Srdeční resynchronizační léčba

J. Janoušek

Dětské kardiocentrum 2. LF UK a FN Motol

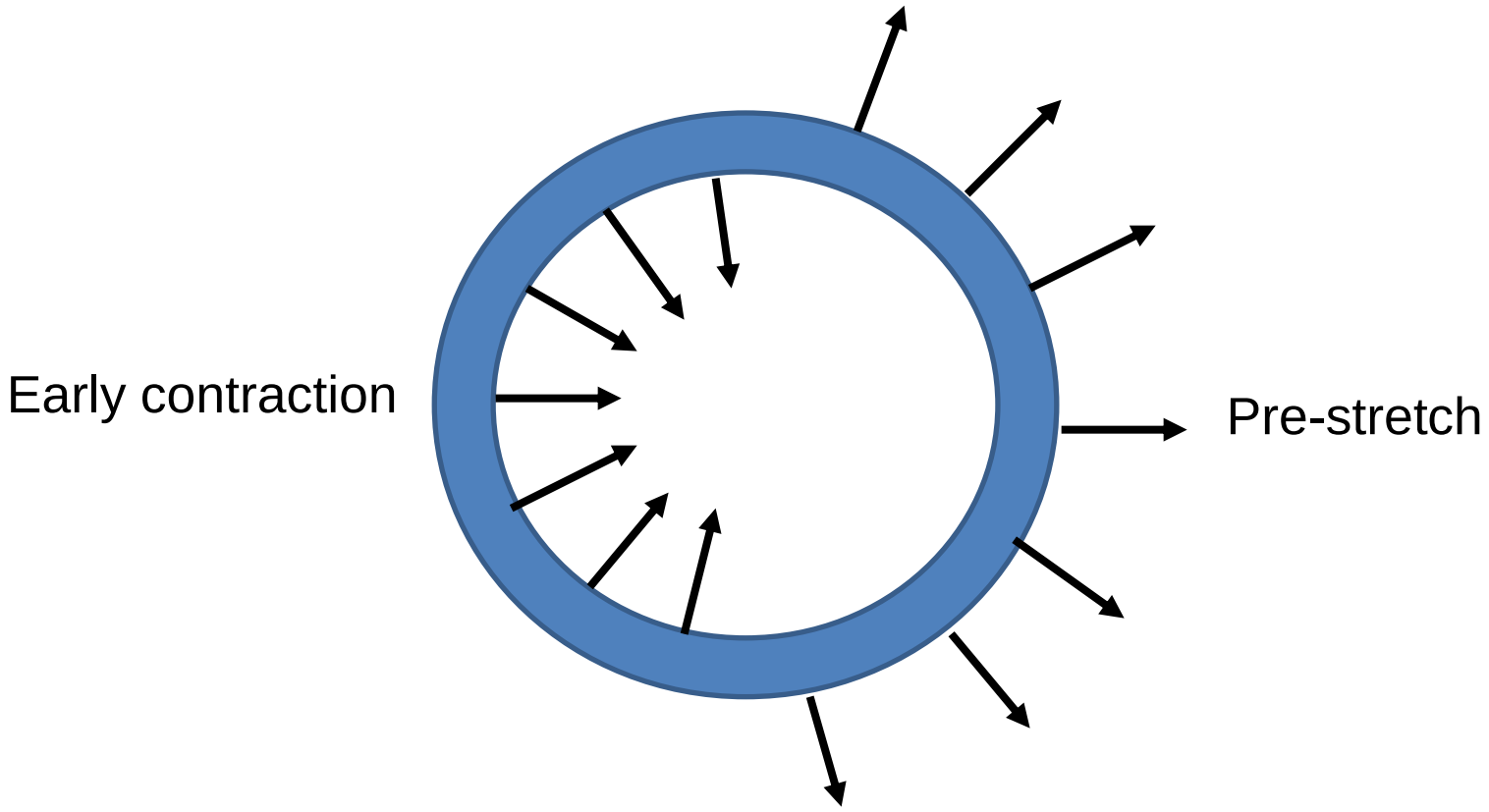
Components of cardiac output

- Heart rate
- Contractility
- Preload
- Afterload

AND

- Synchrony!

Clustered electromechanical dyssynchrony



Helm RH et al.,Circulation 2005

Components of cardiac output

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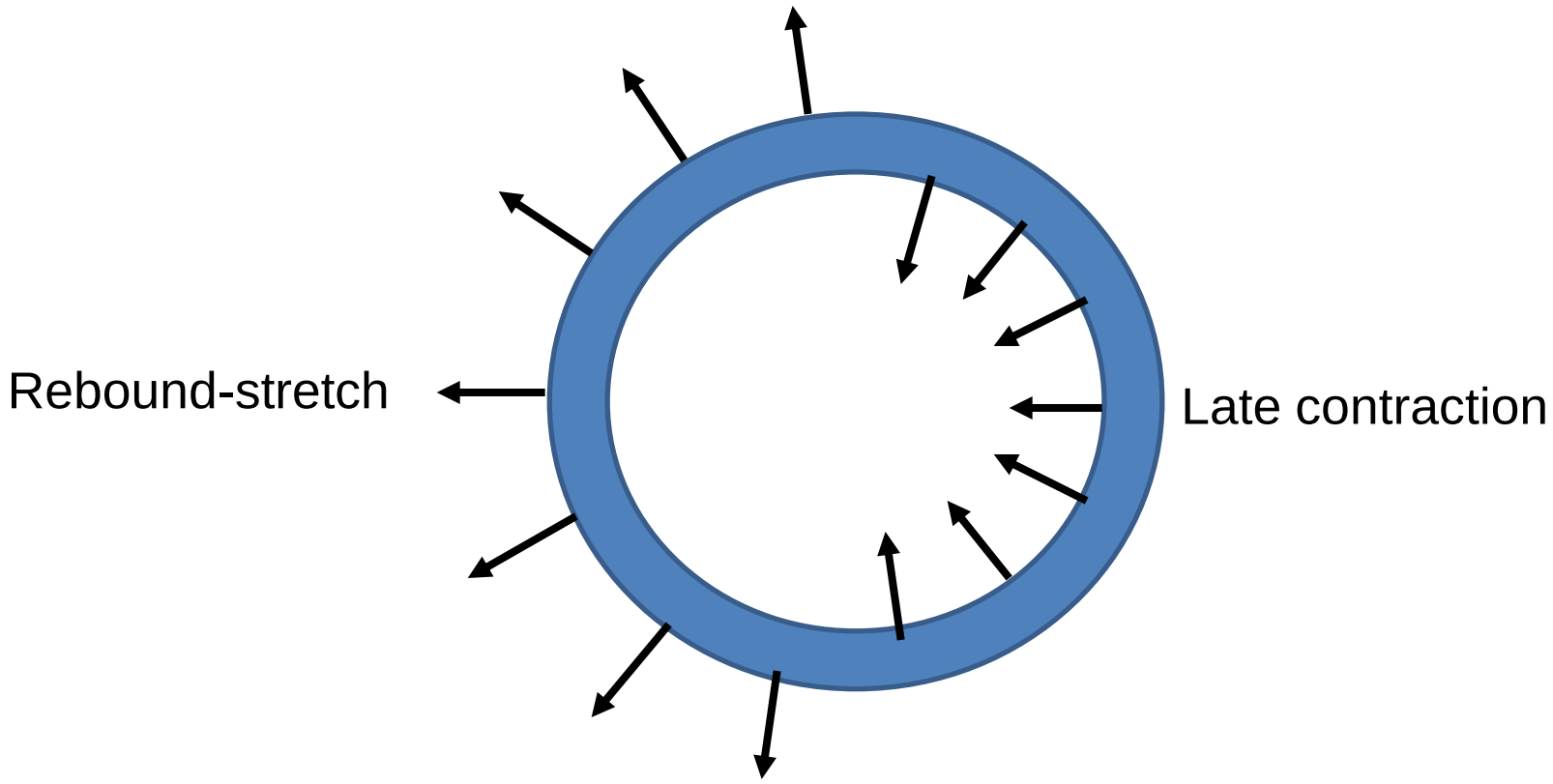
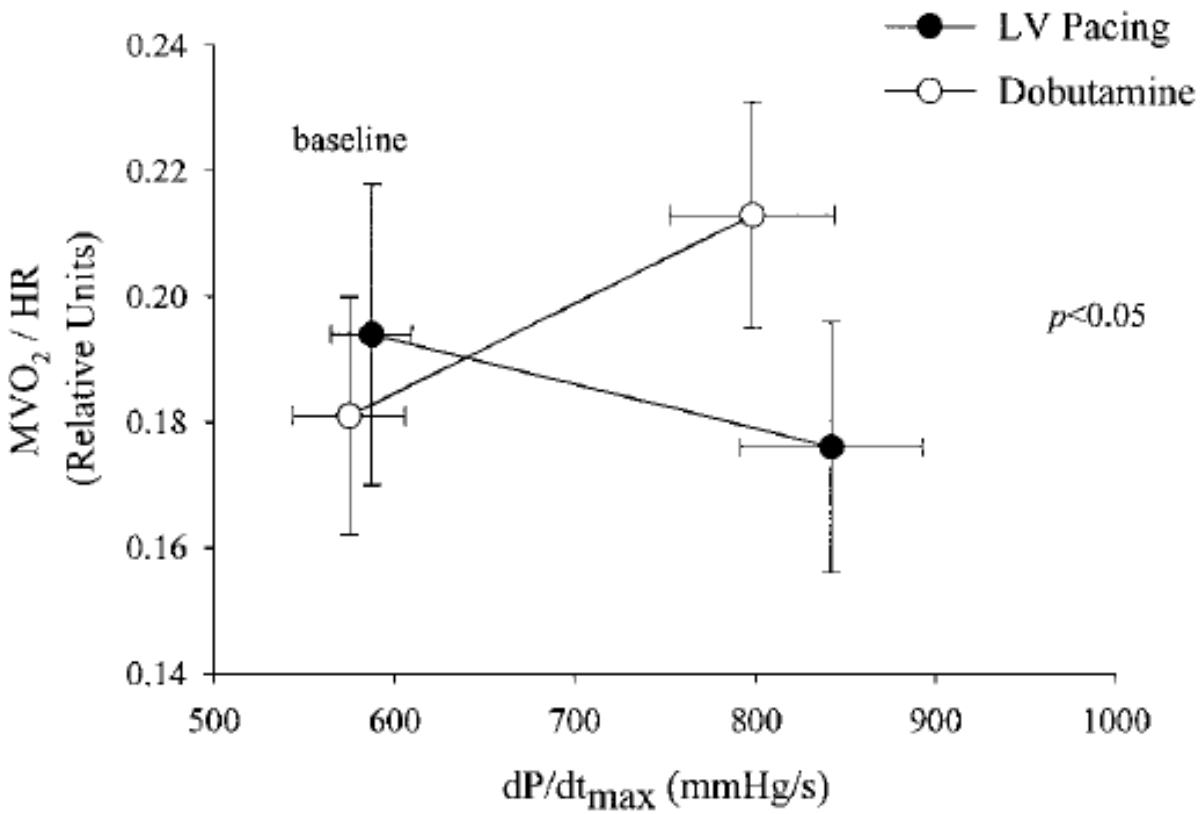


