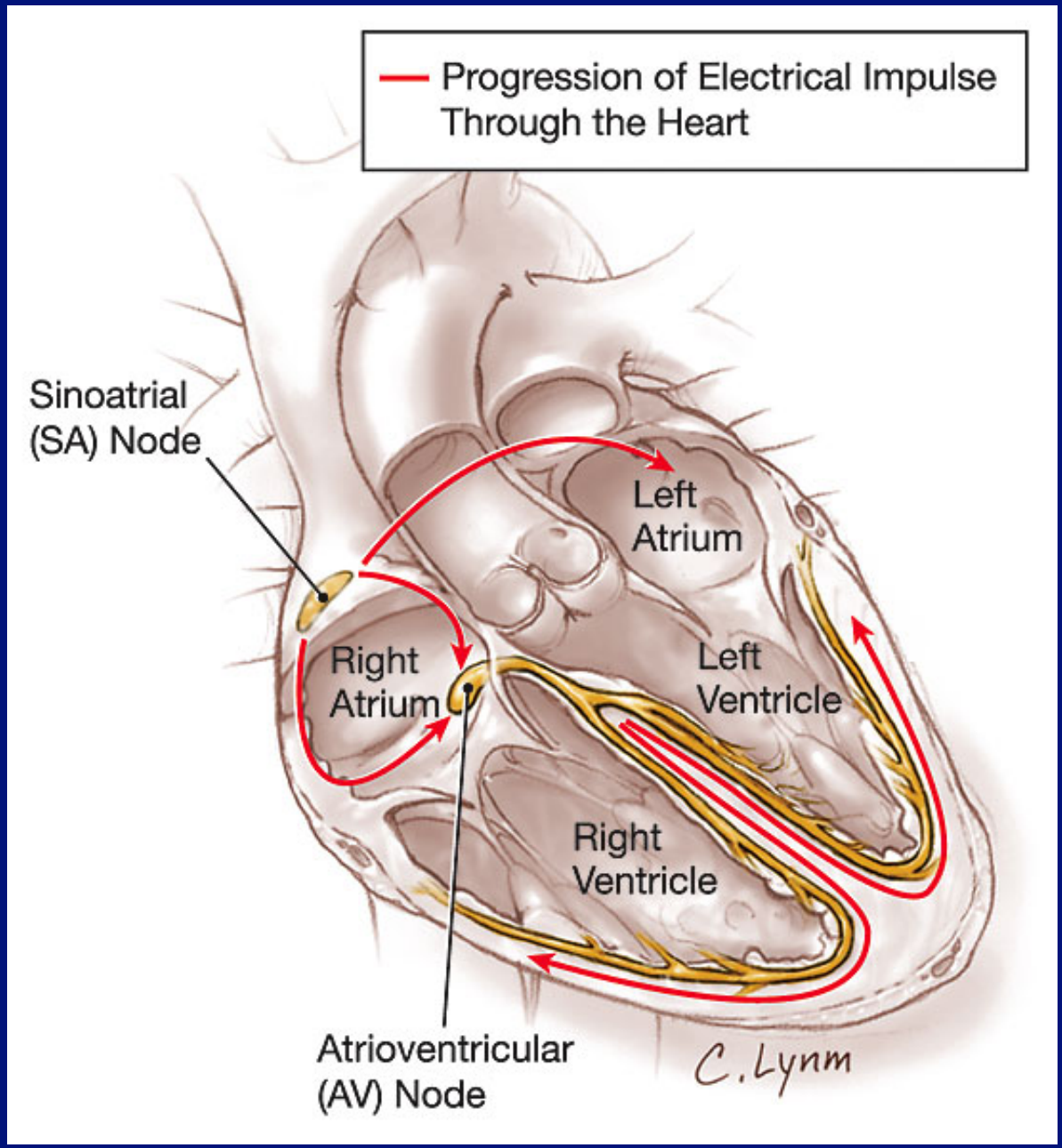

Pacing For
Congestive Heart Failure
William M Miles, MD, FHRS
Professor of Medicine
Silverstein Chair for Cardiovascular Education
University of Florida College of Medicine
UF | UNIVERSITY of FLORIDA
The Foundation for The Gator Nation

Disclosures

- Medtronic, Inc. (Clinical Events Committee, consultant)
- Biosense-Webster, Boston Scientific, Medtronic, St. Jude

  (UF EP Fellowship Support)



JAMA 2006;296:1314

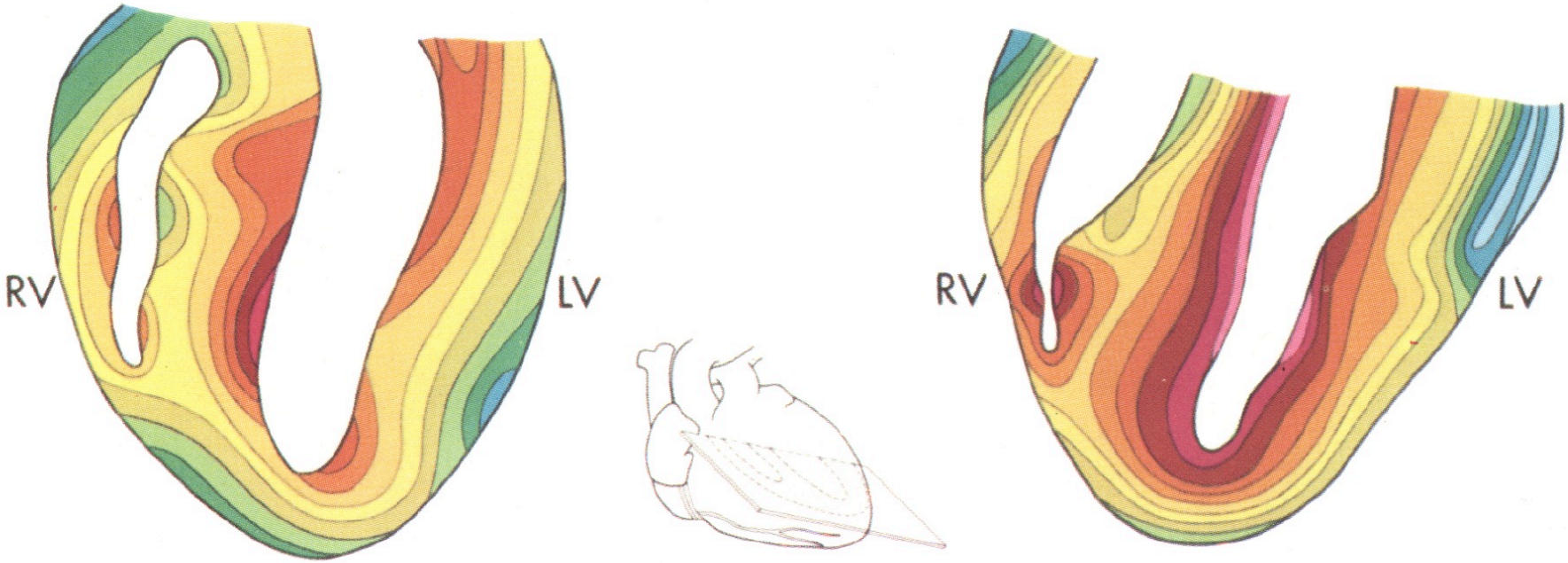
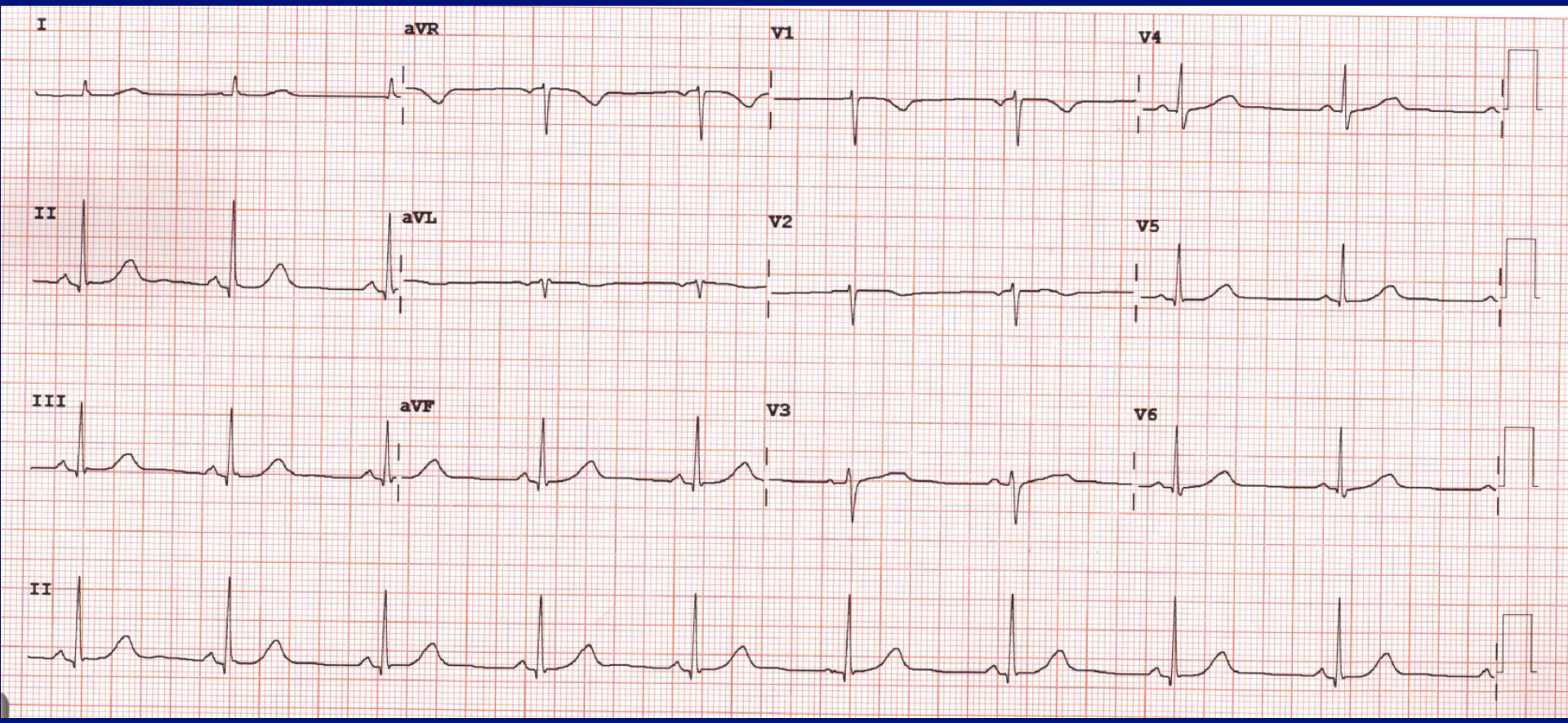


