

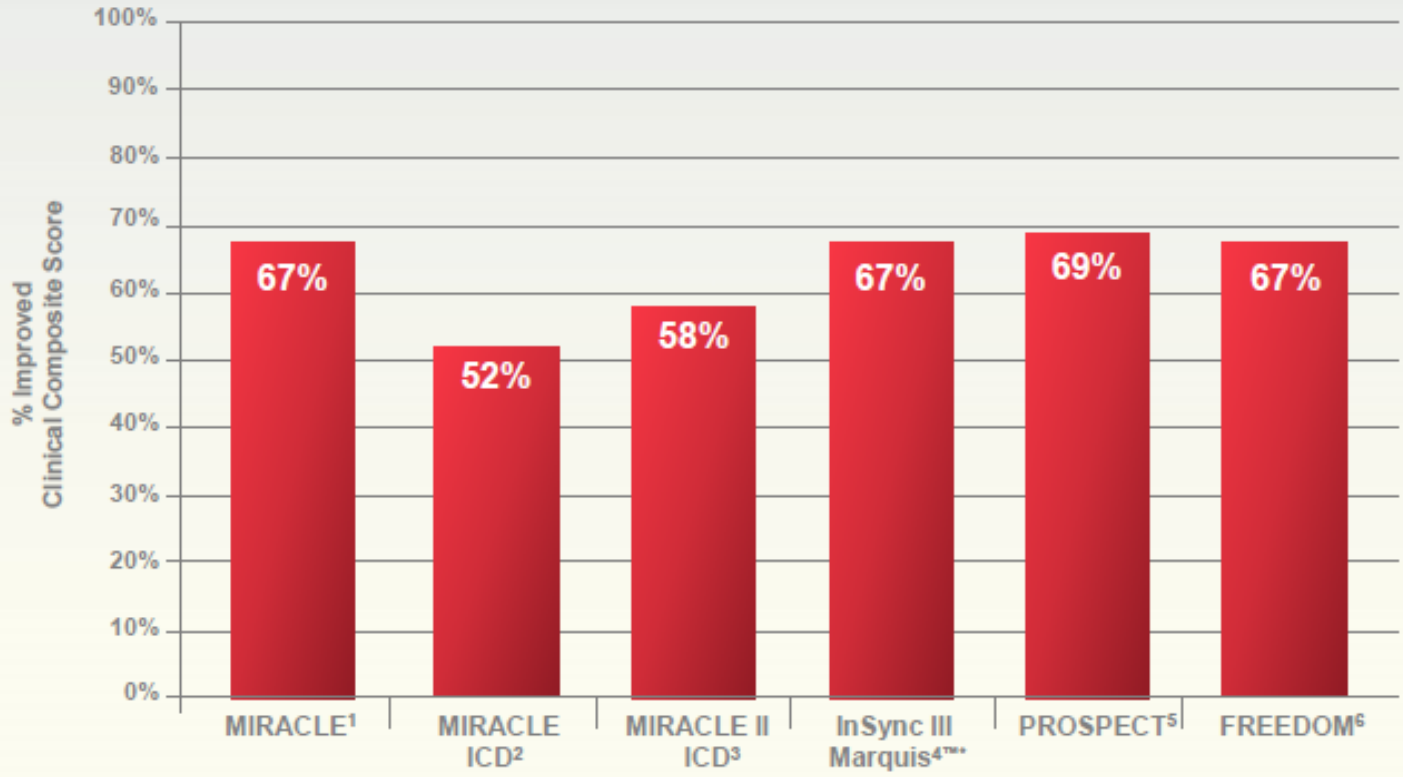




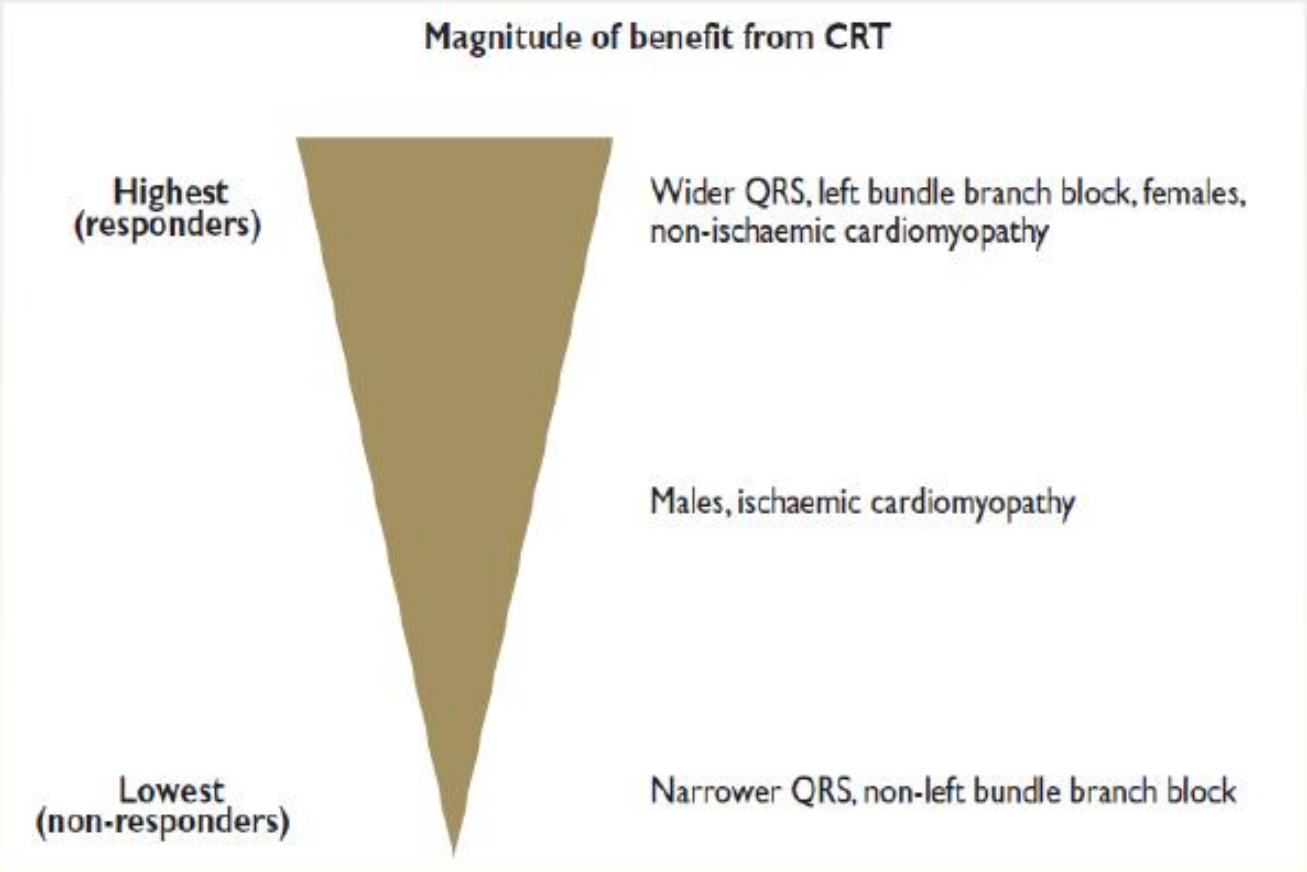
Greece 2013: ~30 new CRT impl/10^6inhabitants