Amenable to CRT

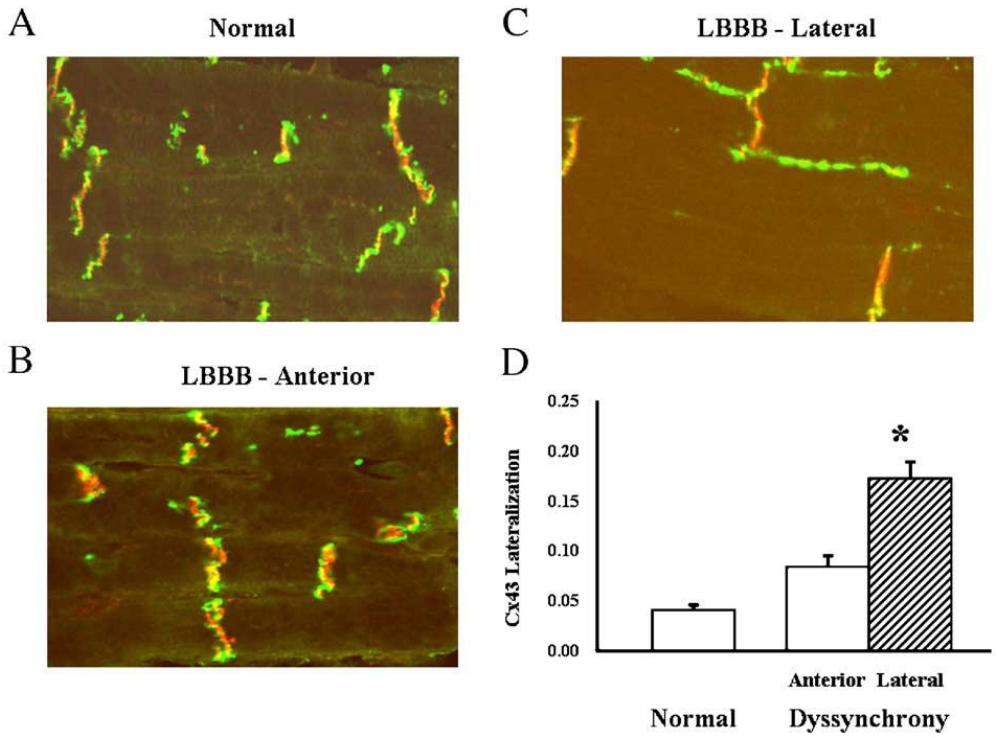
Helm RH et al.,Circulation 2005

What are the effects of CRT?

Improved cardiac function at diminished energy cost



Reverse cellular remodeling



CRT restores normal connexine distribution and conduction velocity in late contracting segments

Nelson GS et al., Circulation 2000

What are the indications for CRT?

- Systemic LV failure
  - Left bundle branch block
  - RV paced
- Systemic RV failure
  - Right bundle branch block
  - LV paced
- Single-ventricular failure
  - Any bundle branch block
  - Single site pacing
- Pulmonary RV failure?
  - Right bundle branch block

Specific for CHD

Much more structural and functional diversity!

What are the indications for CRT?

- Systemic LV failure
  - Left bundle branch
  - RV paced
- Systemic RV failure
  - Right bundle bran
  - LV paced
- Single-ventricular f
  - Any bundle branch
  - Single site pacing
- Pulmonary RV failu
  - Right bundle bran

2023 HRS/APHRS/LAHRS guideline on cardiac physiologic pacing for the avoidance and mitigation of heart failure

EF <45 %

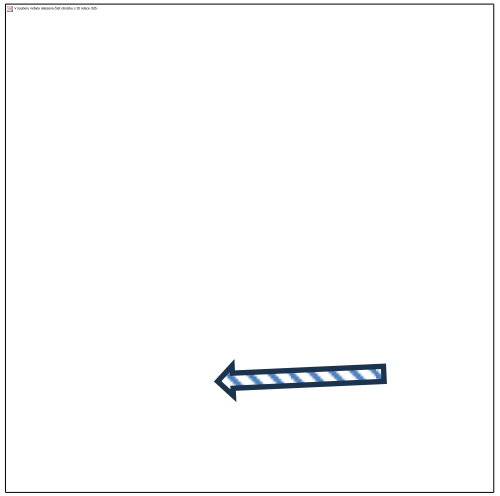
Recommendations for CHD

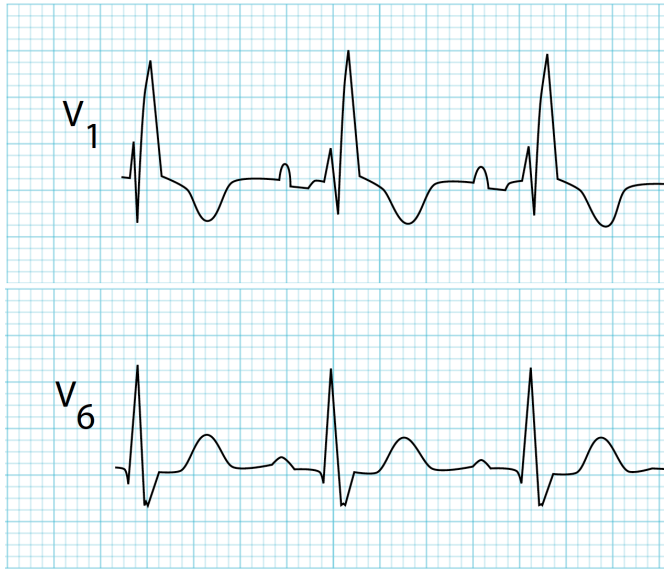
COR	LOE	Recommendations	References
2a	C-LD	1. In patients with CHD on GDMT with a systemic LV, LVEF <45%, and ventricular dyssynchrony (as defined by a QRS duration z score of ≥3 or ventricular pacing ≥40%), CRT with BiV pacing is reasonable to reduce the risk of mortality or need for transplant.	400–408
2a	C-LD	2. In patients with CHD and a systemic single ventricle who require pacing, apical pacing is reasonable in preference to nonapical pacing.	409
2b	C-LD	3. In patients with CHD and a systemic single ventricle with symptomatic HF on GDMT, CRT with multisite ventricular pacing may be considered to maintain functional class or ventricular function.	400,402,410,411
2b	C-LD	4. In patients with CHD and a systemic RV with symptomatic HF on GDMT associated with ventricular electrical delay or requiring substantial ventricular pacing, CRT with BiV pacing may be considered to improve or maintain functional class or ventricular function.	400–408,412–415
2b	C-LD	5. In patients with CHD and a subpulmonary RV with RV dysfunction and RBBB, CRT with fusion-based pacing may be considered to improve RV function.	416–418
2b	C-LD	6. In patients with CCTGA and AV block in whom anatomic repair has not been performed, CSP with HBP or LBBAP may be considered to improve functional status.	419,420

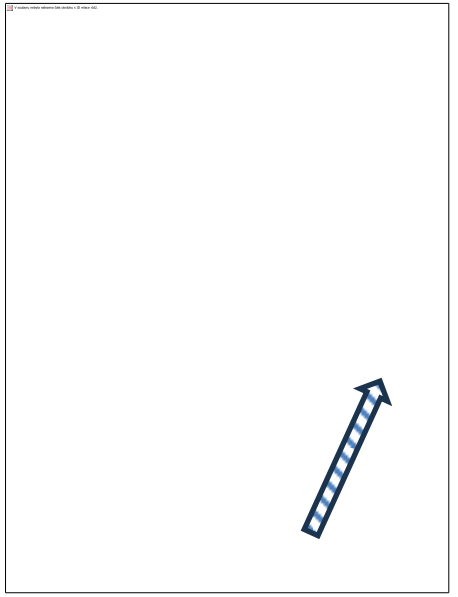
Keep things simple while looking for a CRT candidate!

- Patient with systolic ventricular dysfunction and wide QRS
  - Observe the ECG first!
  - Is there a conduction delay within the failing ventricle?
  - If so, think about CRT!

Right bundle branch block







Electromechanical dyssynchrony essential for CRT to be effective

Role of echocardiography

Conventional

2D and blood Doppler

Global picture of filling and ejection timing in a failing heart

Advanced

Speckle tracking imaging

Classic-pattern dyssynchrony

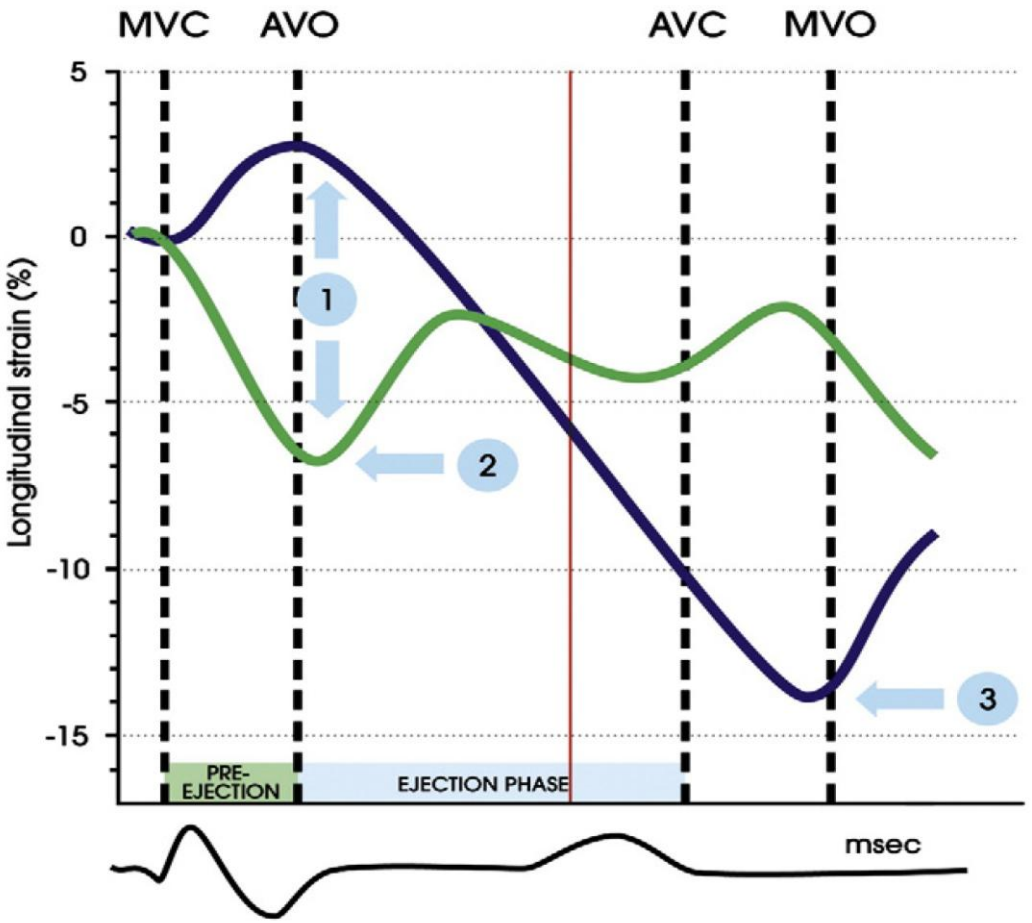
Segmental motion timing

Relation to filling and ejection

Simple regional strain pattern analysis to predict response to cardiac resynchronization therapy: Rationale, initial results, and advantages

(Am Heart J 2012;163:697-704.)