Figure 2

Nearly identical sections of two different human hearts. Inset shows how the sections were made. The color scheme of the isochronic areas is the same as in figure 1. RV = right ventricle; LV = left ventricle.

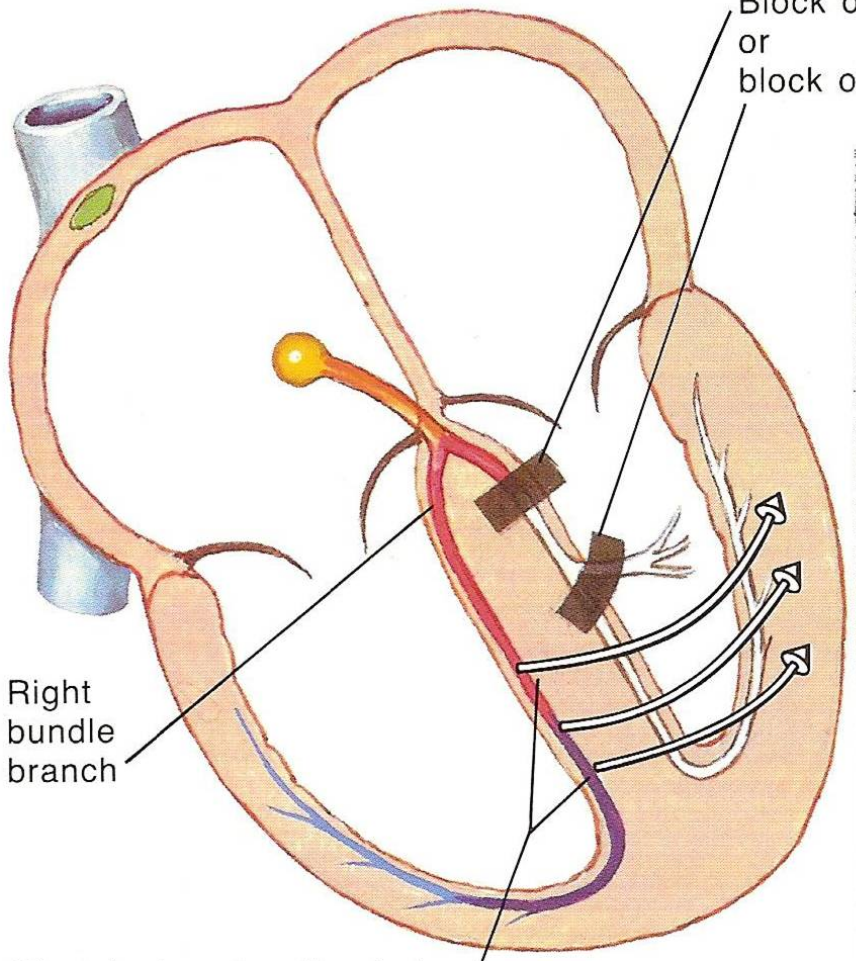
Durrer et al. Circulation Volume XLI, June 1970

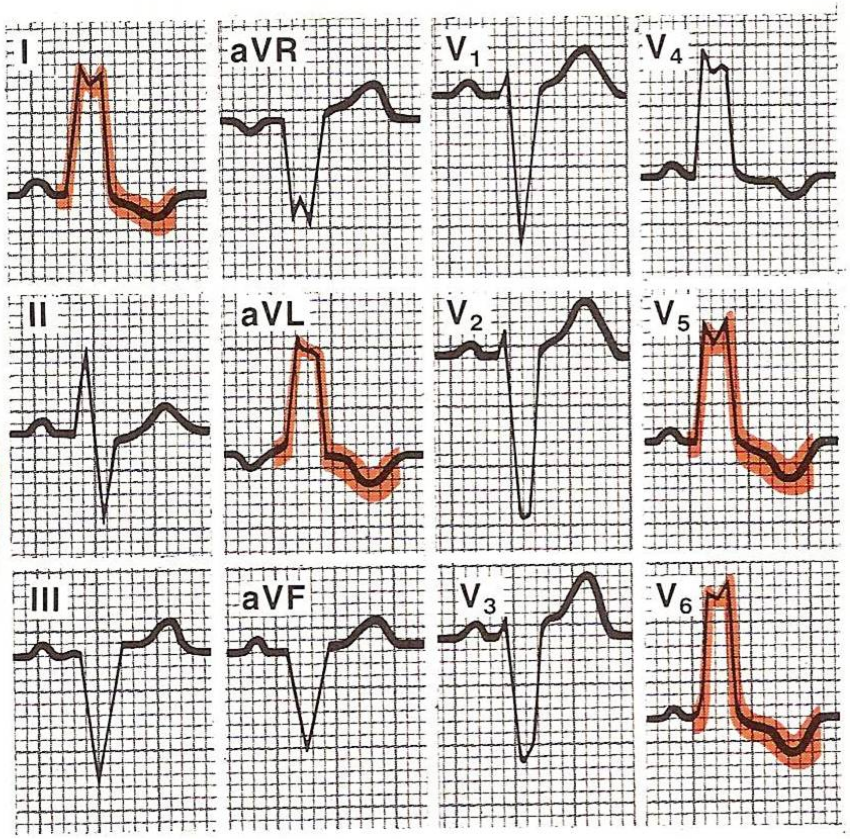
Normal ECG With Septal Q Waves



Left Bundle Branch Block

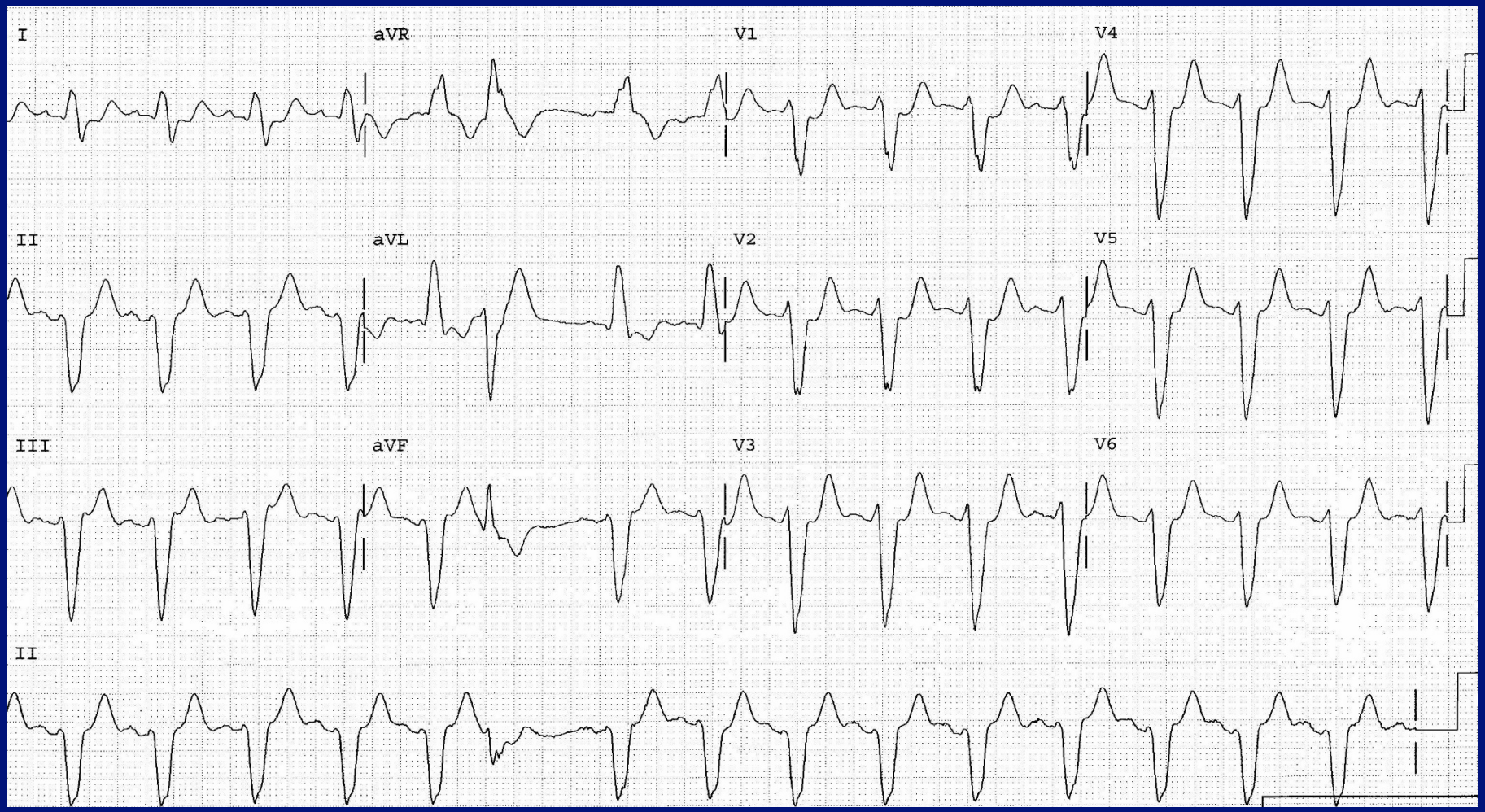
F. Netter M.D.