2013 ESCGuidelines on cardiac pacing and cardiac resynchronization therapy: Addenda Brignole et al www.escardio.org/guidelines

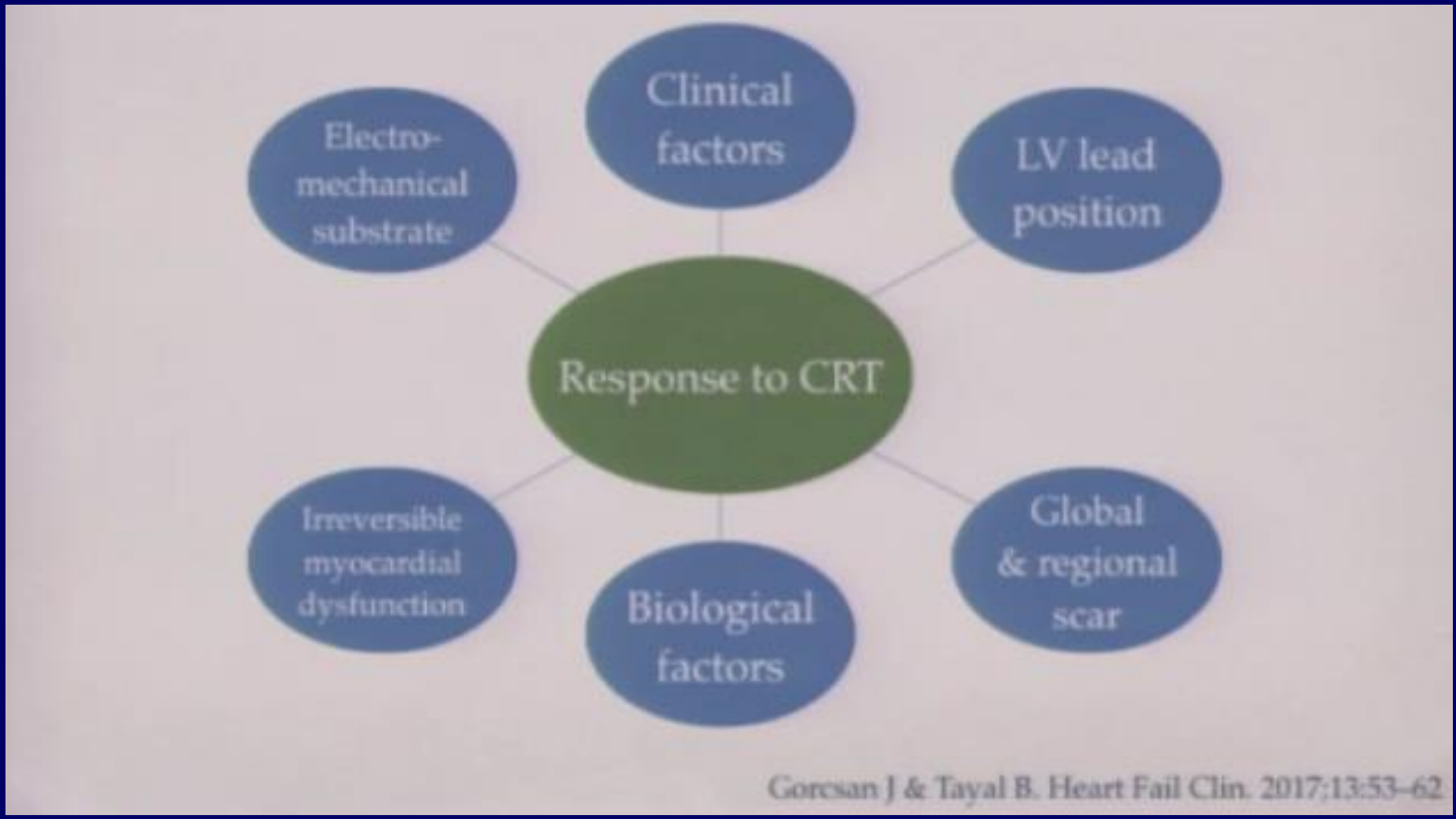
Up to 1/3 of pts do not experience the full benefits of CRT