Niels Risum, MD,[a] Christian Jons, MD, PhD,[a] Niels T. Olsen, MD, PhD,[a] Thomas Fritz-Hansen, MD,[a]
Niels E. Bruun, MD, DMSc,[a] Michael V. Hojgaard, MD, PhD,[a] Nana Valeur, MD, PhD,[a]
Mads B. Kronborg, MD, PhD,[b] Joseph Kisslo, MD,[c] and Peter Sogaard, MD, PhD[a] *Skejby, Denmark; and Durham, NC*



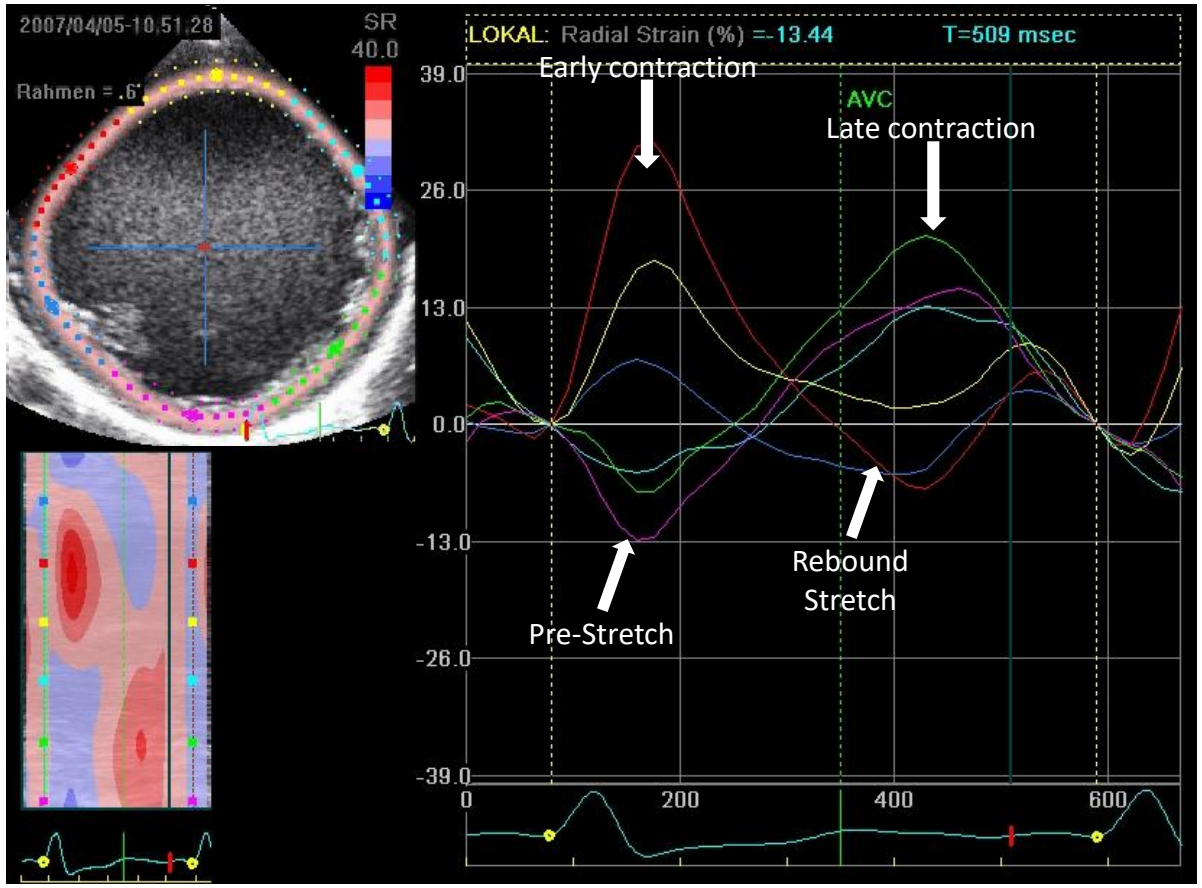
Classic-pattern dyssynchrony

1. Early septal contraction and *early lateral wall stretching*
2. Peak septal contraction <70 % of ejection phase followed by *rebound stretch*
3. Peak lateral wall contraction after AVC

Correlates wit CRT efficacy

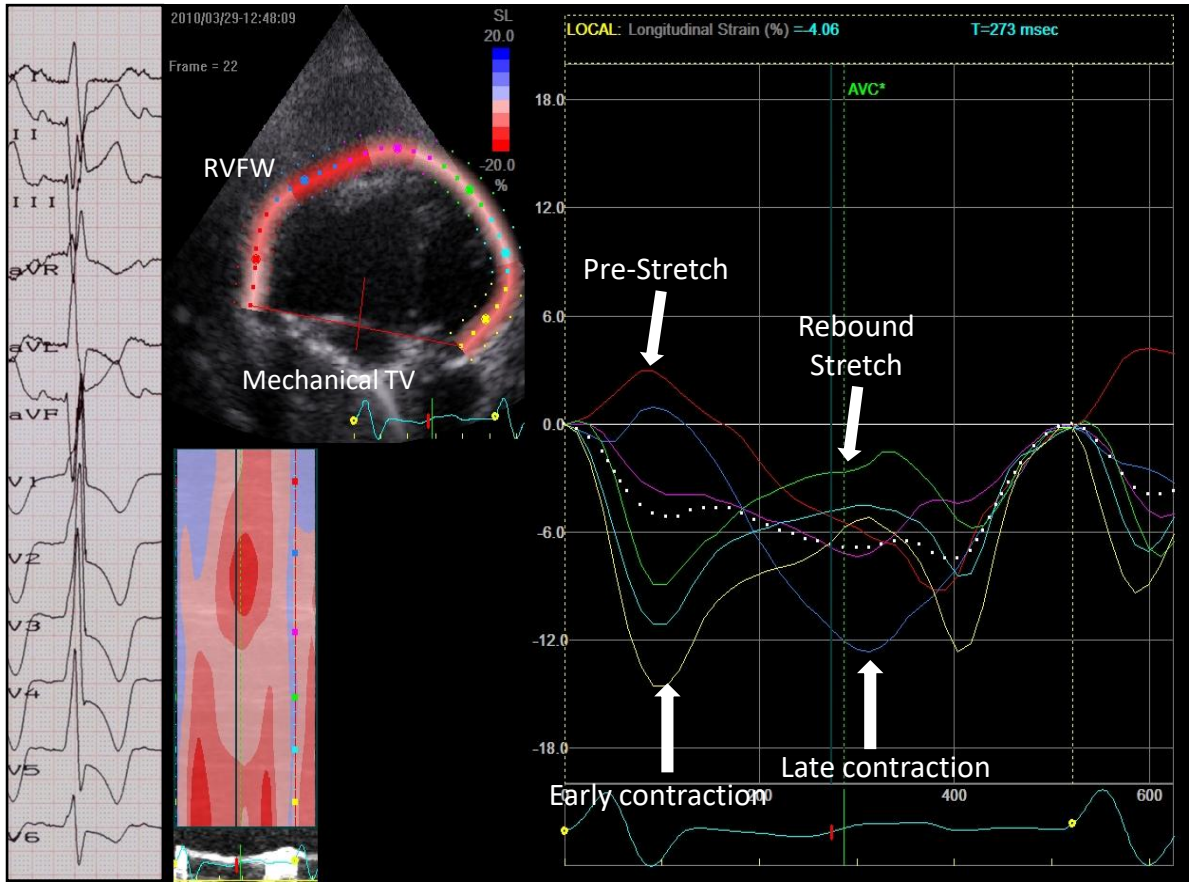
We are able to evaluate classic-pattern dyssynchrony in pediatric heart disease and support CRT indication!