Wide QRS complex (≥0.12 second), with ST depressions and inverted T waves, particularly in leads I, aVL, V_5 and V_6

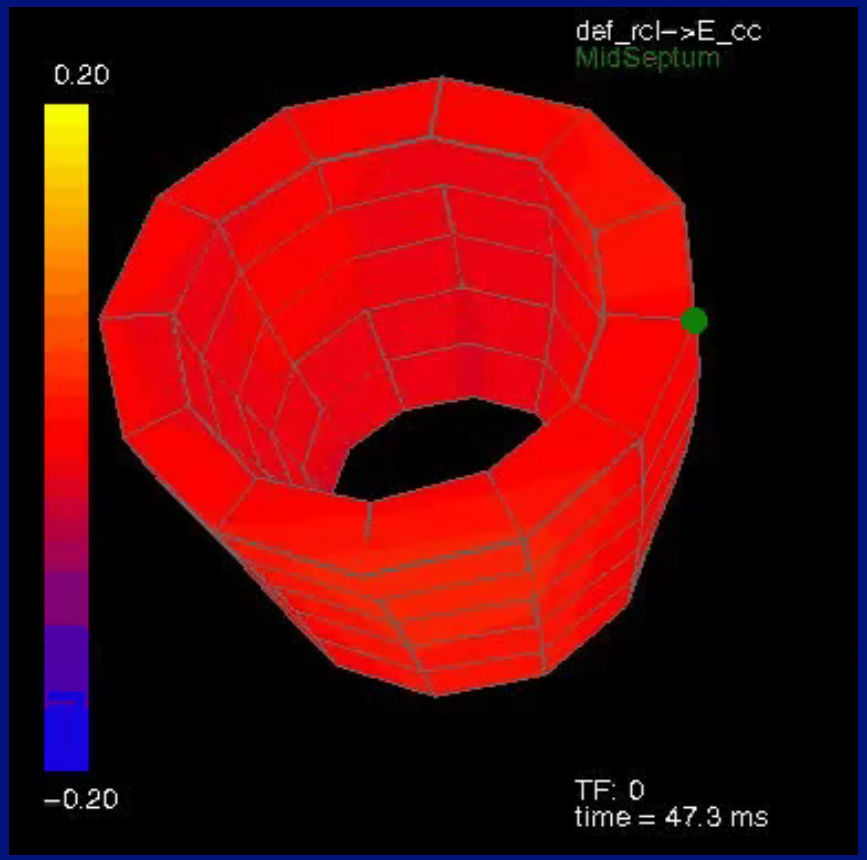
Left Bundle Branch Block



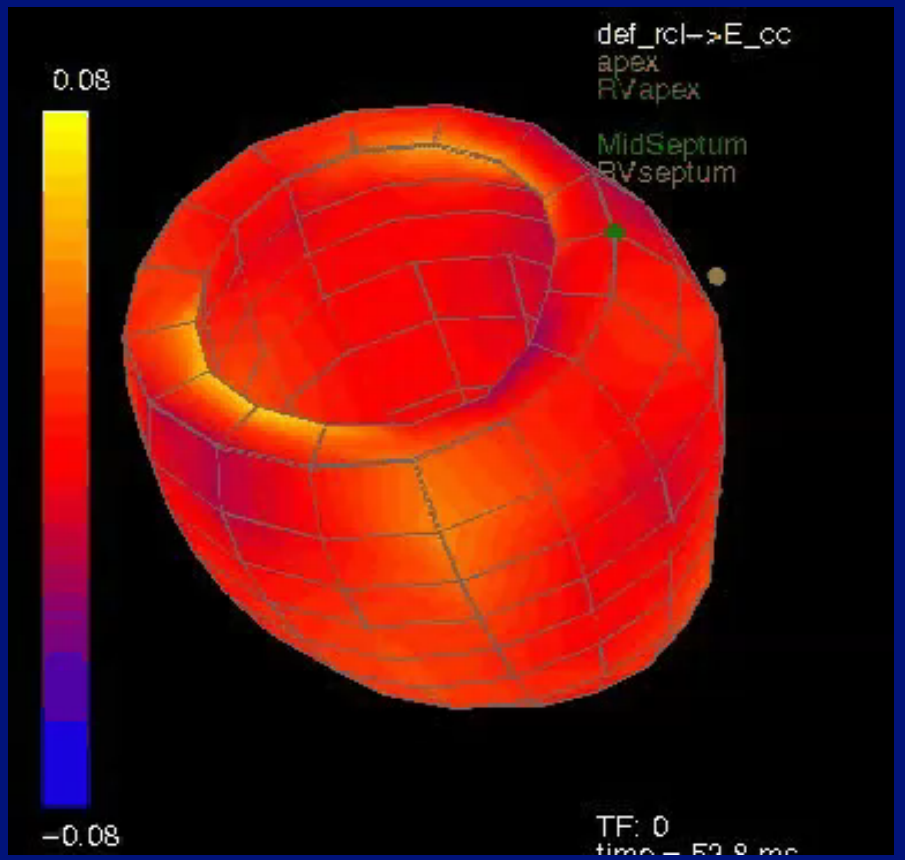
Ventricular Dysynchrony in CHF

- Abnormalities in electromechanical coupling due to BBB
- Mechanical dysynchrony leads to:
  - Impaired systolic function
  - Impaired diastolic function
- Increased mitral regurgitation

Mechanical Dyssynchrony in Dilated Cardiomyopathy With Intraventricular Conduction Delay as Depicted by 3D Tagged Magnetic Resonance Imaging