Clinical factors influencing the likelihood to respond to CRT

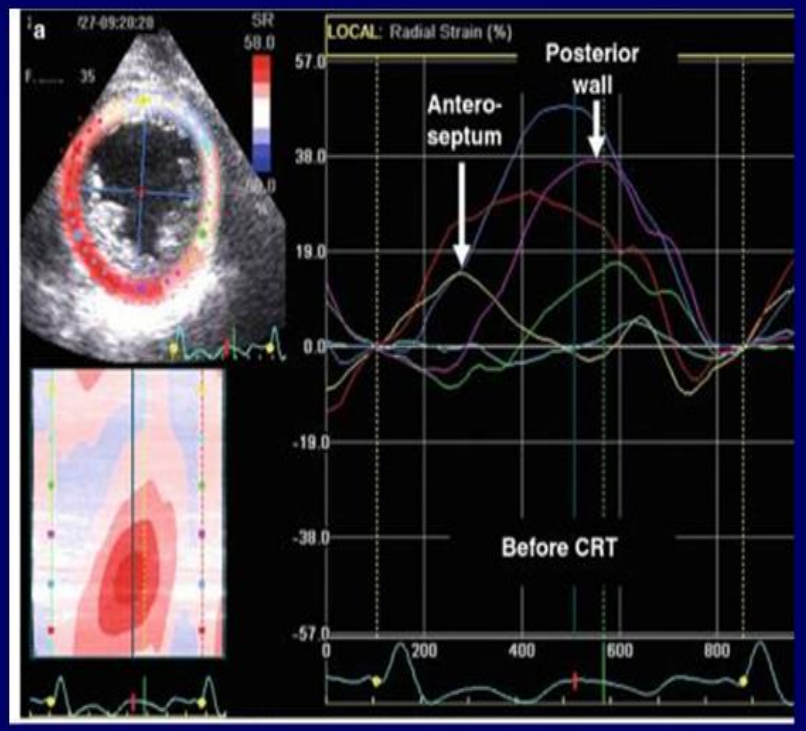


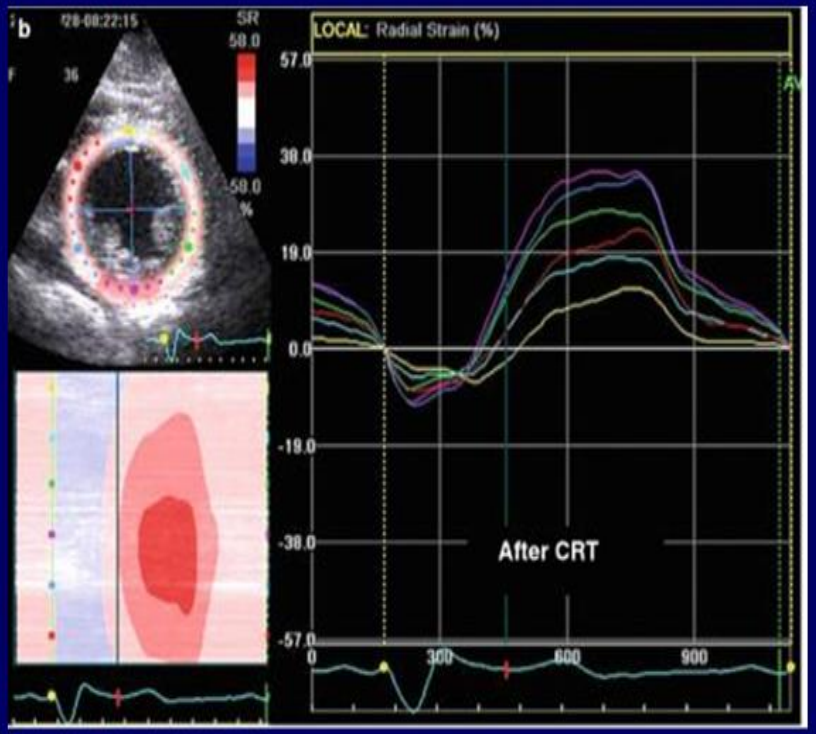
Response to CRT



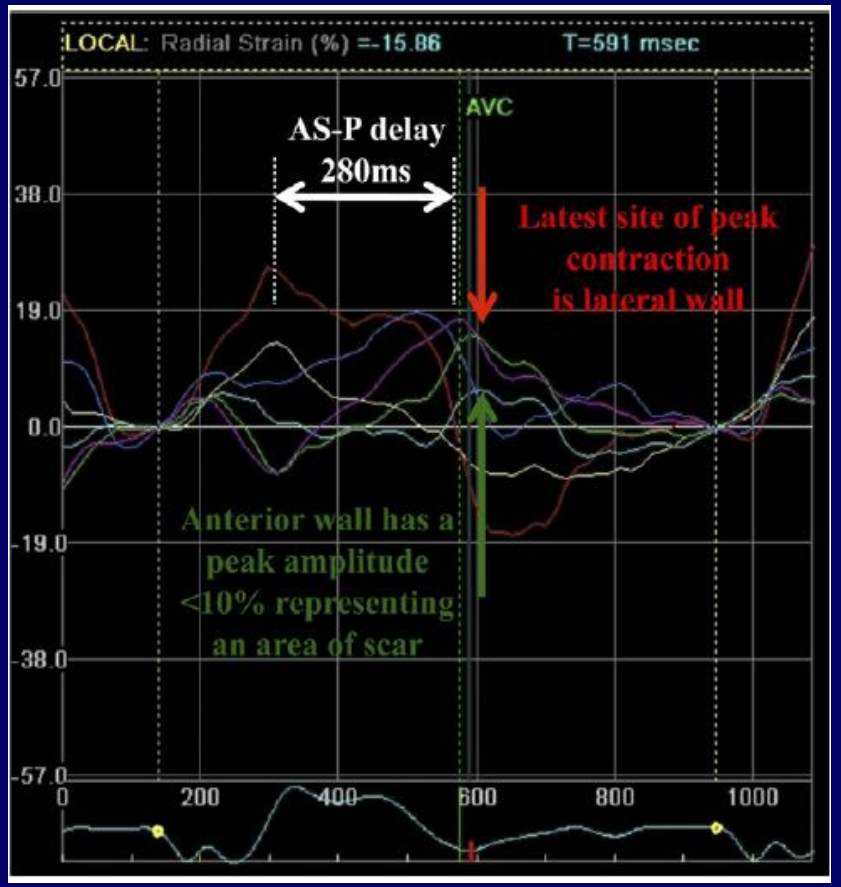
Speckle tracking

***A time difference ≥ 130 ms between the radial strain peak of LV posterior wall and anterior septum has shown to be highly predictive* of an improved EF**





The TARGET Study: A Randomized, Controlled Trial. Echo guided LV lead placement offers additional benefits



Echocardiographic speckle-tracking 2-D radial strain imaging

220 pts randomized 1:1 to Echo guided vs standard LV lead CRT implantation

Segments with radial strain amplitude 10% were regarded as nonviable (scar)

The LV pacing lead was placed in the most delayed segment in 63% of pts in TARGET Group vs 47% in control group.

Compared with standard CRT treatment, the use of speckle-tracking echocardiography to the target LV lead placement yields significantly improved response and clinical status and lower rates of combined death and heart failure–related hospitalization

Khan F et al. J Am Coll Cardiol 2012;59:1509–1518

The TARGET Study: A Randomized, Controlled Trial. Echo guided LV lead placement offers additional benefits