Systemic left ventricle, LBBB



Gonzales MB, PACE 2009

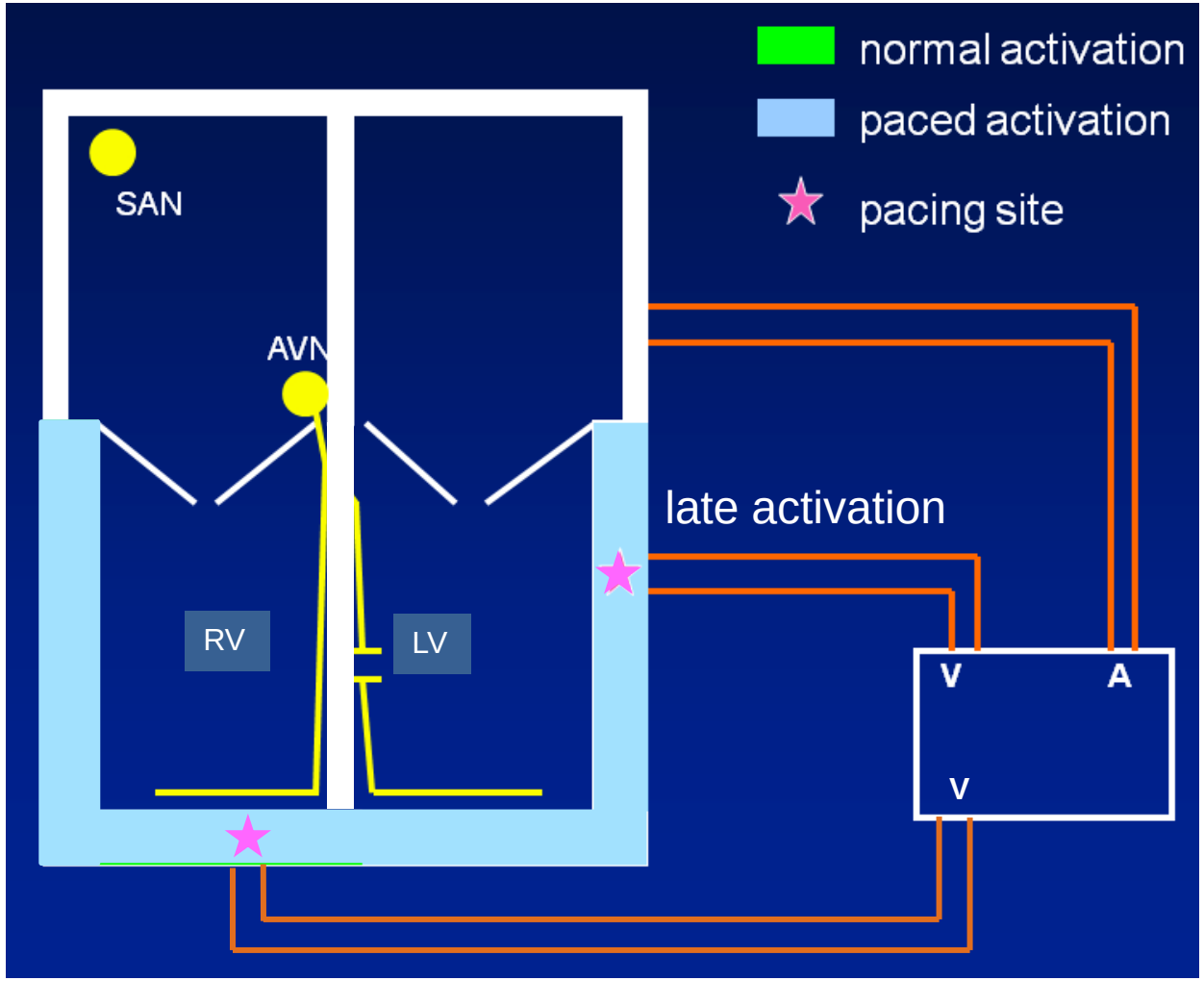
Single right ventricle, RBBB



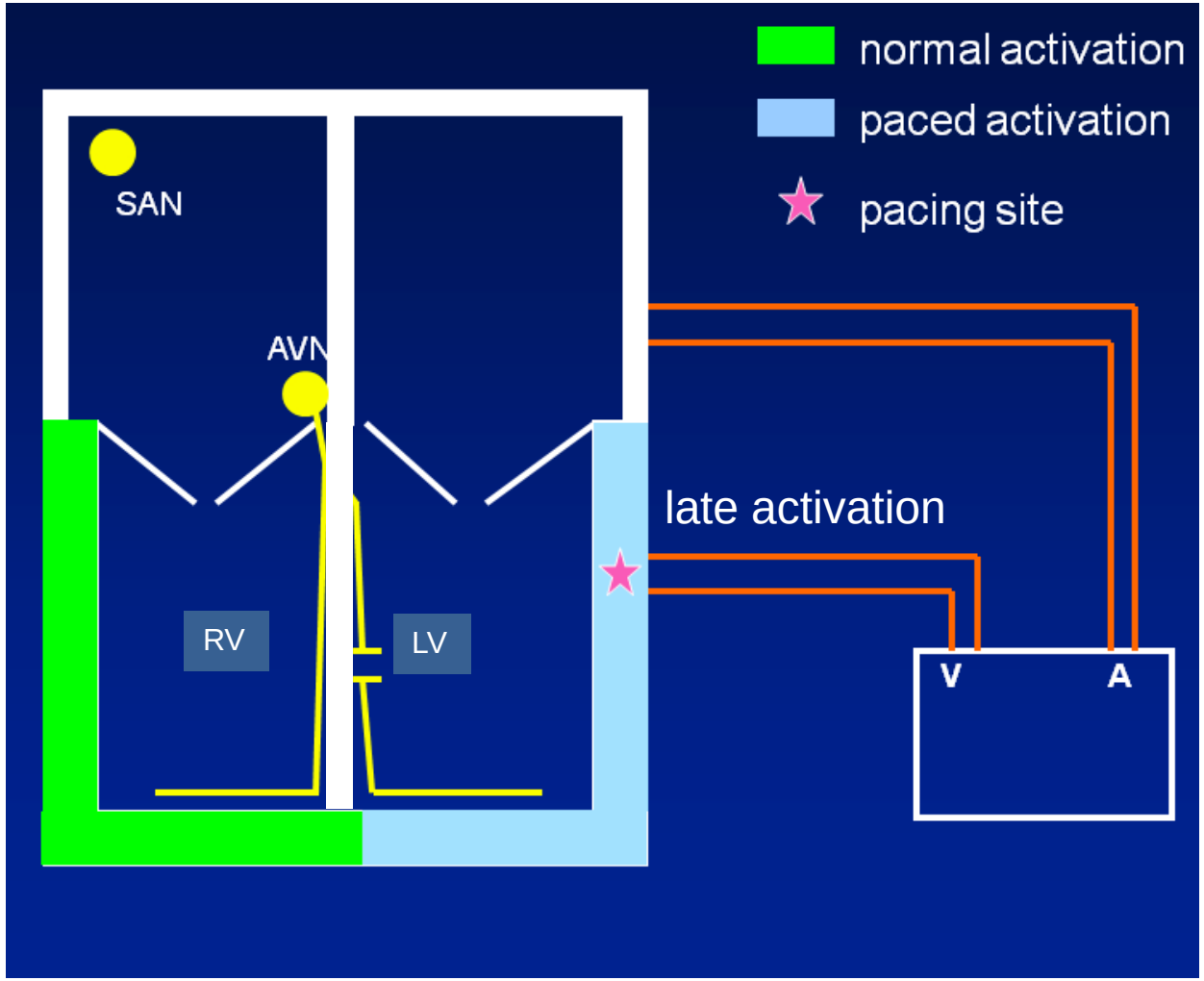
Materna O, HeartRhythm J 2014

How to apply CRT in pediatric patients?

Classical biventricular pacing



Single site pacing in fusion

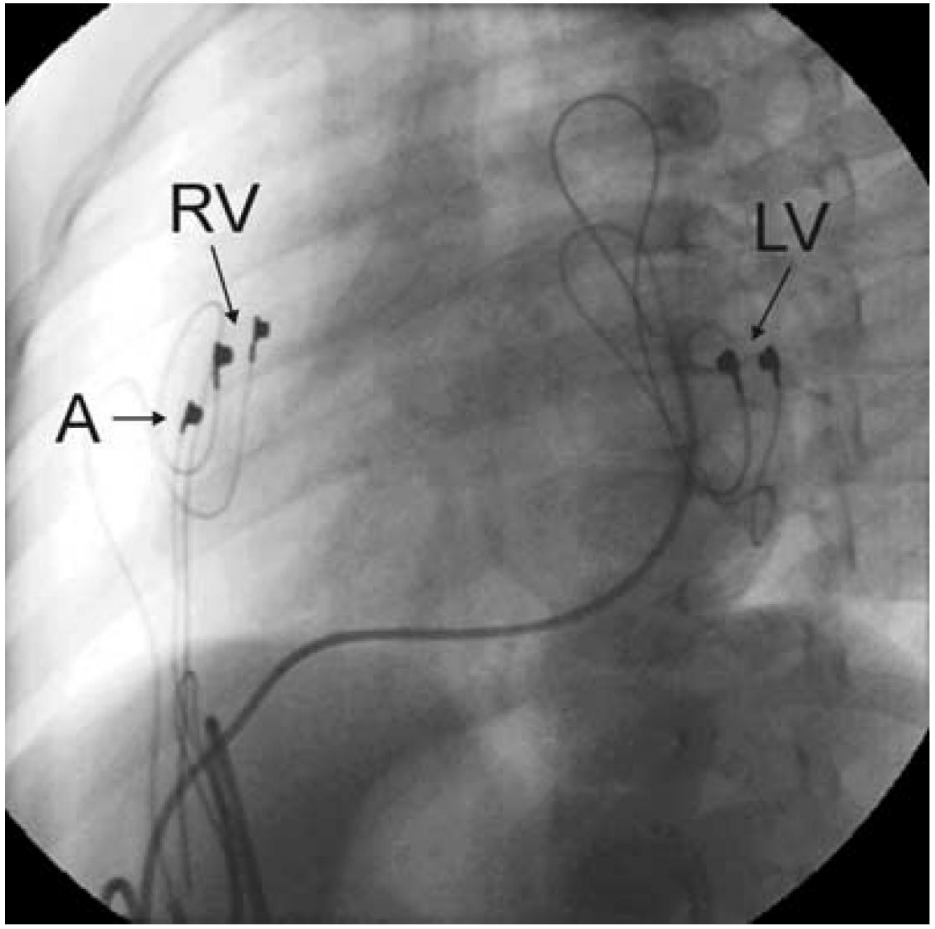


How to apply CRT in pediatric patients?

At least one lead must be placed at the site of late ventricular activation!

Dilated Cardiomyopathy Associated with Dual-Chamber Pacing in Infants: Improvement Through Either Left Ventricular Cardiac Resynchronization or Programming the Pacemaker Off Allowing Intrinsic Normal Conduction *JCE 2004*

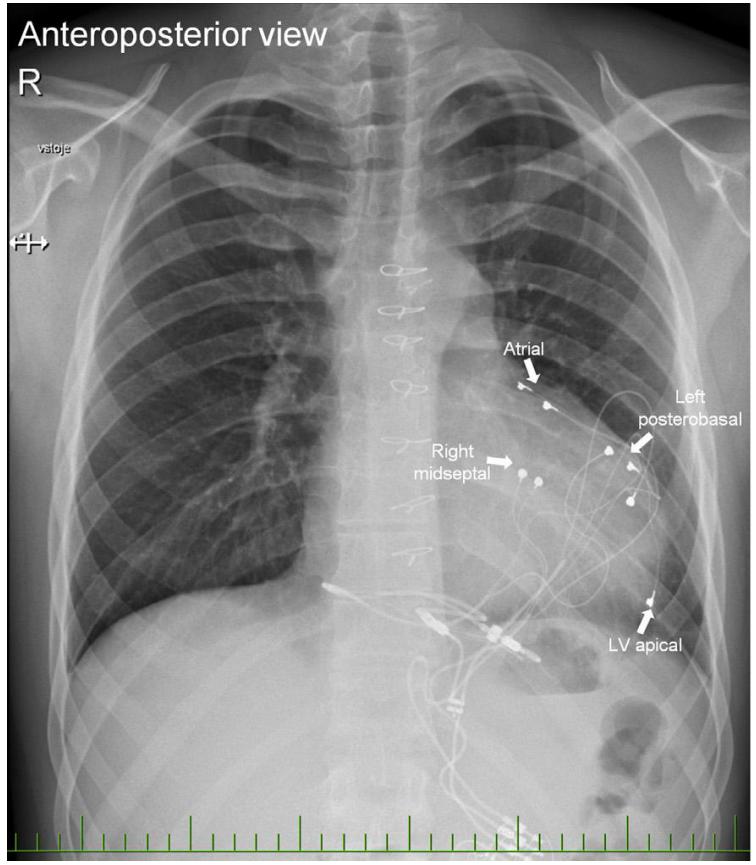
JAN JANOUŠEK, M.D., VIKTOR TOMEK, M.D., VÁCLAV CHALOUPECKÝ, M.D., PH.D., and ROMAN ANTONÍN GEBAUER, M.D.