Normal



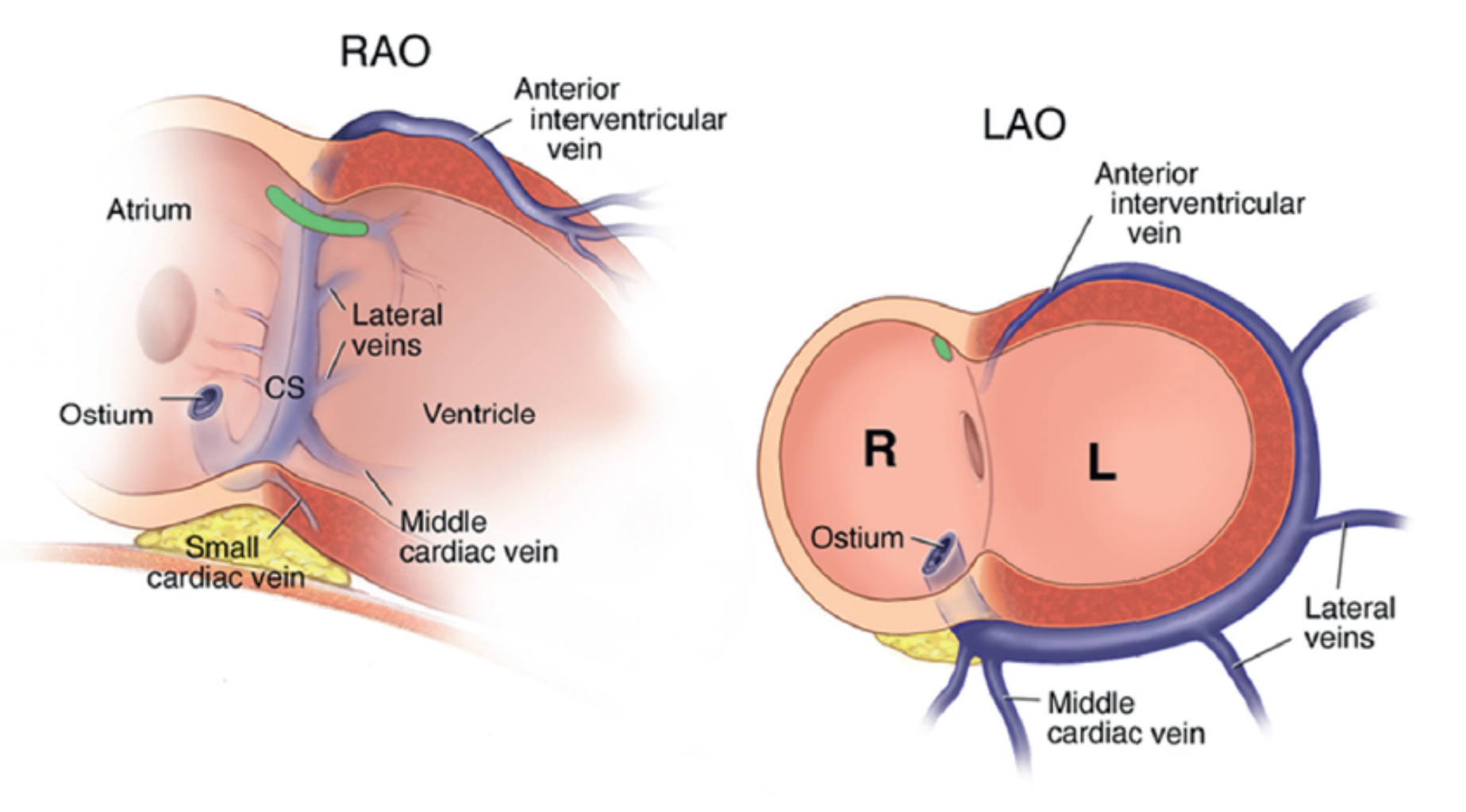
Severe CM and LBBB

Curry, Circulation 2000;101:e2

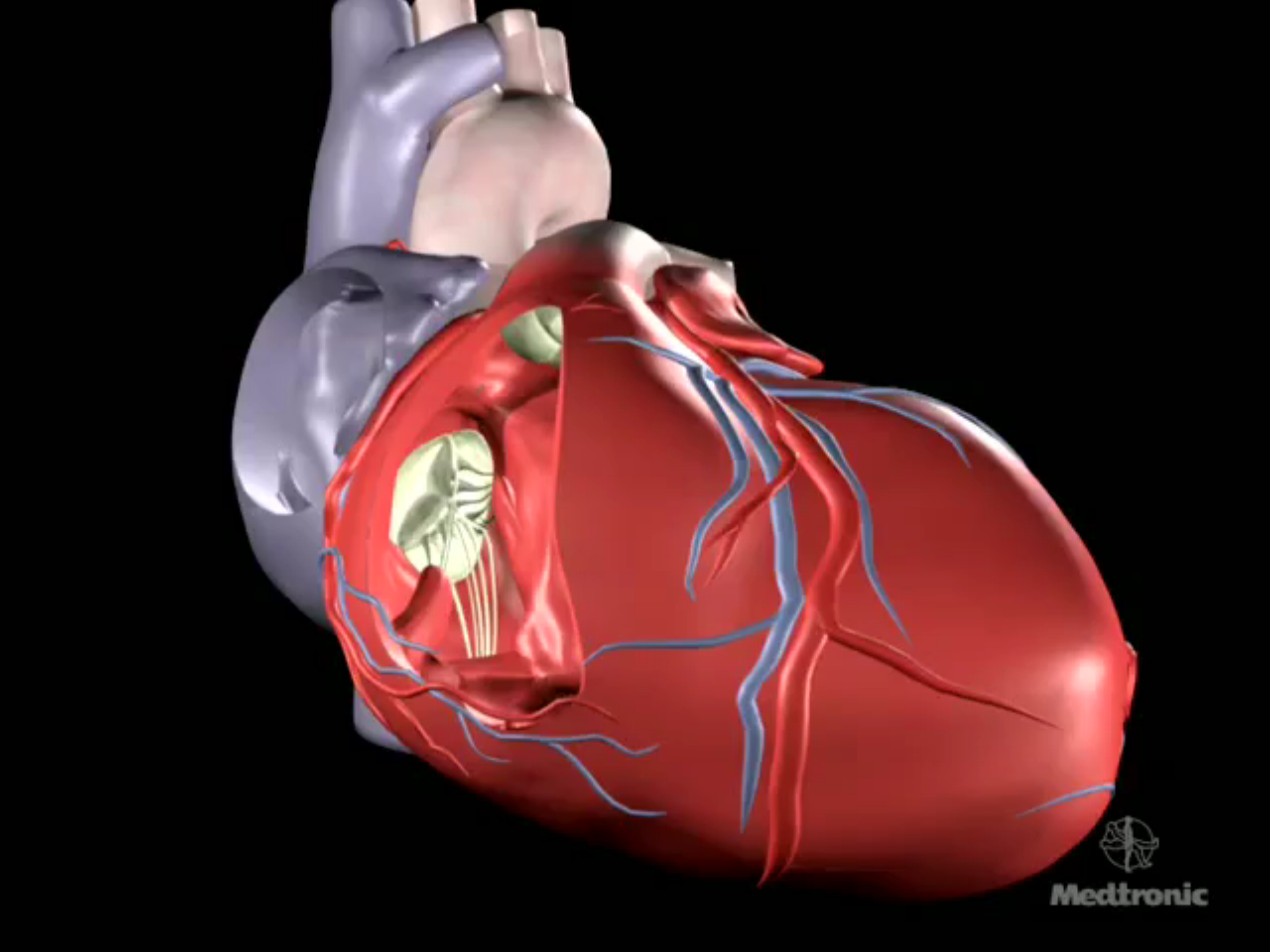
Biventricular Pacing for CHF

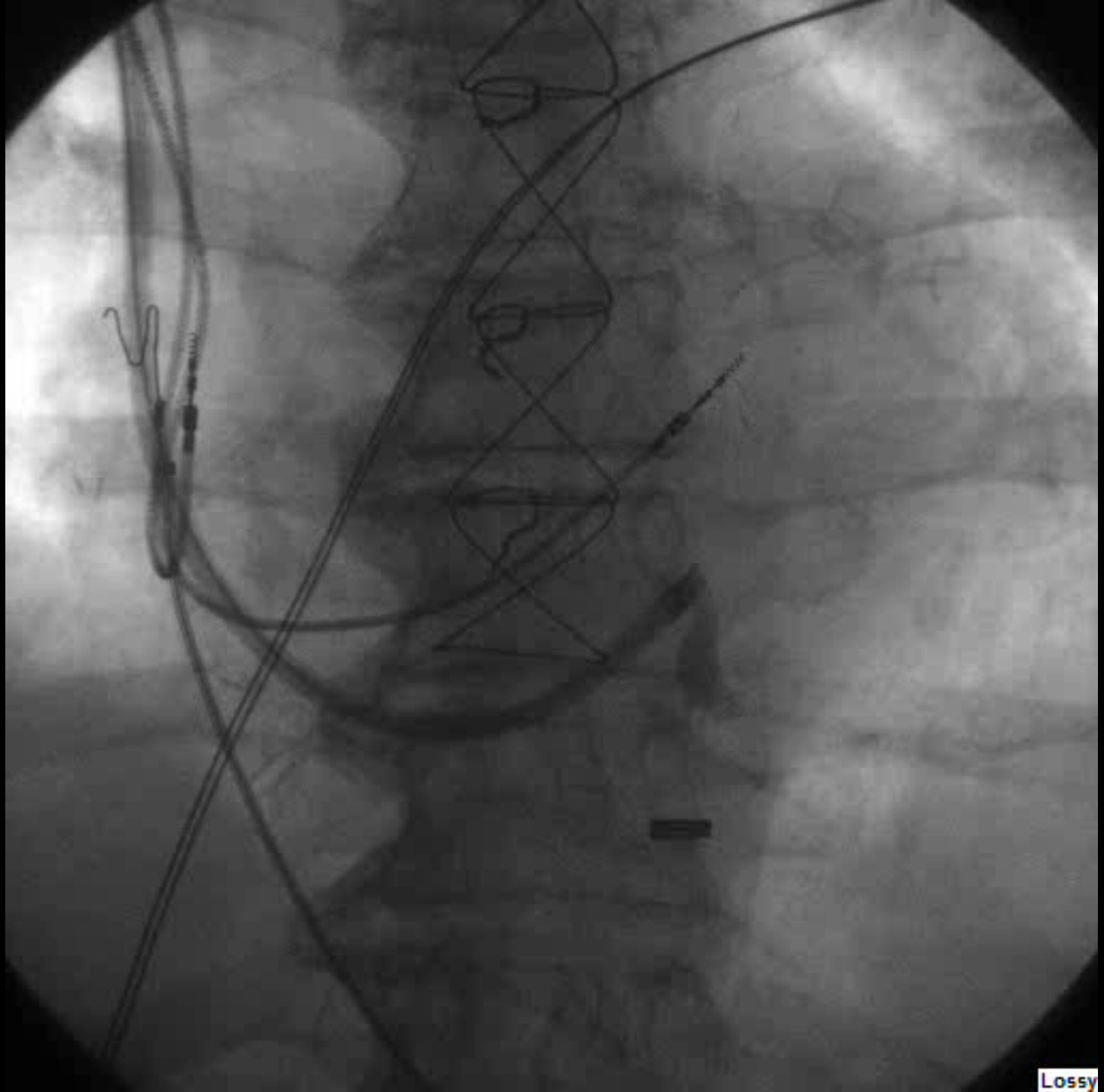
- 30-50% of patients with CHF have IVCDs
- IVCD leads to discoordinated contraction of an already hemodynamically compromised ventricle
- IVCD is an independent predictor of mortality
- Biventricular pacing can provide a more coordinated pattern of ventricular contraction, reduce the QRS duration, and reduce intraventricular and interventricular asynchrony