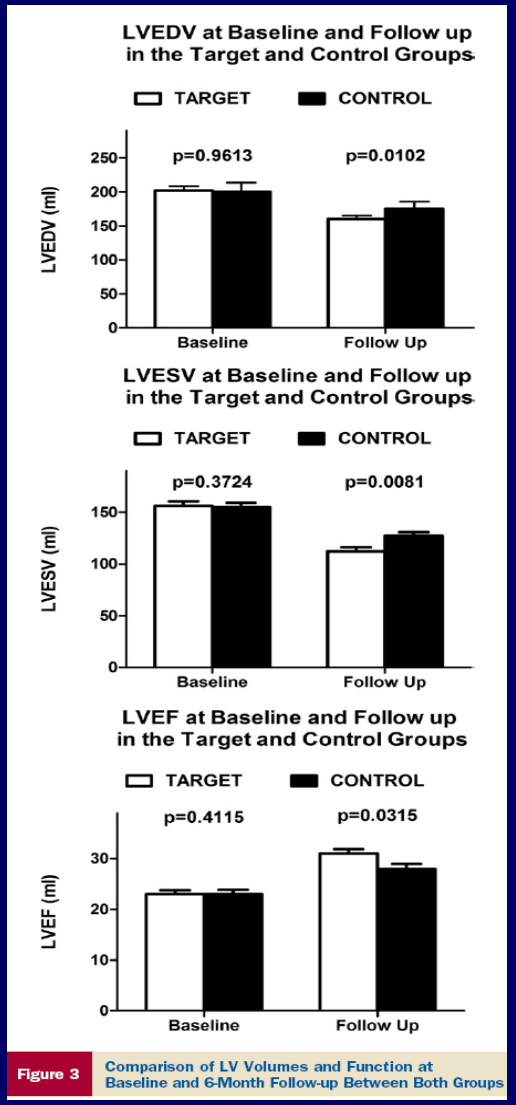


Figure 3 Comparison of LV Volumes and Function at Baseline and 6-Month Follow-up Between Both Groups

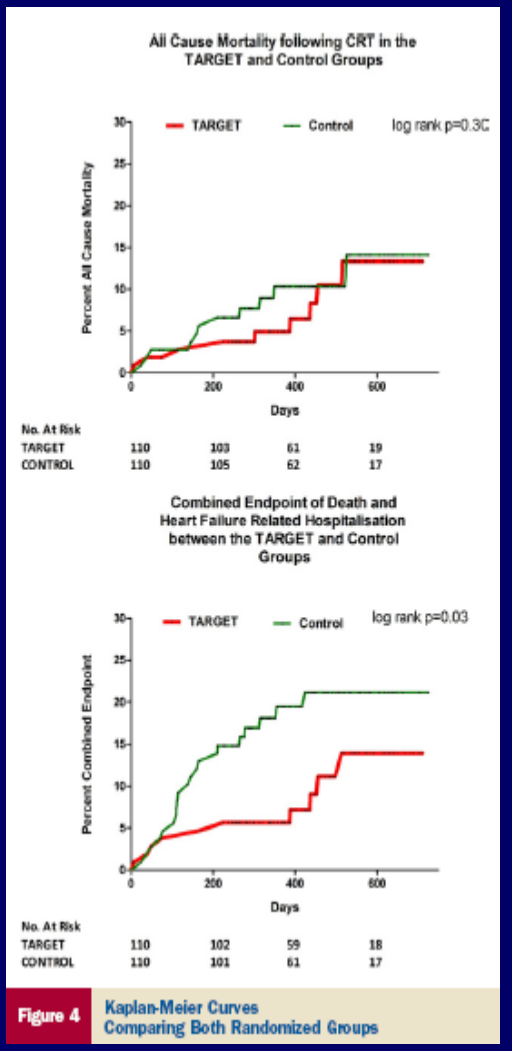


Figure 4 Kaplan-Meier Curves Comparing Both Randomized Groups

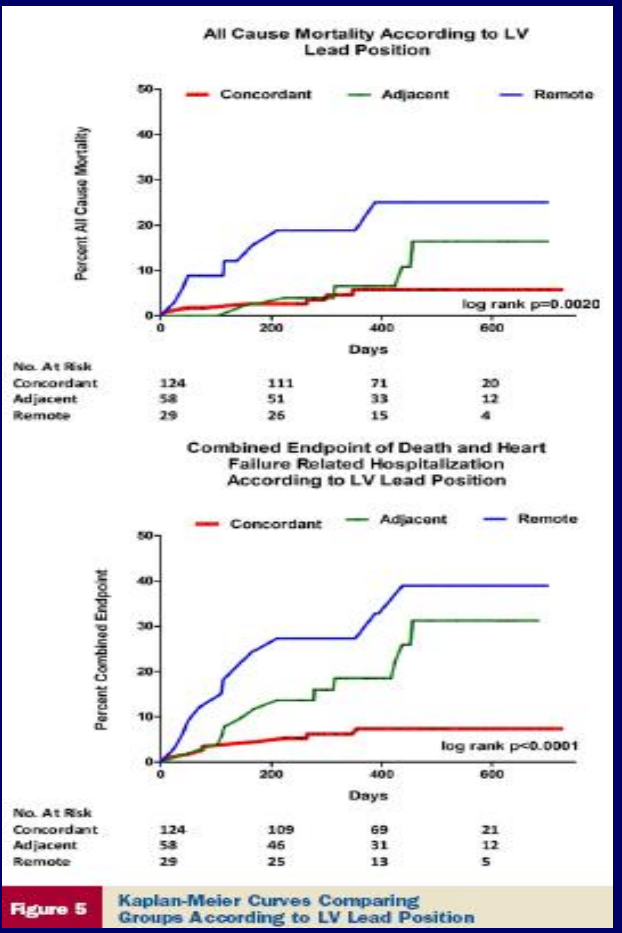


Figure 5 Kaplan-Meier Curves Comparing Groups According to LV Lead Position

The greatest benefit is demonstrated in pts with a concordant LV lead at sites free of scar

Khan F et al. J Am Coll Cardiol 2012;59:1509–1518

Original Article

Echocardiography-Guided Left Ventricular Lead Placement for Cardiac Resynchronization Therapy

STARTER STUDY

Results of the Speckle Tracking Assisted Resynchronization Therapy for Electrode Region Trial

110 were randomized to EG and 77 to routine strategies.