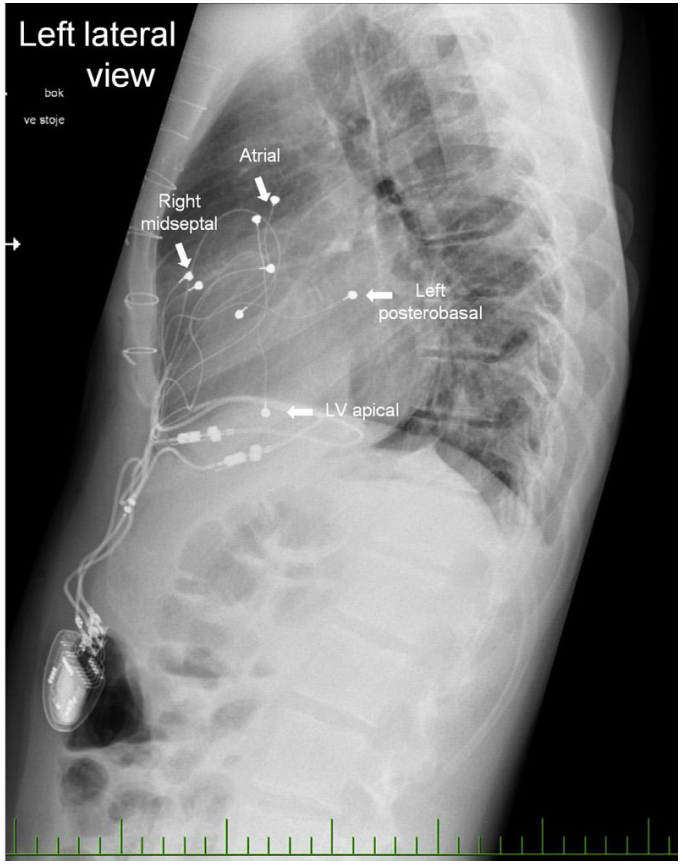


Multisite Pacing for Heart Failure Associated With Left Ventricular Apical Pacing in Congenital Heart Disease

JACC CE 2022

Karel Koubský, MD, PHD,[a] Jan Kovanda, MD,[a] Miroslav Ložek, MSC,[a,b] Viktor Tomek, MD, PHD,[a] Michal Jičínský, MD,[a] Roman Gebauer, MD,[a] Peter Kubuš, MD, PHD,[a] Jan Janoušek, MD, PHD[a]





What do we get clinically from CRT: ventricular function

Reverse ventricular remodeling and up to normalization of ventricular function in super-responders

Before CRT, EF = 14%

After 3 weeks of CRT, EF = 28 %

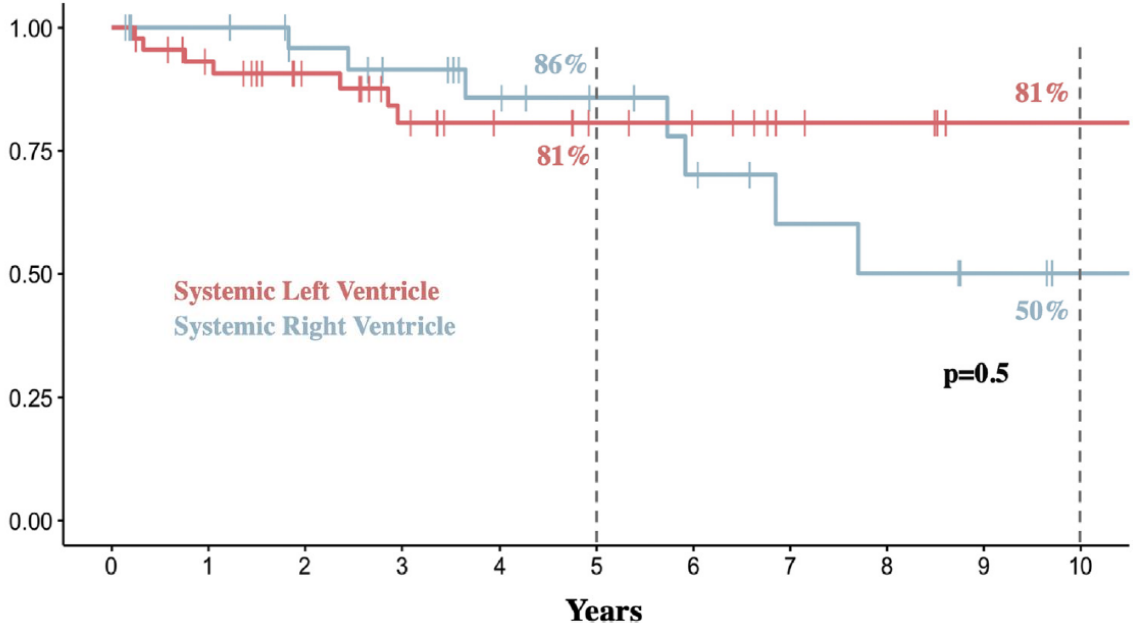
Gonzales MB et al. PACE 2009

Cardiac resynchronization therapy in patients with congenital heart disease and systemic right ventricle

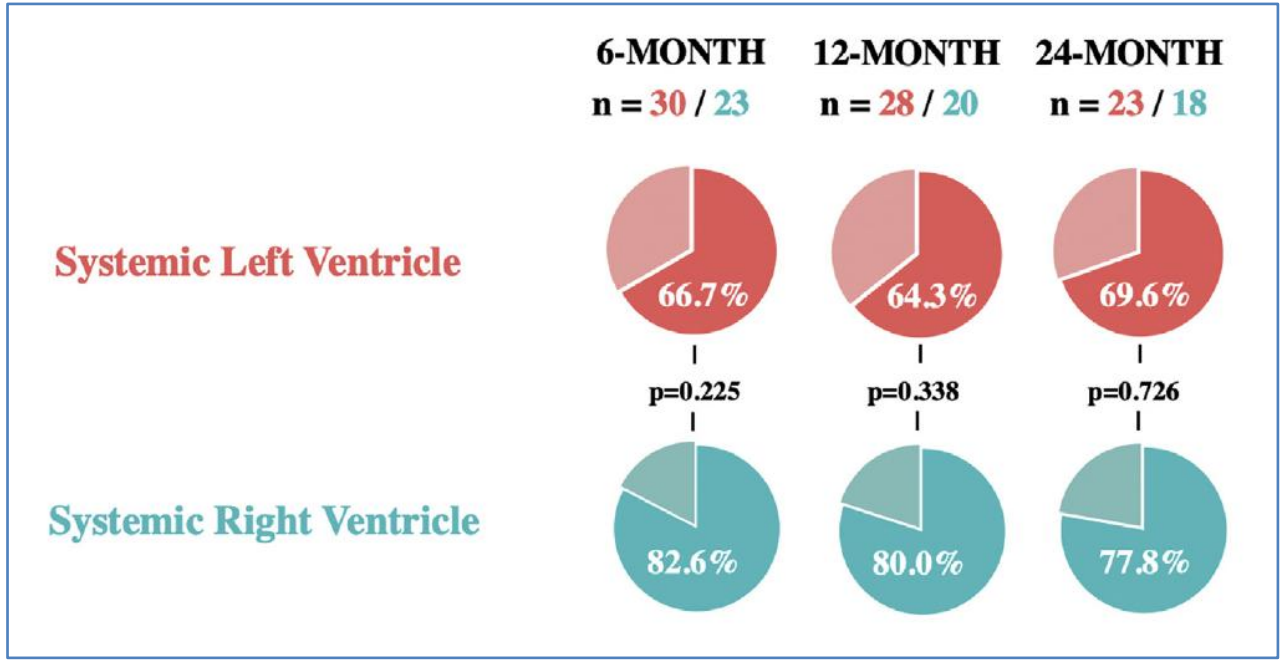
- N = 85 with CHD, mainly adults,
- Systemic RV = 36.5 %

Response to CRT was defined as an increase in systemic ventricular ejection fraction of ≥10% and/or an improvement in New York Heart Association functional class by at least 1 grade.