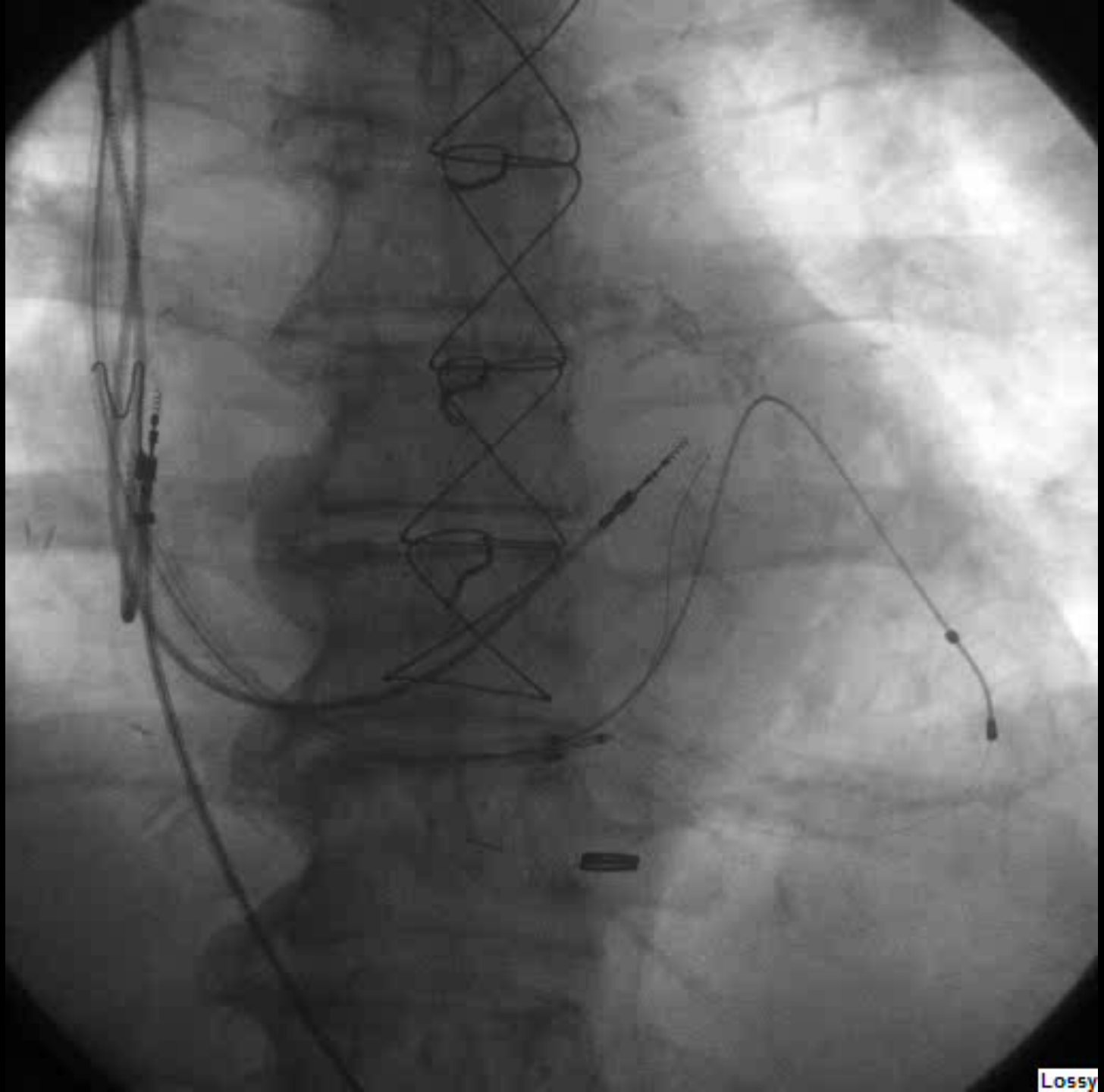
Coronary Sinus Anatomy

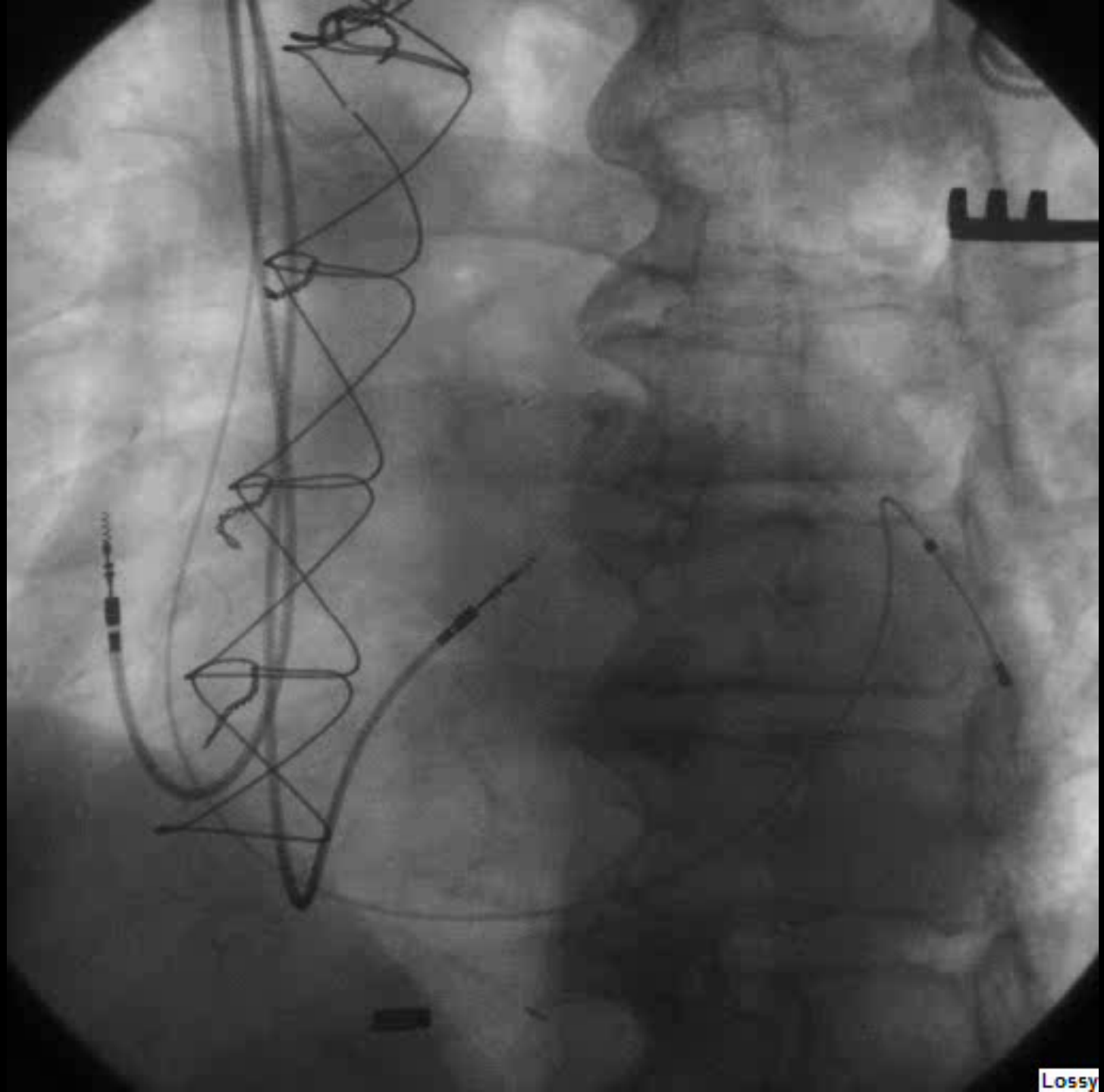


Madhavan et al. J Am Coll Cardiol 2017;69:211–35

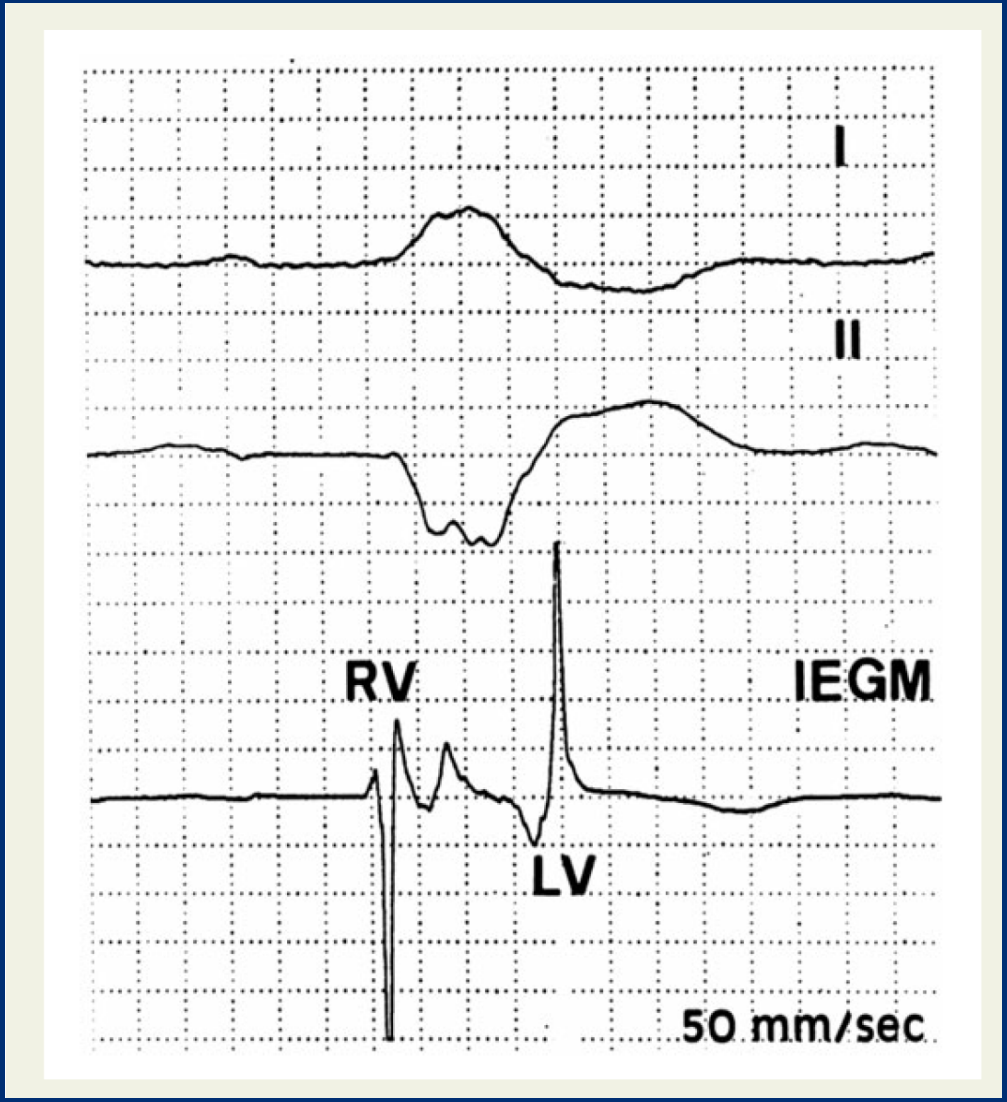