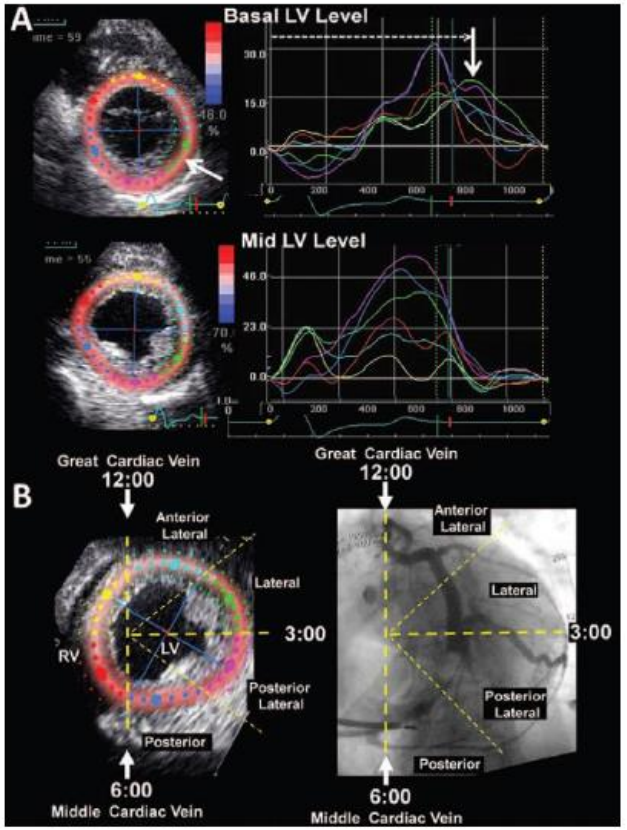
Evan Adelstein, MD; Pamela White, RN; Olusegun A. Oyenuga, MD; Tetsuari Onishi, MD; Prem Soman, MD; John Gorcsan III, MD

LV lead placement was attempted at the site of latest time to peak radial strain by speckle tracking echocardiography.

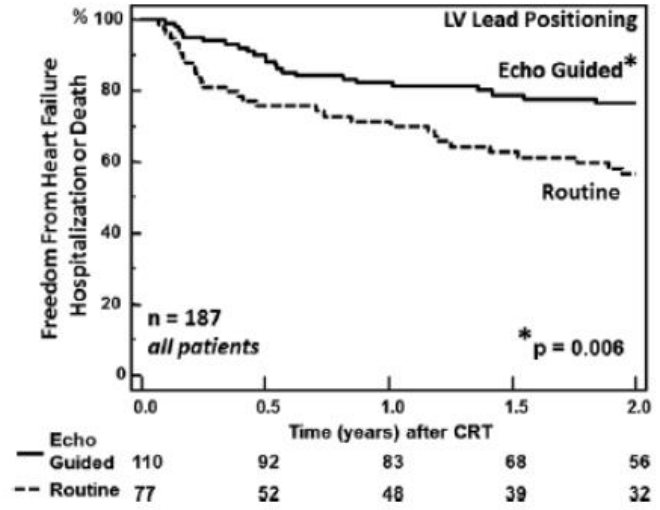
a prospective, double-blind, randomized controlled trial testing the hypothesis that an incremental benefit to cardiac resynchronization therapy would be gained by echo-guided (EG) transvenous LV lead placement versus a routine fluoroscopic approach. EG LV lead placement was attempted at the site of latest time to peak radial strain by speckle tracking echocardiography. The prespecified primary end point was first HF hospitalization or death. Of 187 New York Heart Association class II to IV patients with HF (62% ischemic; ejection fraction 26±6%; QRS 159±27 ms), 110 were randomized to EG and 77 to routine strategies. Primary events included 30 deaths and 37 HF hospitalizations over 1.8 years. Using intention-to-treat, patients randomized to an EG strategy had a significantly more favorable event-free survival (hazard ratio, 0.48; 95% confidence interval, 0.28–0.82; P=0.006). Exact or adjacent concordance of LV lead with latest site could be achieved in 85% of the EG group and occurred fortuitously in 66% of controls (P=0.010) and was associated with an improvement in event-free survival (hazard ratio, 0.40; 95% confidence interval, 0.22–0.71; P=0.002).

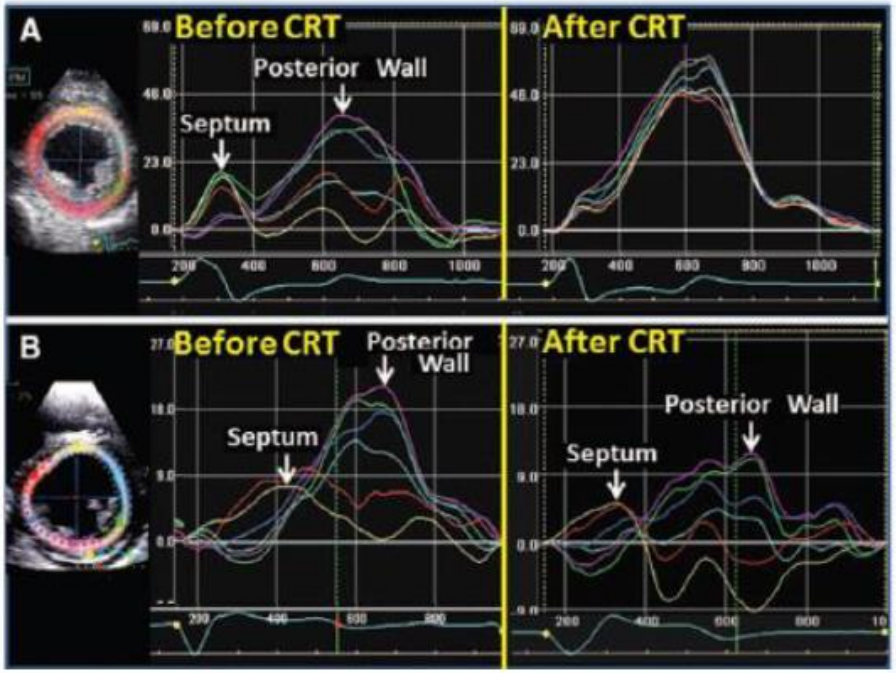
Conclusions—A strategy of EG LV lead placement for cardiac resynchronization therapy improved patient outcomes by reducing the combined risk of death or HF hospitalizations and has implications for delivery of cardiac resynchronization therapy.