Overall mortality and heart transplantation

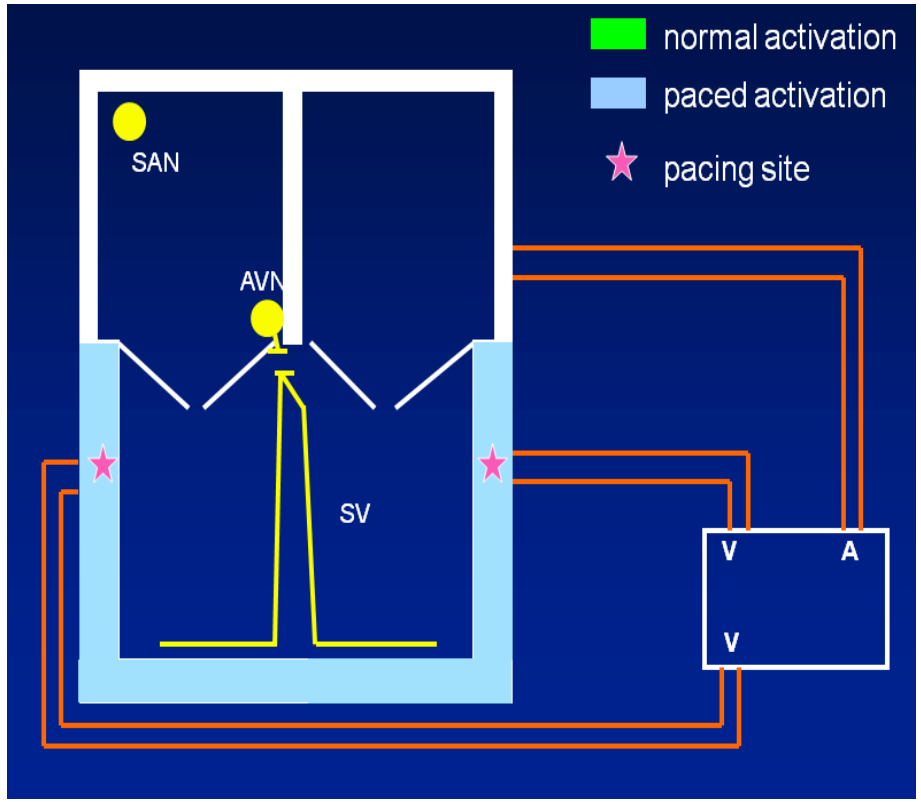


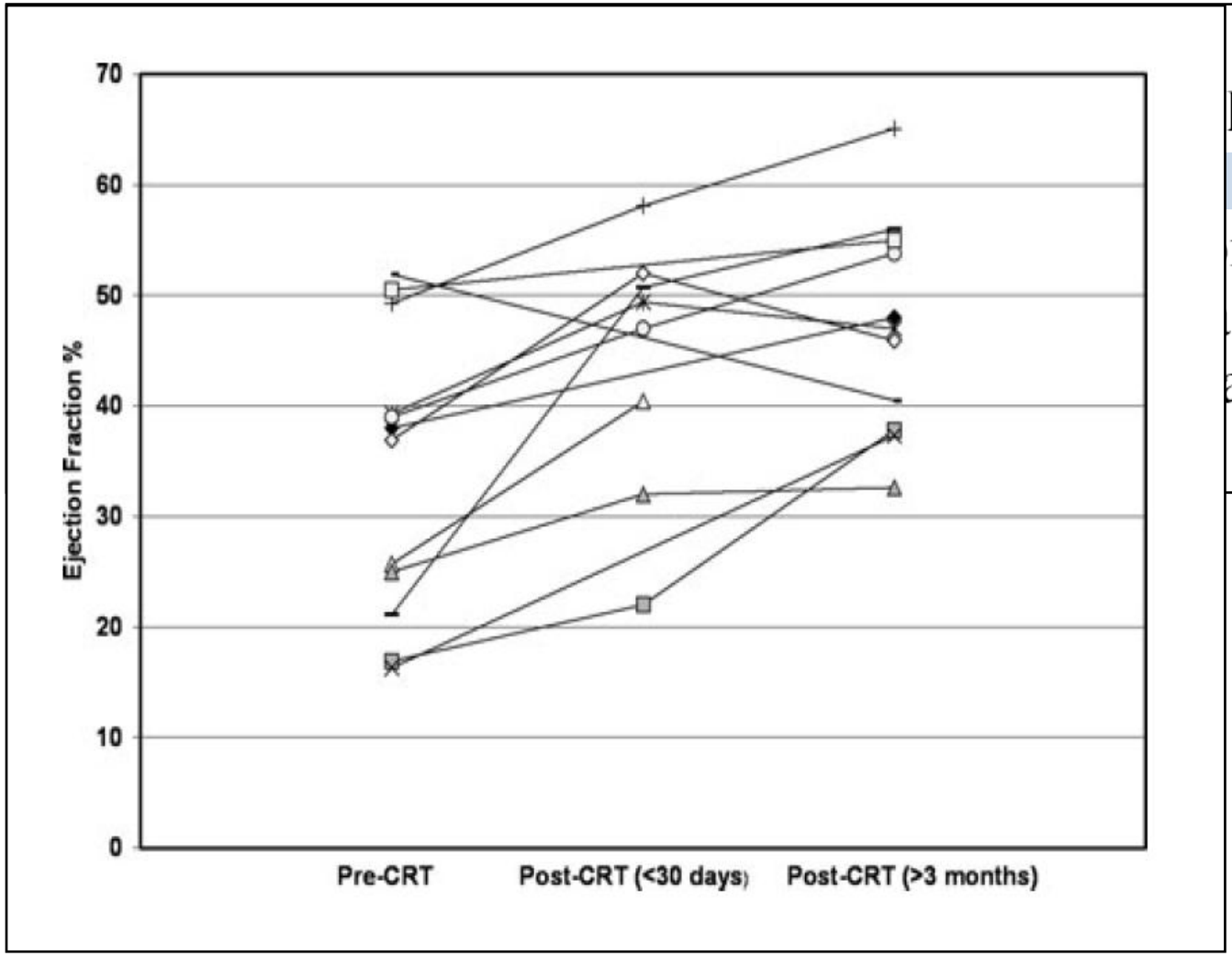
Rate of CRT responders



Jacquemart et al. Heart Rhythm 2022

Resynchronizing the single ventricle





Our
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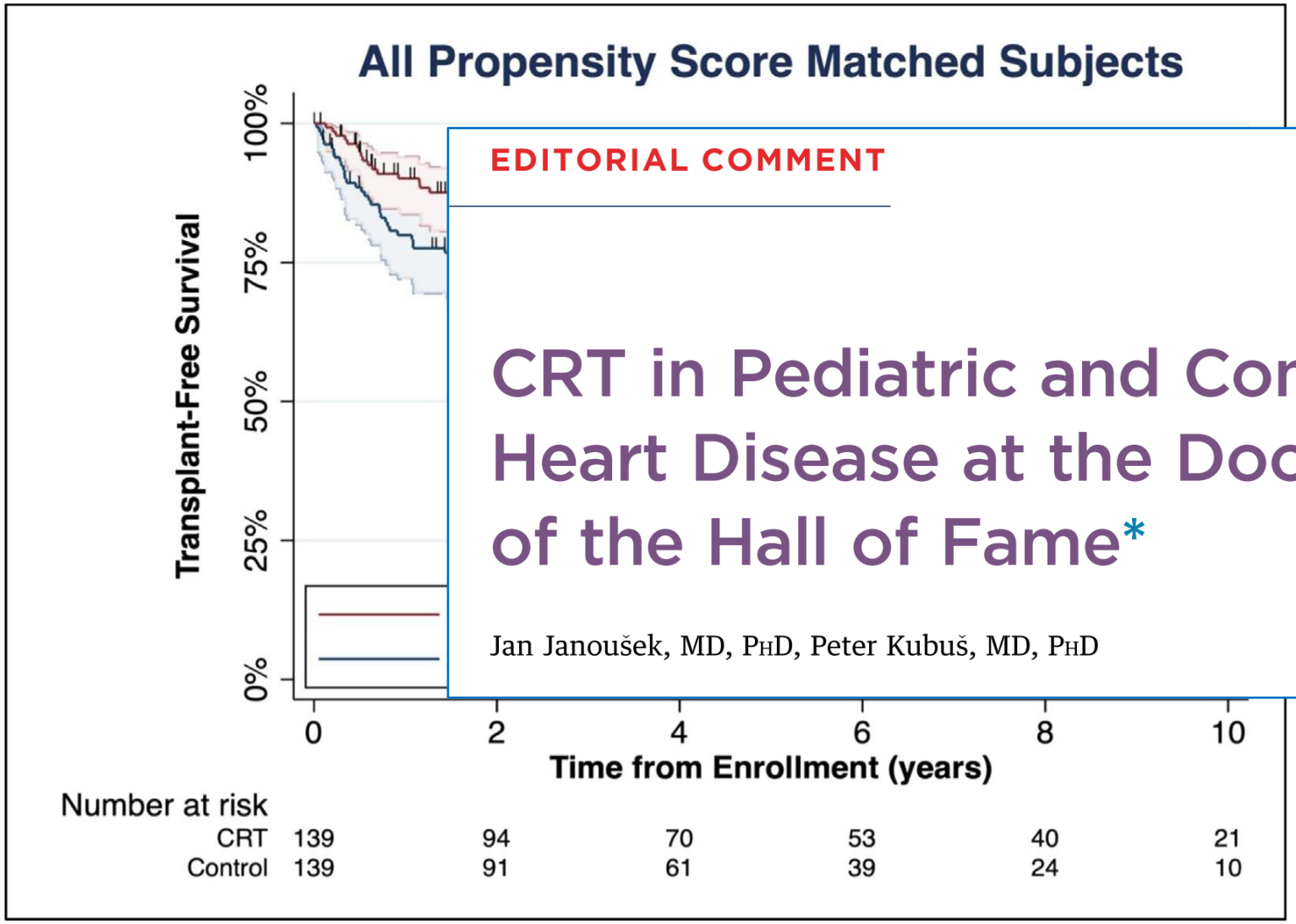
Cecchin F et al. JCE 2009;20:58-65

What is the impact of CRT on survival?



EDITORIAL COMMENT

CRT in Pediatric and Congenital Heart Disease at the Doorsteps of the Hall of Fame*

Jan Janoušek, MD, PhD, Peter Kubuš, MD, PhD

JACC-EP 2024

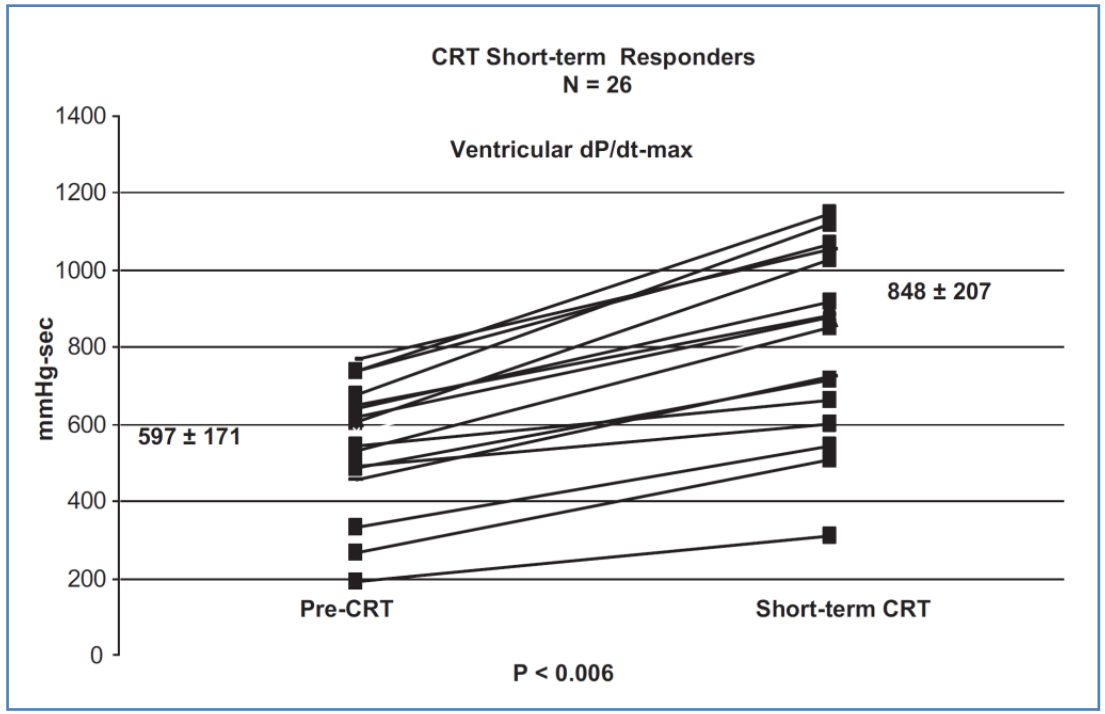
patients
ge 12.8 (4.9-20.0) yrs
propensity score
hed controls
ge 14.9 (6.9-22.5) yrs