Medtronic


Lossy


Lossy

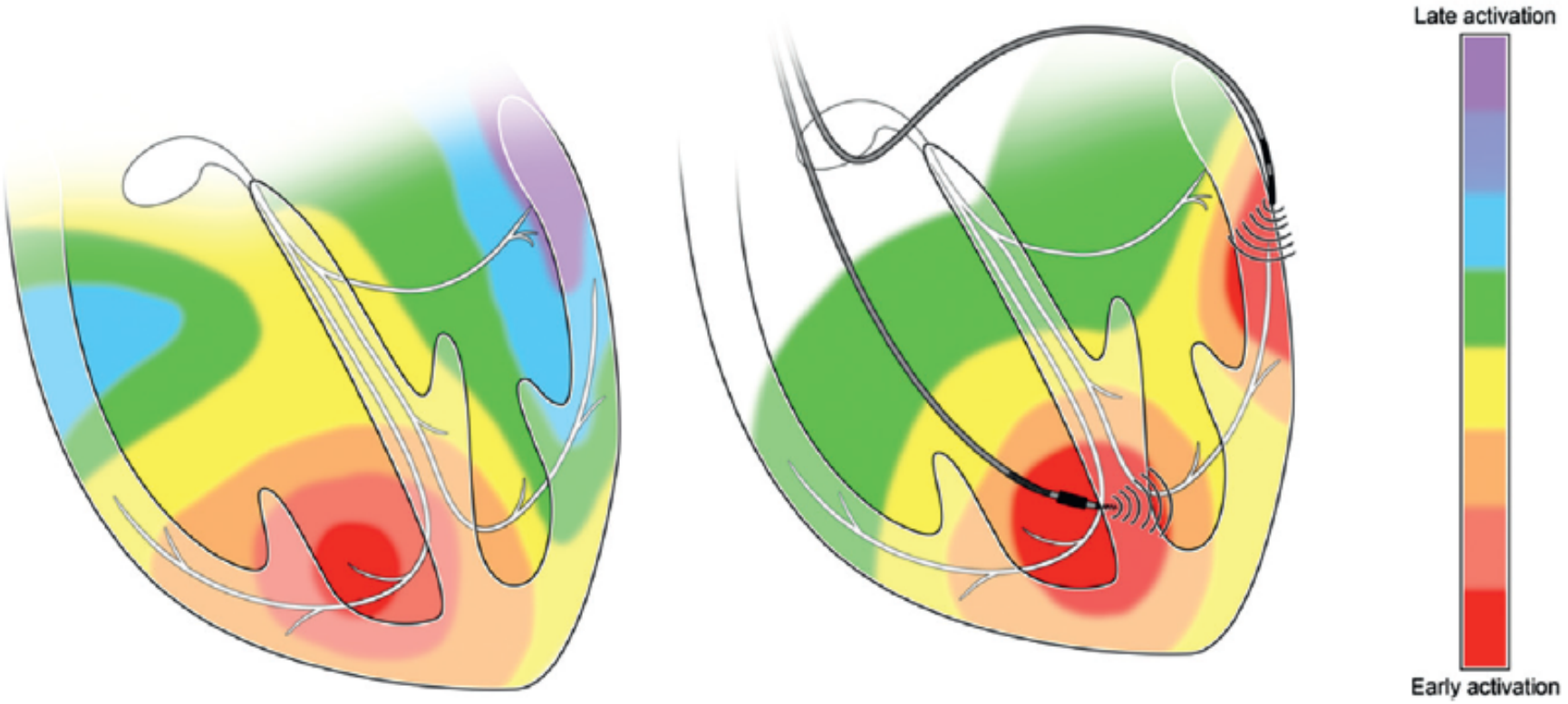

Lossy

Identification of Latest Activation Site During Spontaneous Conduction



Daubert et al. European Heart J 2016 doi:10.1093/eurheartj/ehw270