Clinical Trial Registration—URL: http://www.clinicaltrials.gov. Unique identifier: NCT00156390. (***Circ Heart Fail.*** **2013;6:427-434.**)



Primary end point of freedom from heart failure hospitalization or death after CRT





Left Ventricular Lead Location by Fluoroscopy and Relationship to Site of Latest Mechanical Activation

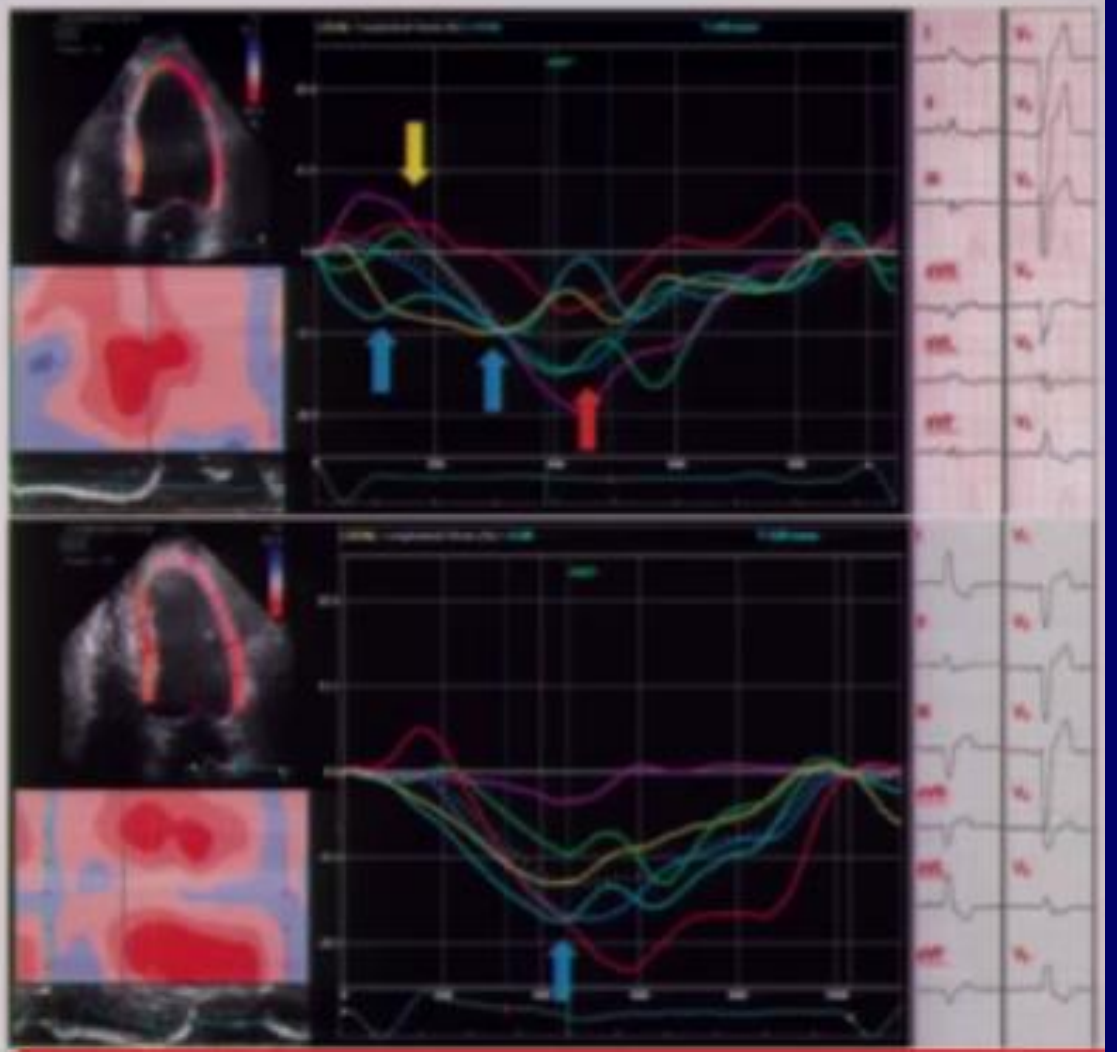
	Echocardiographic-Guided CRT (n=96)	Routine Control CRT (n=69)	*P* Value
Distribution of LV lead location			
LAO projection			0.867
Anterolateral	17%	15%	
Lateral	40%	46%	
Posterolateral	36%	30%	
Posterior	7%	9%	
RAO projection			0.114
Basal	39%	17%	
Mid-ventricular	39%	43%	
Apical	23%	33%	
Relationship of LV lead location to site of latest mechanical activation			
Exact concordance	30%	12%	0.011
Concordant or adjacent	85%	66%	0.010
Remote	15%	33%	0.010

Speckle tracking:
Classical LBBB longitudinal strain

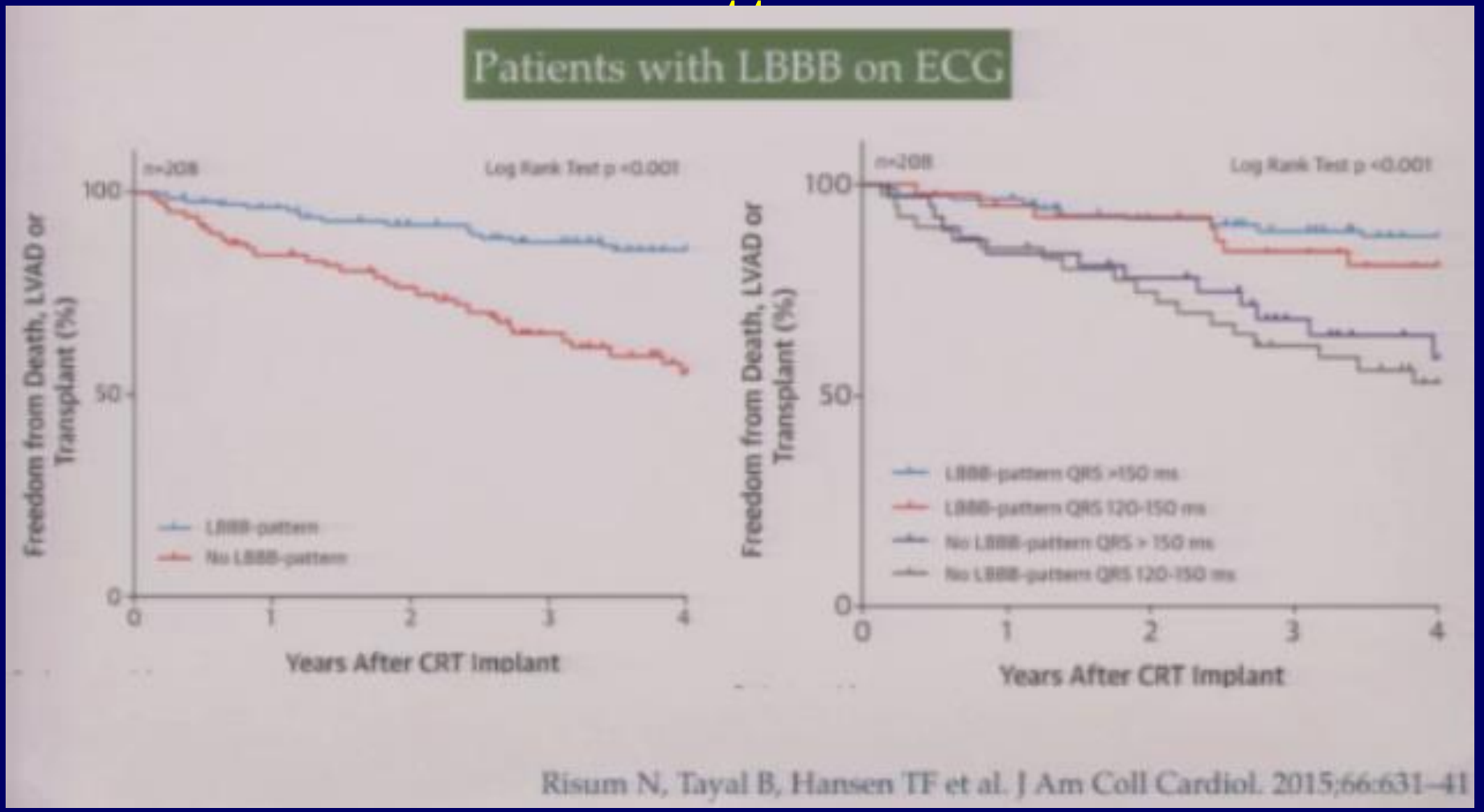
1. Early septal contraction with free wall stretch followed by delayed free wall contraction