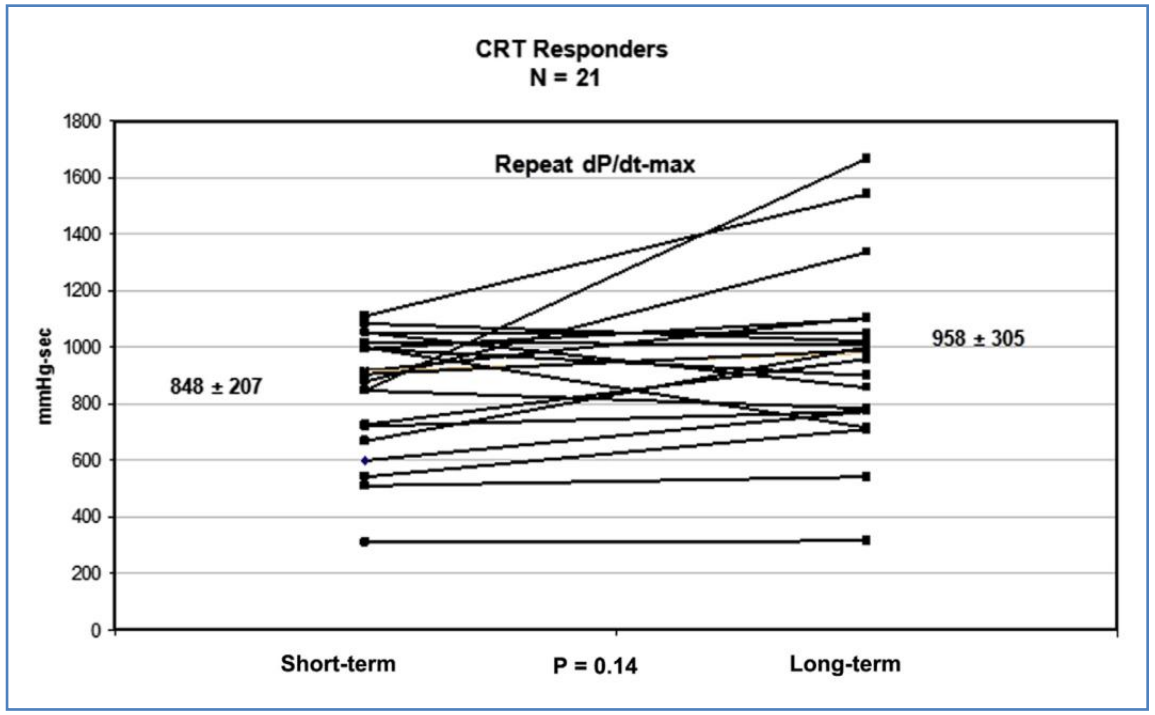
udy of Survival Benefit of Cardiac Resynchronization Therapy in Pediatric and Congenital Heart Disease

Henry Chubb, MA, MBBS, PhD,[a,b] Douglas Y. Mah, MD,[c,d] Maully Shah, MD,[e] Kimberly Y. Lin, MD,[e]

JACC: CLINICAL ELECTROPHYSIOLOGY VOL. ■, NO. ■, 2023

How to predict CRT efficacy?





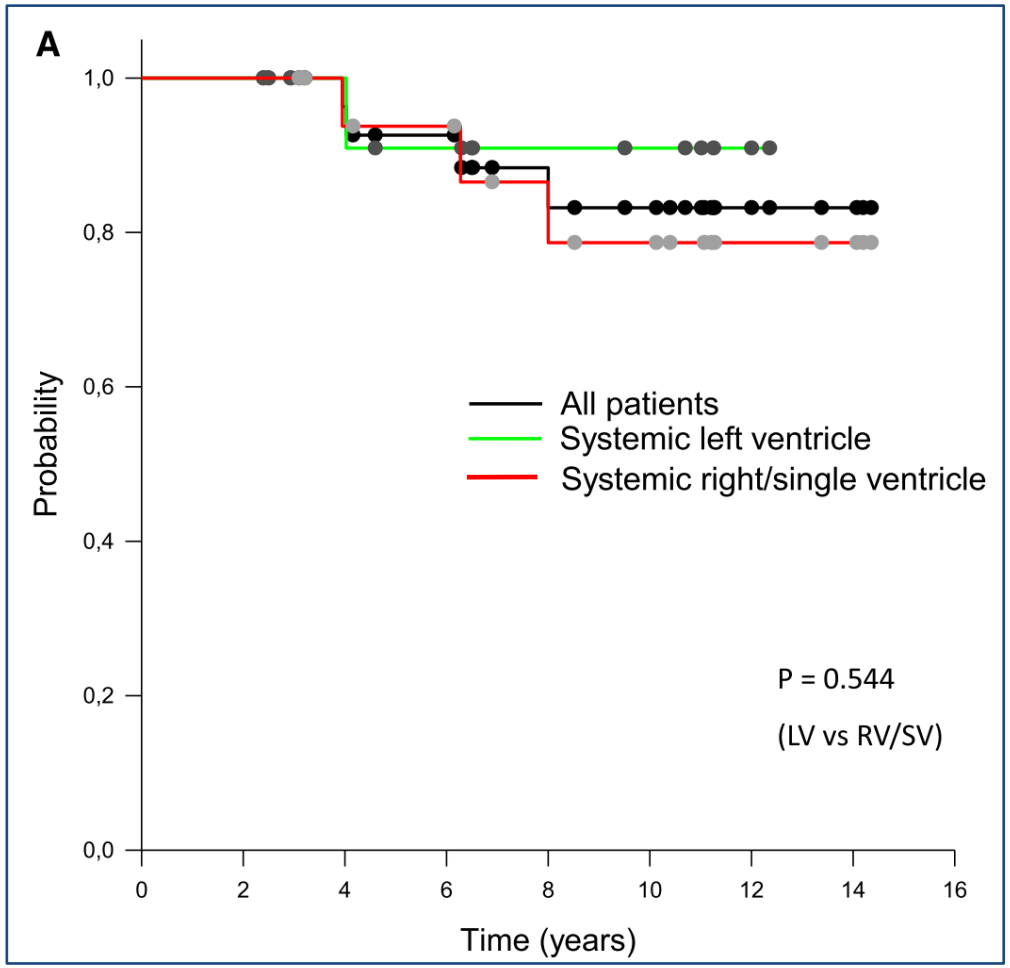
16 Years of Cardiac Resynchronization Pacing Among Congenital Heart Disease Patients J Am Coll Cardiol EP 2017

Direct Contractility (dP/dt-max) Screening When the Guidelines Do Not Apply

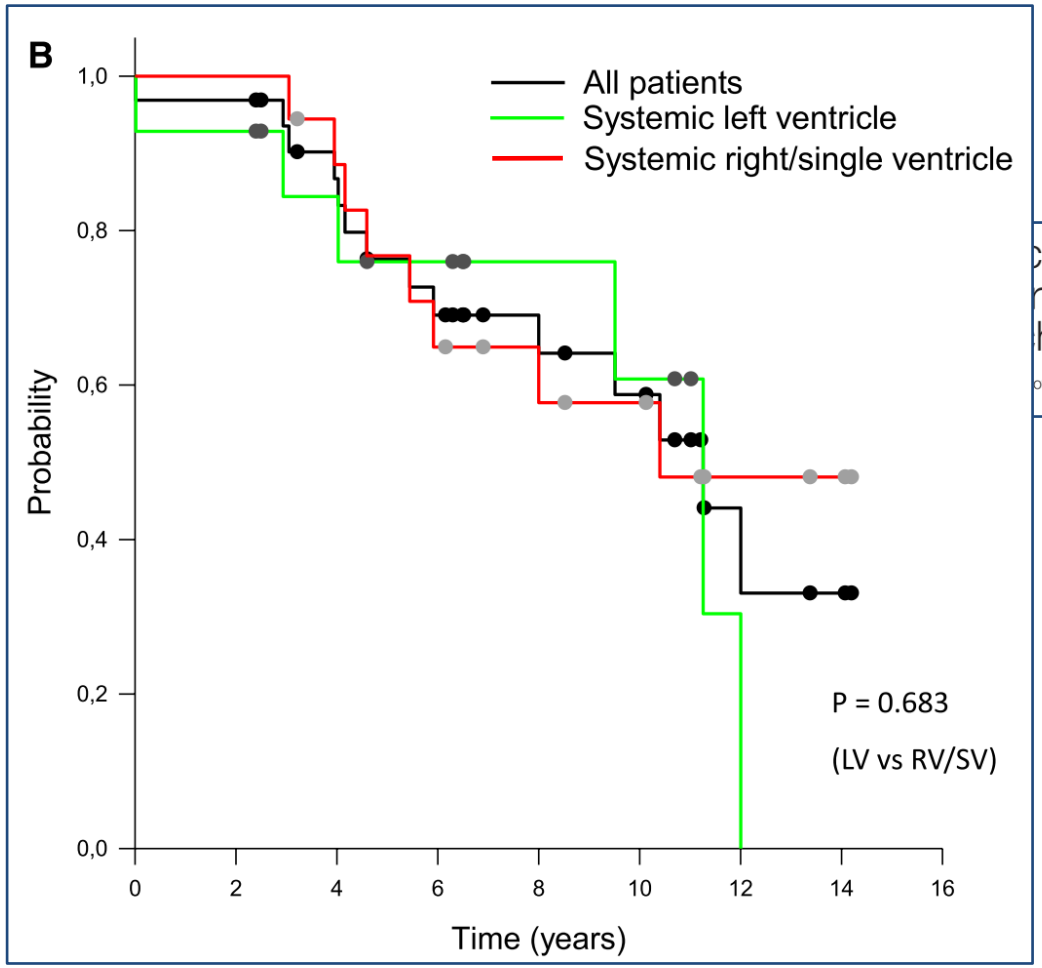
Peter P. Karpawich, MSc, MD, Neha Bansal, MD, Sharmeen Samuel, MD, Yamuna Sanil, MD, Kathleen Zelin, MSN, CPNP

What is the probability of CRT complications?