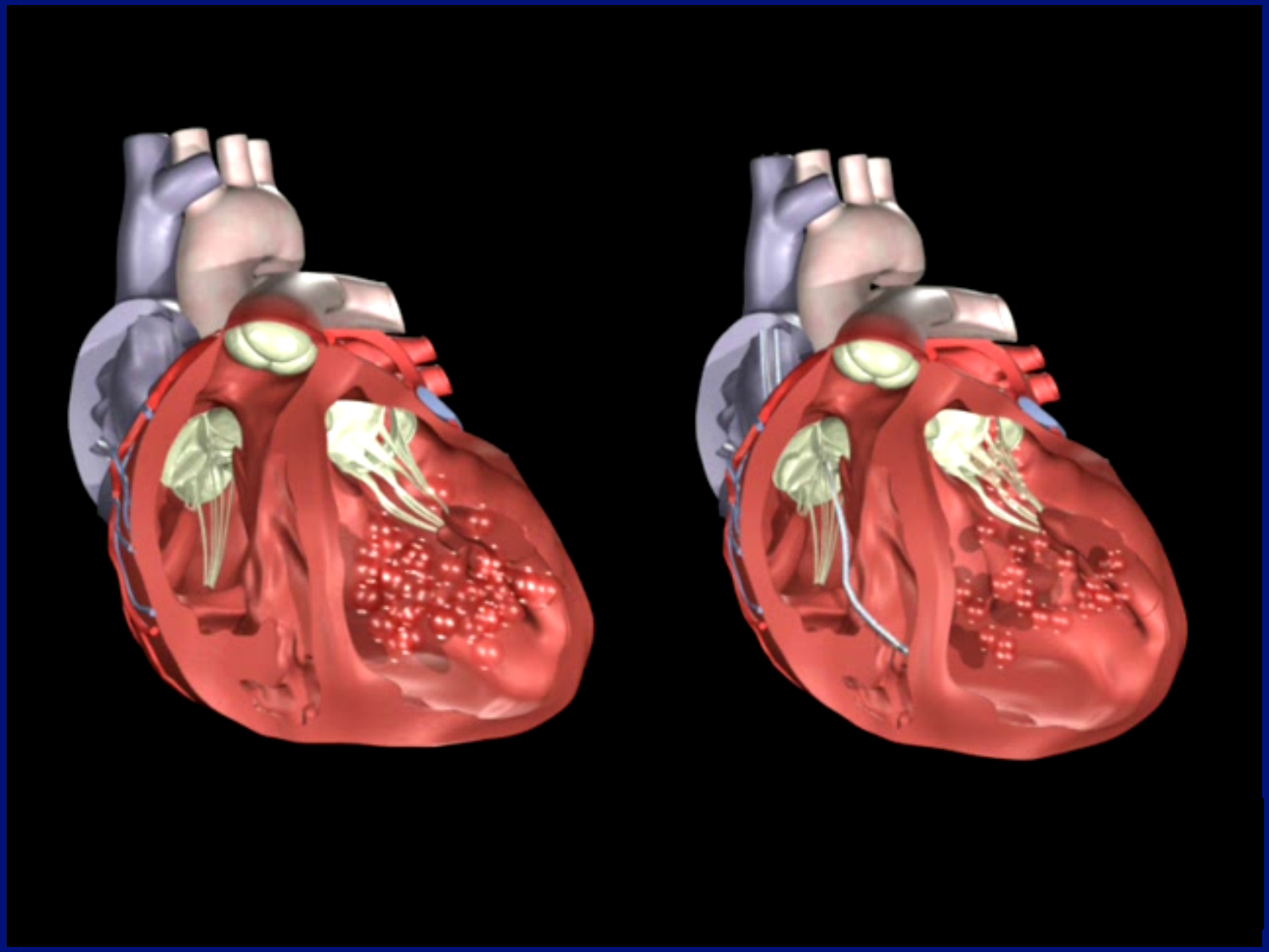
CRT for the Treatment of Heart Failure



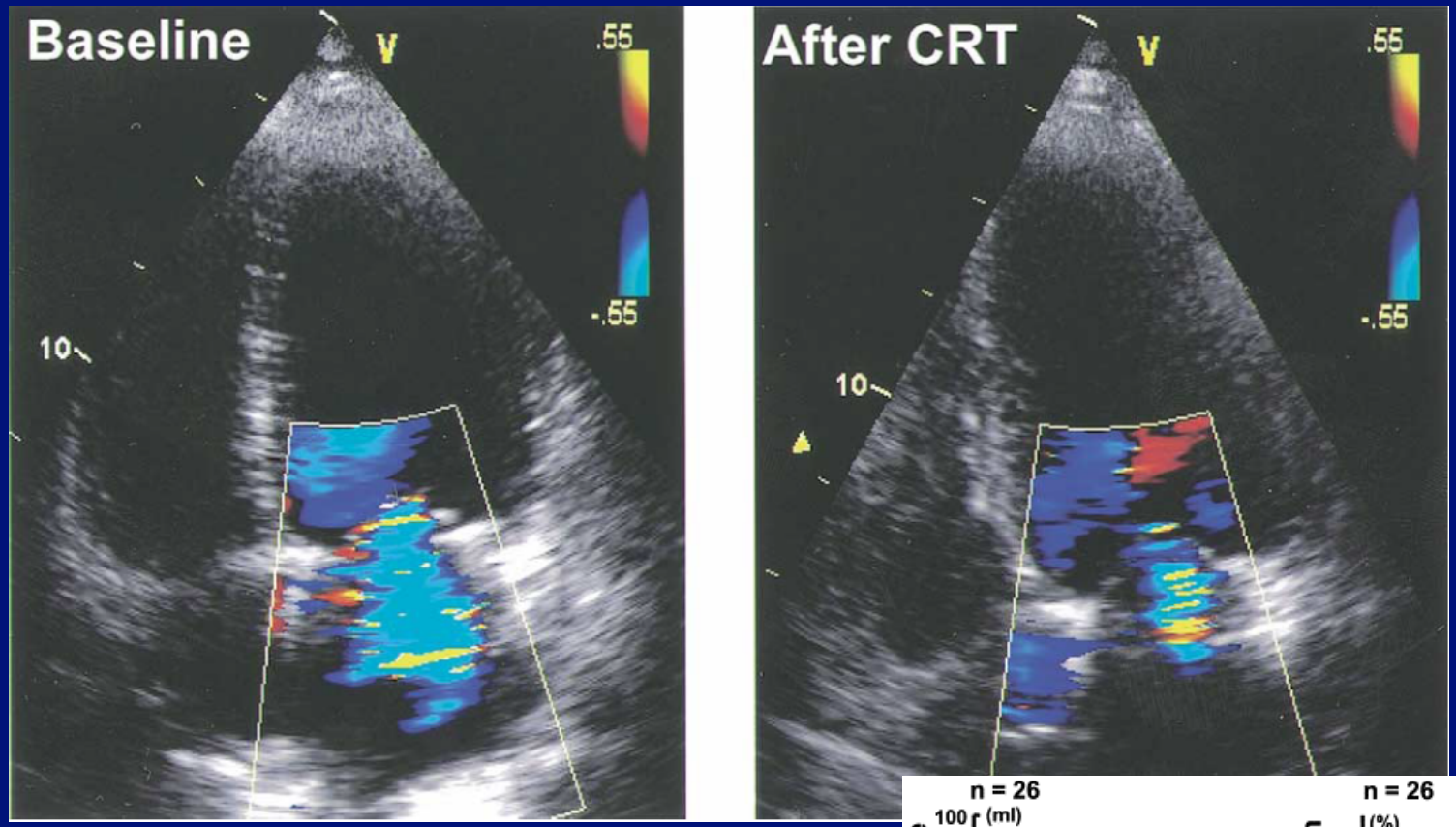
Madhavan et al. J Am Coll Cardiol 2017;69:211–35