2. Early septal peak shortening (within the first 70% of the ejection phase)

3. Lateral wall peak shortening after aortic valve closure



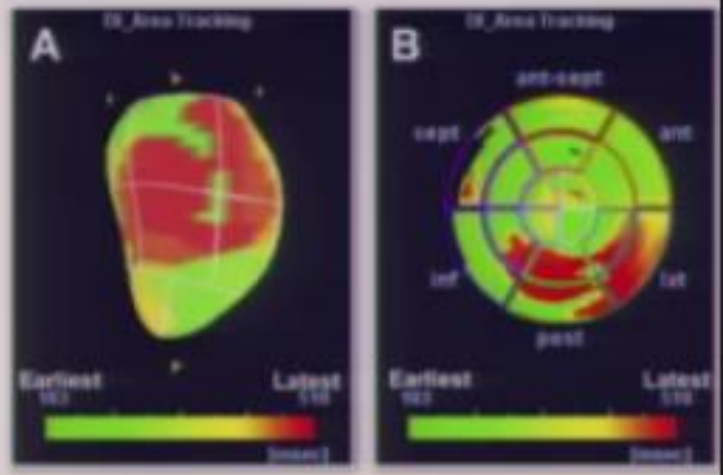
Speckle tracking: Classical LBBB longitudinal strain



Risum N, Tayal B, Hansen TF et al. J Am Coll Cardiol. 2015;66:631–41

3D Echocardiography

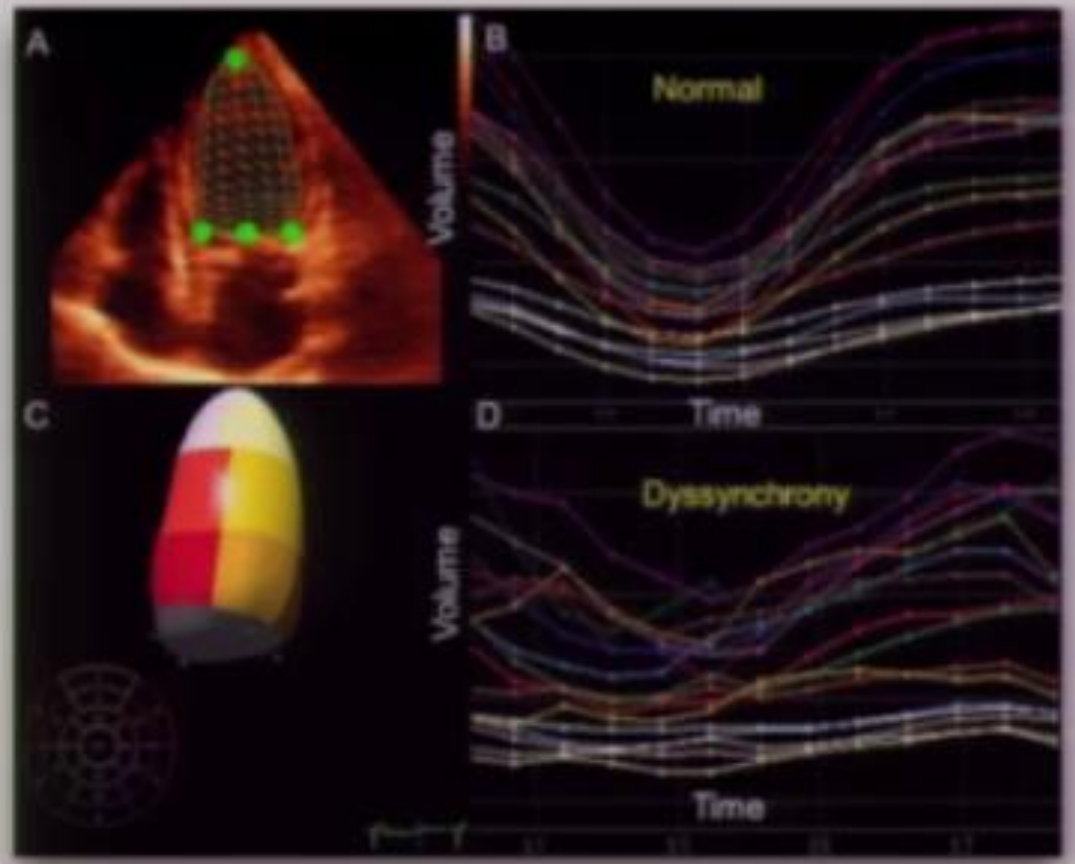
- Simultaneous calculation of global and regional LV volumetric changes
- Temporal differences of LV segmental volumetric differences
- 3D assessment feasible in 94% of patients



Gorcsan J & Tayal B. Heart Fail Clin. 2017;13:53–62
Kleijn SA, Aly MF, Knol DL et al.Eur Heart J Cardiovasc Imaging. 2012;13:763–75