Freedom from cardiovascular death, heart failure hospitalization and new transplant listing



Freedom from A + CRT termination, or surgical revision of the pacing system other than elective battery replacement



come of Patients With
rt Disease Undergoing
hronization Therapy

ová Popelová, MD; Jan Kovanda, MD; Kamil Sedláček, MD;

JAHA 2021

Circulation: Arrhythmia and Electrophysiology

Janousek J et al., 2019

SPECIAL REPORT

Cardiac Resynchronization Therapy for Treatment of Chronic Subpulmonary Right Ventricular Dysfunction in Congenital Heart Disease

Chronic Response	Baseline	Last Follow-Up	*P* Value
QRS duration, ms	158 (29) [200, 180, 150]	113 (20) [140, 120, 90]	0.002
NYHA class ≥2 [n]	6/6 [3/3]	1/6 [0/3]	0.015
NT-proBNP, ng/L	842 (756) [N/A, 361, 556]	233 (175) [81, 123, 460]	0.156
RV fractional area change, %	17.5 (9.2) [18, 32, 24]	35.0 (3.3) [36, 34, 36]	0.006
RV end-diastolic area index, cm^2/m^2 BSA	28.1 (11.4) [32.0, 18.8, 18.2]	20.1 (3.6) [24.3, 17.5, 20.6]	0.198
RV end-systolic area index, cm^2/m^2 BSA	23.7 (11.2) [26.4, 12.8, 13.8]	13.1 (2.1) [15.5, 11.5, 13.2]	0.086
RV dP/dt_{max}, mm Hg/s	316 (153) [113, 301, 374]	444 (161) [305, 386, 409]	0.051
Late systolic right to left septal flash [n]	6/6 [3/3]	1/6 [0/3]	0.015
RV septal to lateral mechanical delay, ms	150 (80) [131, 88, 83]	1 (22) [–62, 81, 49]	0.044
RV systolic stretch fraction, %	28.4 (22.3) [22.5, 15.7, 7.5]	11.7 (4.8) [13.0, 11.0, 4.0]	0.092
LV ejection fraction, %	62 (19) [59, 29, 66]	62 (13) [72, 43, 71]	0.910

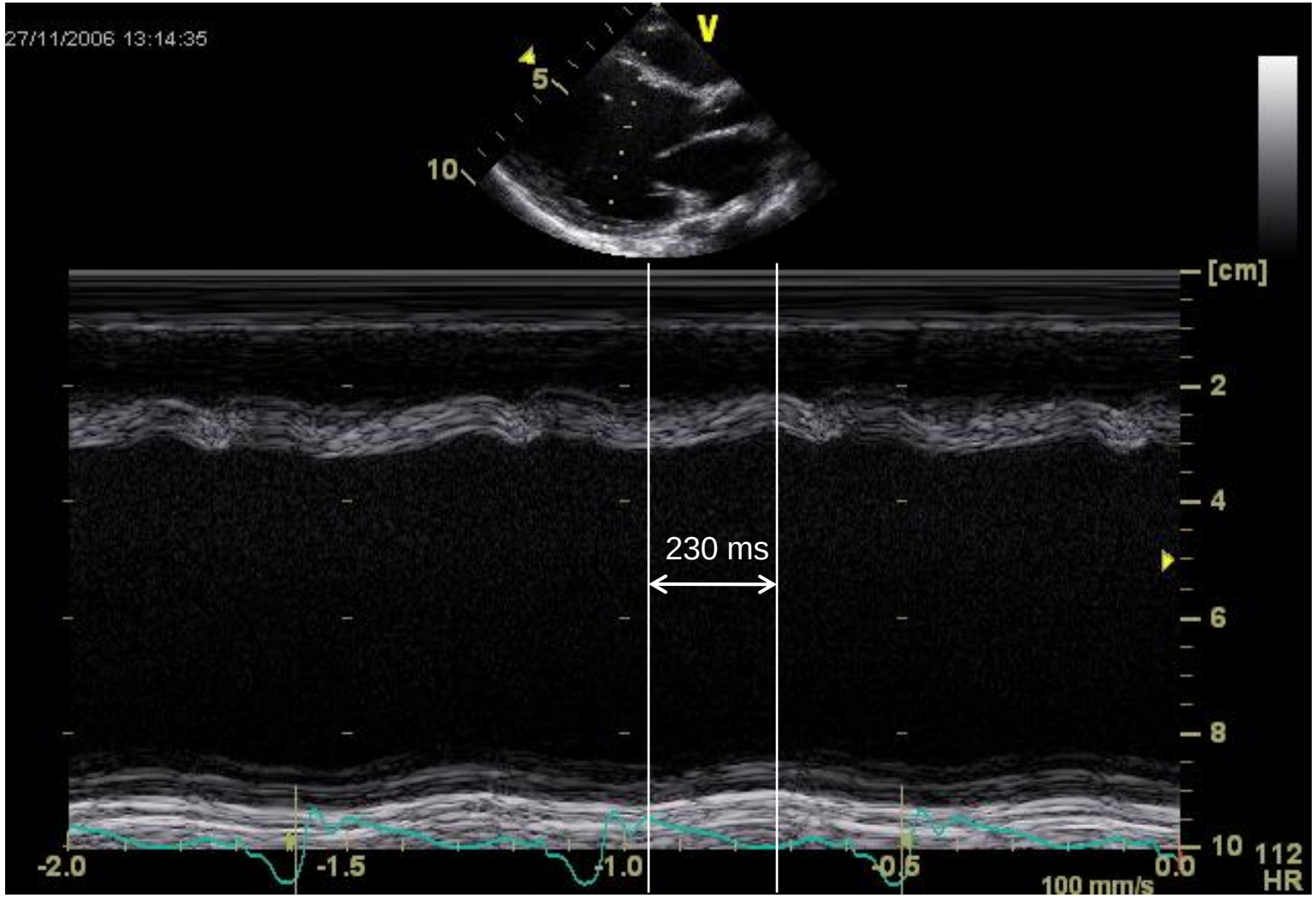
Conclusions

- CRT is a powerful tool for
  - Treatment of chronic dyssynchronous heart failure in CHD
- Basic principles similar to CRT in adults with idiopathic/ischemic heart disease
  - Structural heterogeneity and patient size requires specific approaches
- ECG and ECHO in conjunction are able to identify CRT correctable substrate
  - And individualize the implantation strategy
- Pulmonary RV resynchronization evolves to an additional option for treatment of chronic RV dysfunction

Thank you for your attention

Stay synchronized☺

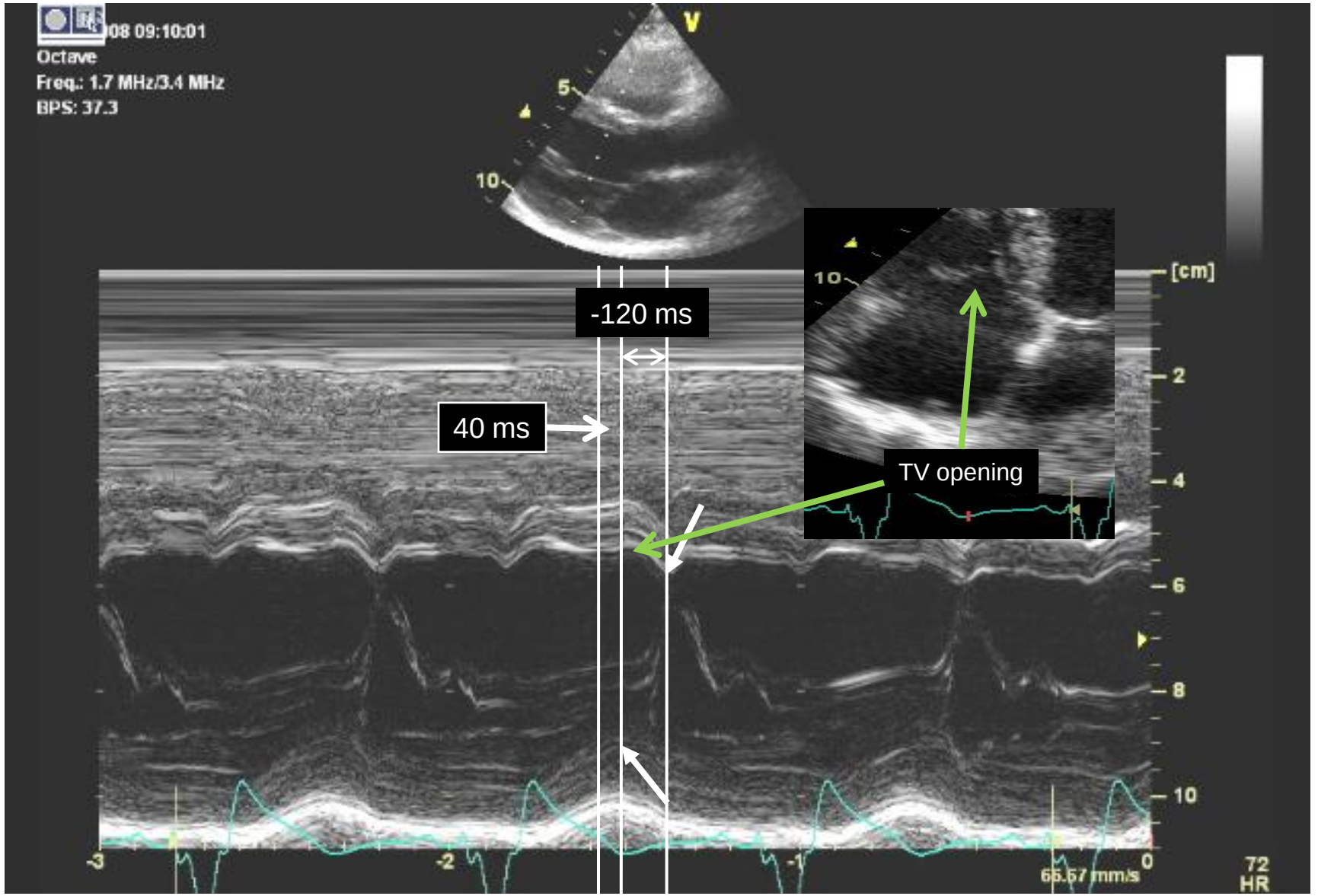
Septal to posterior wall motion delay (SPWMD)



SPWMD >130 ms

Pitzalis MV et al. JACC 2005

Be aware of pitfalls!



LV timing in a CRT candidate with LBBB