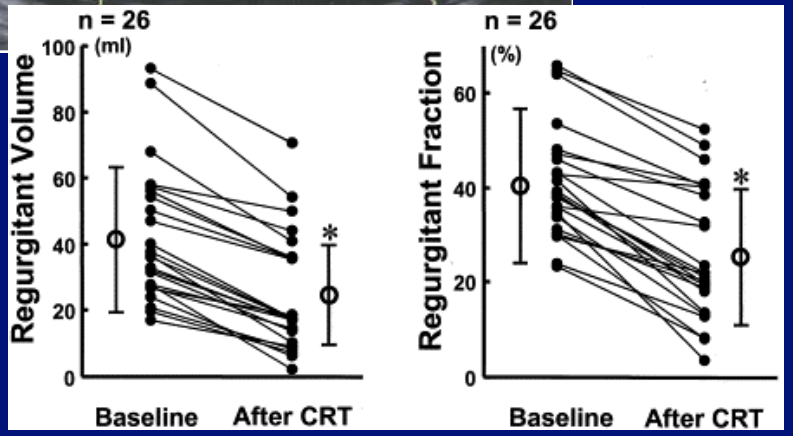
LBBB

BiV Pacing



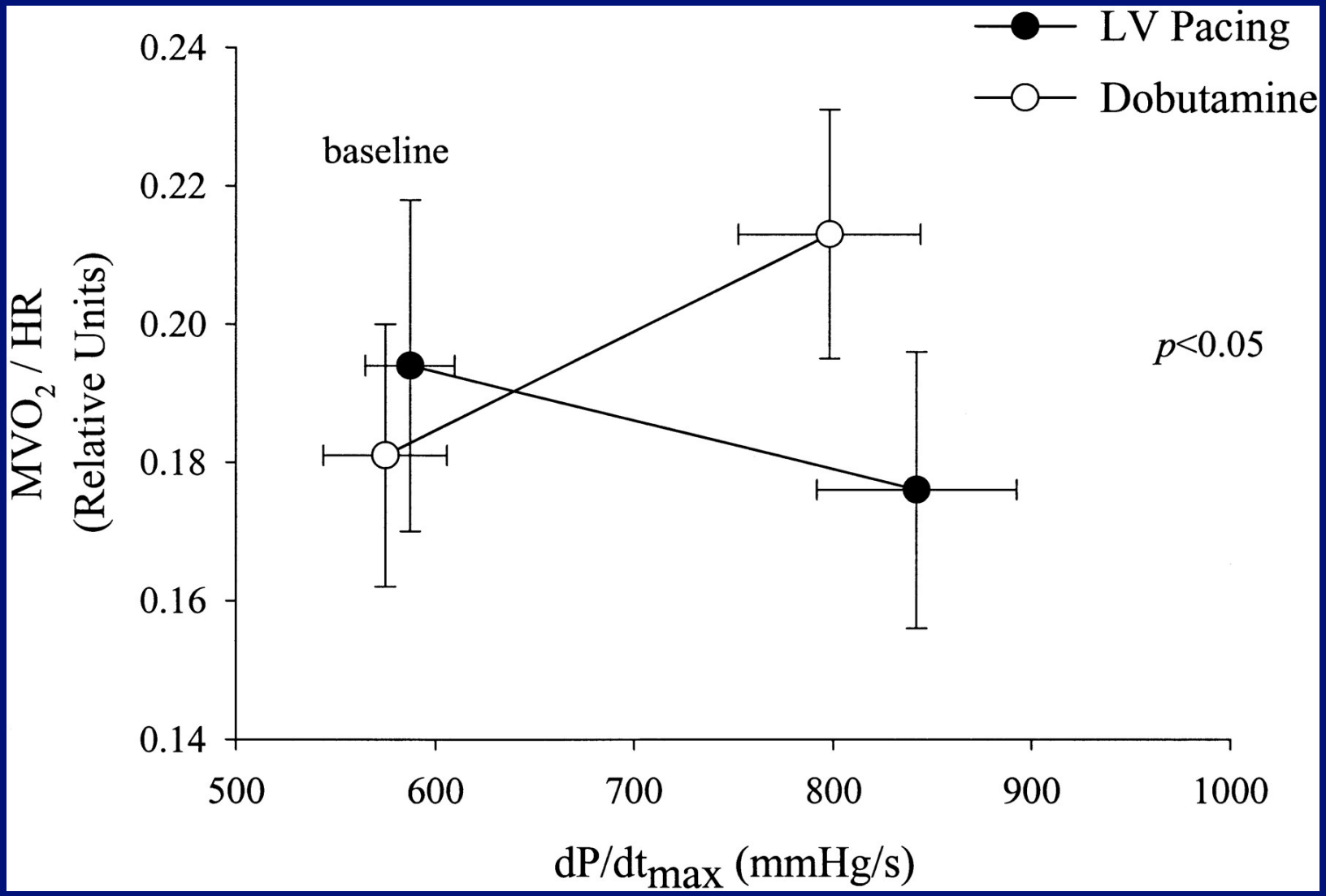
Reduction in MR After CRT





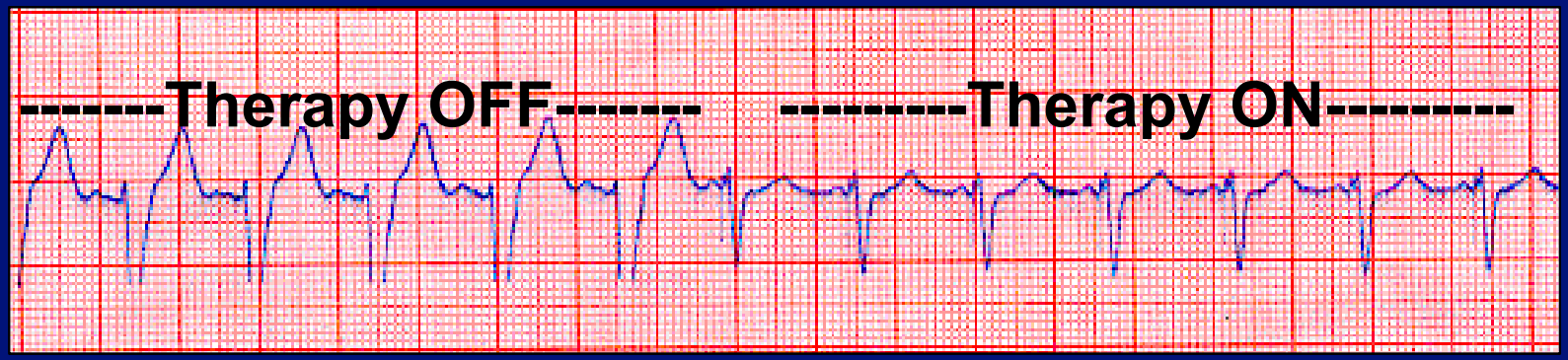
Kanzaki et al. JACC 2004;44:1619

Comparison of Mechanoenergetic Responses to LVFW Pacing vs. IV Dobutamine



Nelson, Circulation 2000;102:3053

QRS Width Reduction ECG



Lead V3

QRS=160 ms

QRS=120 ms

Ventricular Dysynchrony in CHF

Electrical and mechanical dysynchrony are not synonymous

- Pts with a wide QRS have a high incidence of mechanical dysynchrony
- However, correction of the mechanical dysynchrony does not always result in a narrow QRS
  - e.g., LV pacing alone may provide excellent mechanical resynchronization but the QRS remains wide

Randomized Clinical Trials of CRT in CHF

Table 10 Inclusion criteria, design, endpoints, and main findings of the randomized clinical trials evaluating cardiac resynchronization therapy in heart failure patients and sinus rhythm

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_2 LV 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
MIRACLE-ICD II[60]	186	Double-blinded, randomized CRT-D vs. ICD, 6 months	II	≤35%	≥130	Peak VO_2	VE/VCO_2, NYHA, QoL, 6MWD, LV volumes and EF, composite clinical endpoint	CRT-D improved NYHA, VE/CO_2 and reduced LV volumes and improved LVEF
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
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

2013 ESC guidelines on cardiac pacing and cardiac resynchronization therapy.
European Heart Journal (2013) 34, 2281–2329

CRT Indications

EF ≤ 50%
(BLOCK-HF, PACE)

Original indications:
Sinus, EF ≤ 35%
Class 3-4
QRS > 120
(MIRACLE, COMPANION, CARE-HF, others)

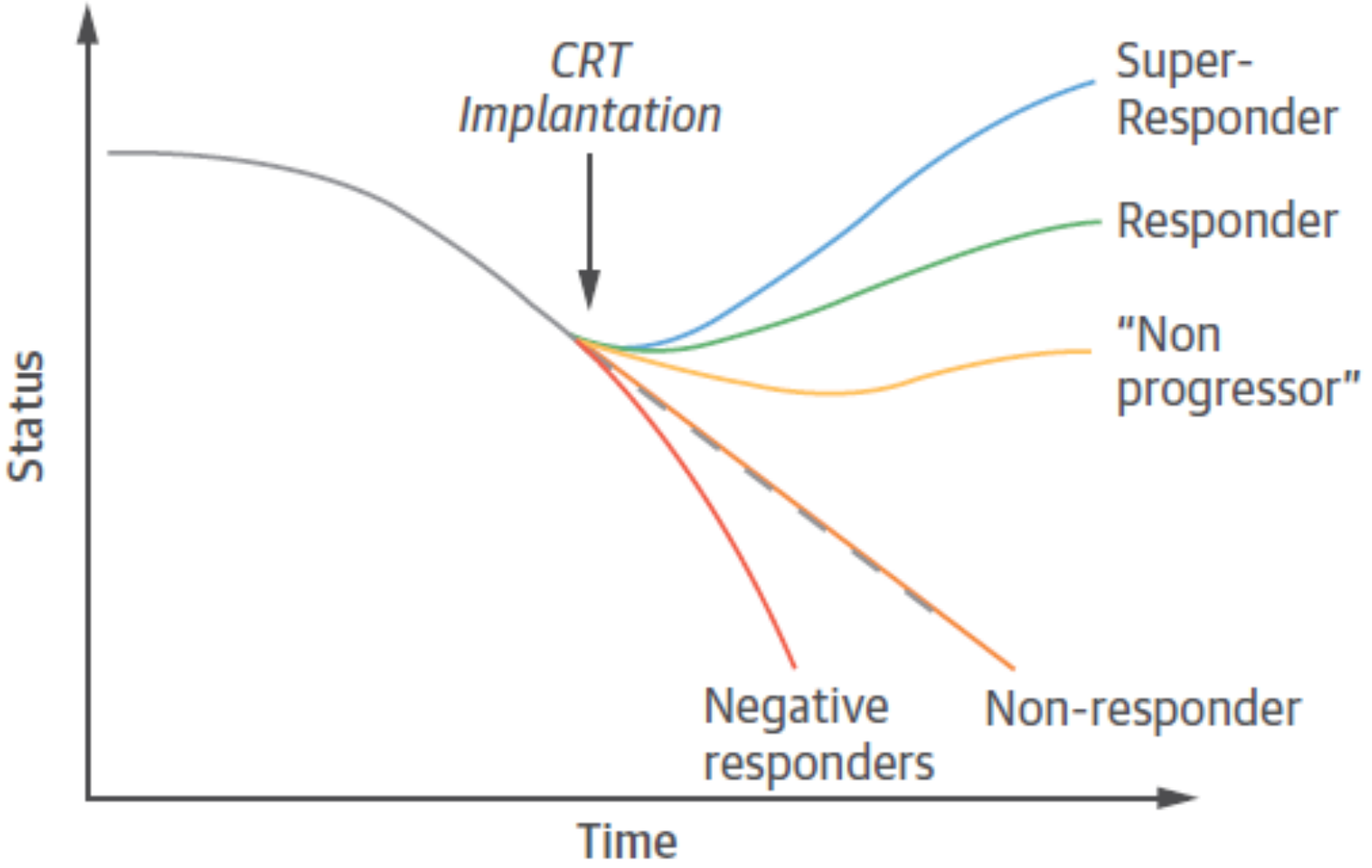
Class 1-2
(CONTAK-CD, MIRACLE ICD-II, REVERSE, MADIT-CRT, RAFT)

Narrow QRS
(RethinQ, EchoCRT, NARROW-CRT)

- Contraindications to CRT:
  - QRS duration < 120
  - EF > 50%
  - NYHA Class I with non-ischemic cardiomyopathy
  - NYHA Class IV non-ambulatory

Adapted from Saba, AHA 2016

What defines a responder vs. "non-responder"?



Madhavan et al. J Am Coll Cardiol 2017;69:211–35