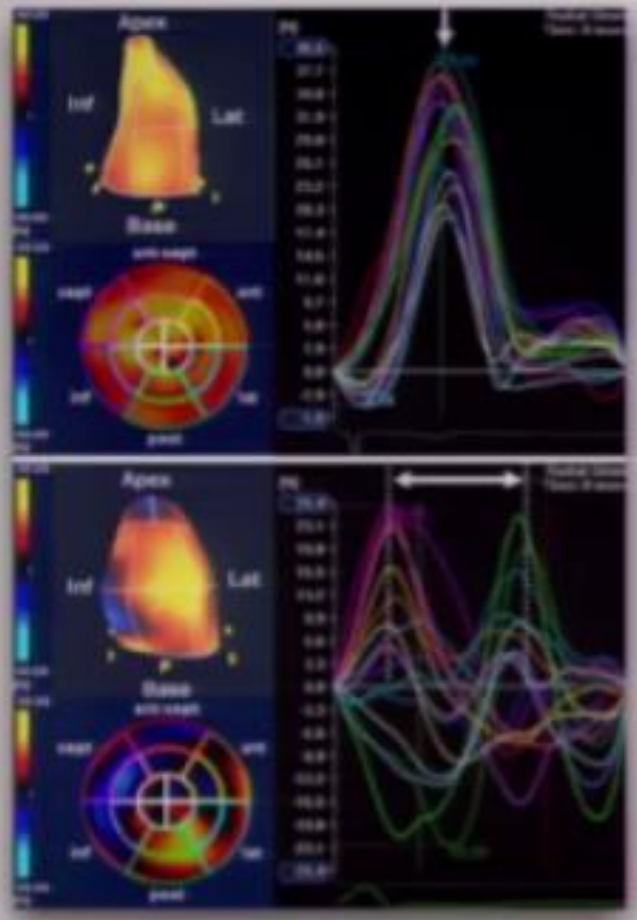
3D Echocardiography

- Systolic dyssynchrony index (SDI) = SD of time to reach minimum regional volume (%)

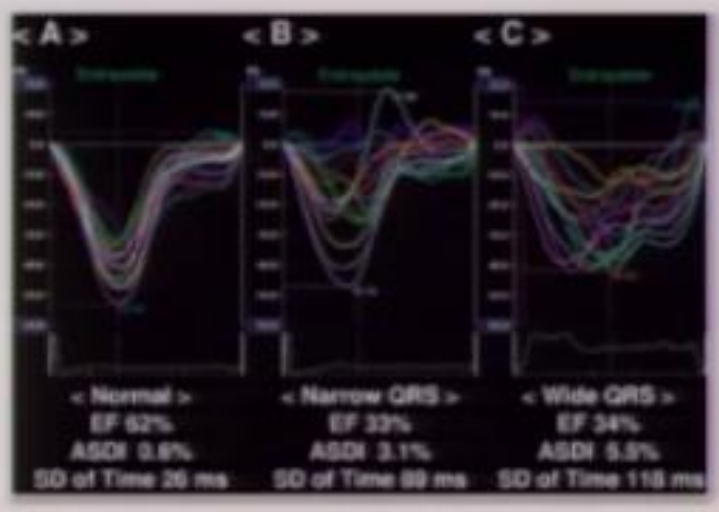


Cai Q, Ahmad M. Echocardiography. 2015;32:1299–306

3D Speckle Tracking



- Area strain dyssynchrony index (ASDI) = average difference between peak and end-systolic area strain from 16 segments



Cai Q, Ahmad M. Echocardiography. 2015;32:1299–306
Tatsumi K, Tanaka H, Matsumoto K et al. Am J Cardiol. 2011;108:867–72

Main echo techniques,parameters and values for detection of interventricular dyssynchrony and prediction of LV reverse remodeling

Technique	Parameter	Authors	Cut-off point
M-mode	SPWMD	Pitzalis et al, J Am Coll Cardiol 2002	> 130 ms
M-mode and PW Doppler	LWPSD	Sassone et al, Am J Cardiol 2007	> 1
PW Tissue Doppler	Diff. of T_s between LV segments	Bax JJ et al, J Am Coll Cardiol 2004	> 65 ms
TVI	T_s-SD	Yu et al, Am J Cardiol 2003	> 32.6 ms
TSI	T_s-SD	Yu et al, J Am Coll Cardiol 2005	> 34.4 ms
SRI	TPS-SD	Mele et al, Eur Heart J 2006	> 60 ms
SRI	ExcT	Porciani MC et al, Eur Heart J 2006	> 760 ms
2D radial strain	Time diff. in peak septal wall-to-posterior wall strain	Suffoletto et al, Circulation 2006	≥ 130 ms
3D echo	Triplane T_s-SD	Van der Veire NR et al, Am J Cardiol 2007	≥ 35.8 *

MRI Dyssynchrony

Quantification of mechanical ventricular dyssynchrony: direct comparison of velocity-encodedand cine magnetic resonance imaging.

Rofo. 2011 Jun;183(6):554-60. Epub 2011 Apr 12.

VENC-MRI and cine-MRI were performed in 20 patients with heart failure NYHA class III and reduced ejection fraction before CRT device implantation.

The interventricular mechanical delay (IVMD) was assessed by VENC-MRI as the temporal difference between the onset of aortic and pulmonary flow.

Intraventricular dyssynchrony was quantified by cine-MRI, using the standard deviation of time to maximal wall thickening in sixteen left ventricular segments (SDt-16).

RESULTS

14 patients (70 %) clinically responded to CRT. A similar accuracy was found to predict the response to CRT by measurements of the IVMD and SDt-16

ALSO data analysis of the IVMD is significantly less time-consuming compared to data analysis of the SDt-16

Συμπεράσματα

- Για να επαυξησουμε την αποκριση στην αμφικοιλιακη βηματοδοτηση πρεπει να κανουμε καλή επιλογή ασθενών ,που σημερα όπως φανηκε με την διαχρονική εξελιξη των guidelines μπορουμε καλύτερα να την κάνουμε
- *Προς το παρόν* η επιλογή ασθενών για θεραπεία δυσυγχρονισμού βάσει υπερηχογραφήματος *δεν* είναι τεκμηριωμένη.
- Στοιχεία από μελέτες καθιστούν υπερηχογραφικές παραμέτρους προ και μετά τη CRT ανεξάρτητους προγνωστικούς παράγοντες επιτυχίας της θεραπειας.
- Η πιο σημαντικη συνιστώσα είναι ο ενδοκοιλιακός δυσυγχρονισμός- οσο πιο μεγάλος τόσο πιο μεγάλη η πιθανότητα για ανάστροφη αναδιαμόρφωση.
- Νεώτερες τεχνικές όπως το speckle tracking και η 3D υπερηχοκαρδιογραφία υποσχονται πολλα στην επιλογή των ασθενών που θα ανταποκριθούν τα μέγιστα μετα τον επανασυγχρονισμό και στην μειωση των non-Responders(30%).


Σας Ευχαριστώ !