

**March 2-3**

**9<sup>th</sup> Congress Edition**  
Novotel PARIS Tour Eiffel



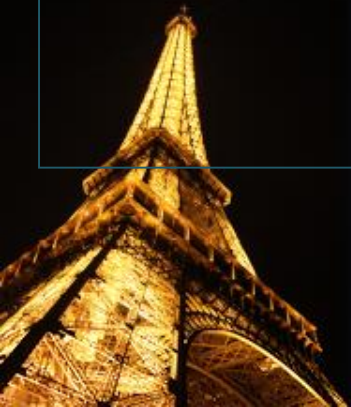
# Multisite Left Ventricular Pacing for Cardiac Resynchronization

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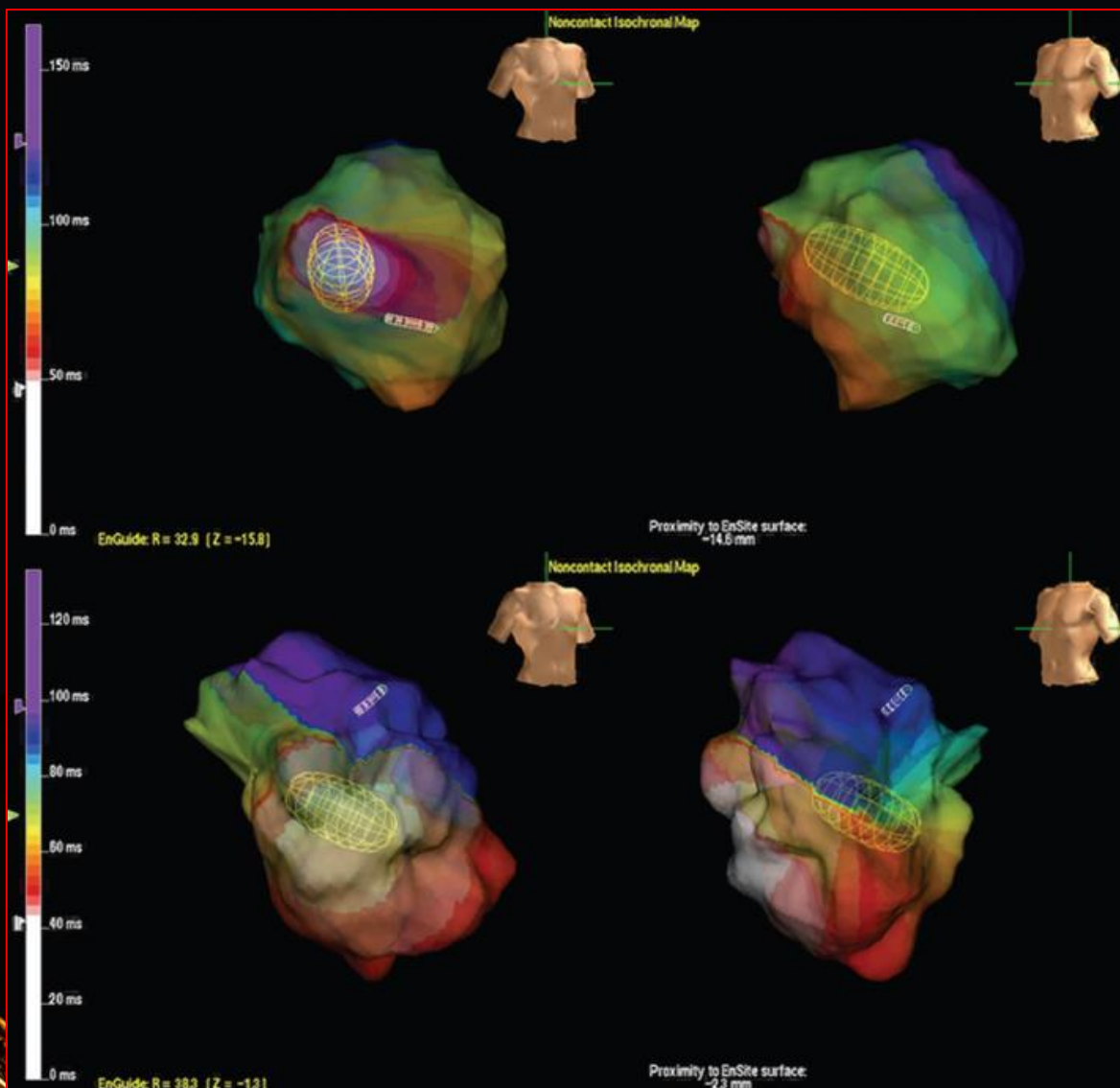
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## Potential conflicts of interest

<b>Consulting</b>	Biotronik, Boston-Scientific, LivaNova, Medtronic, St. Jude Medical/Abbott
<b>Employment in industry</b>	None
<b>Shareholder in a healthcare company</b>	None
<b>Owner of a healthcare company</b>	None
<b>Honoraria/speaker's bureau</b>	Biotronik, Boston-Scientific, LivaNova Medtronic, St. Jude Medical/Abbott
<b>Travel/congress reimbursement</b>	Biotronik, Boston-Scientific, LivaNova, Medtronic, St. Jude Medical/Abbott
<b>Participation in sponsored trials</b>	Biotronik, Boston-Scientific, LivaNova, Medtronic, St. Jude Medical/Abbott



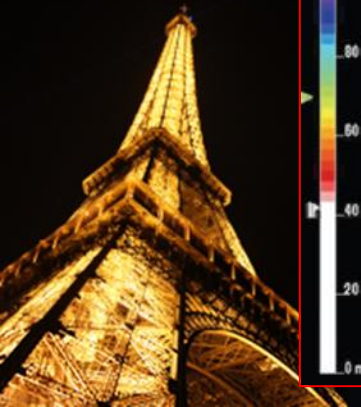
# Left Ventricular Activation



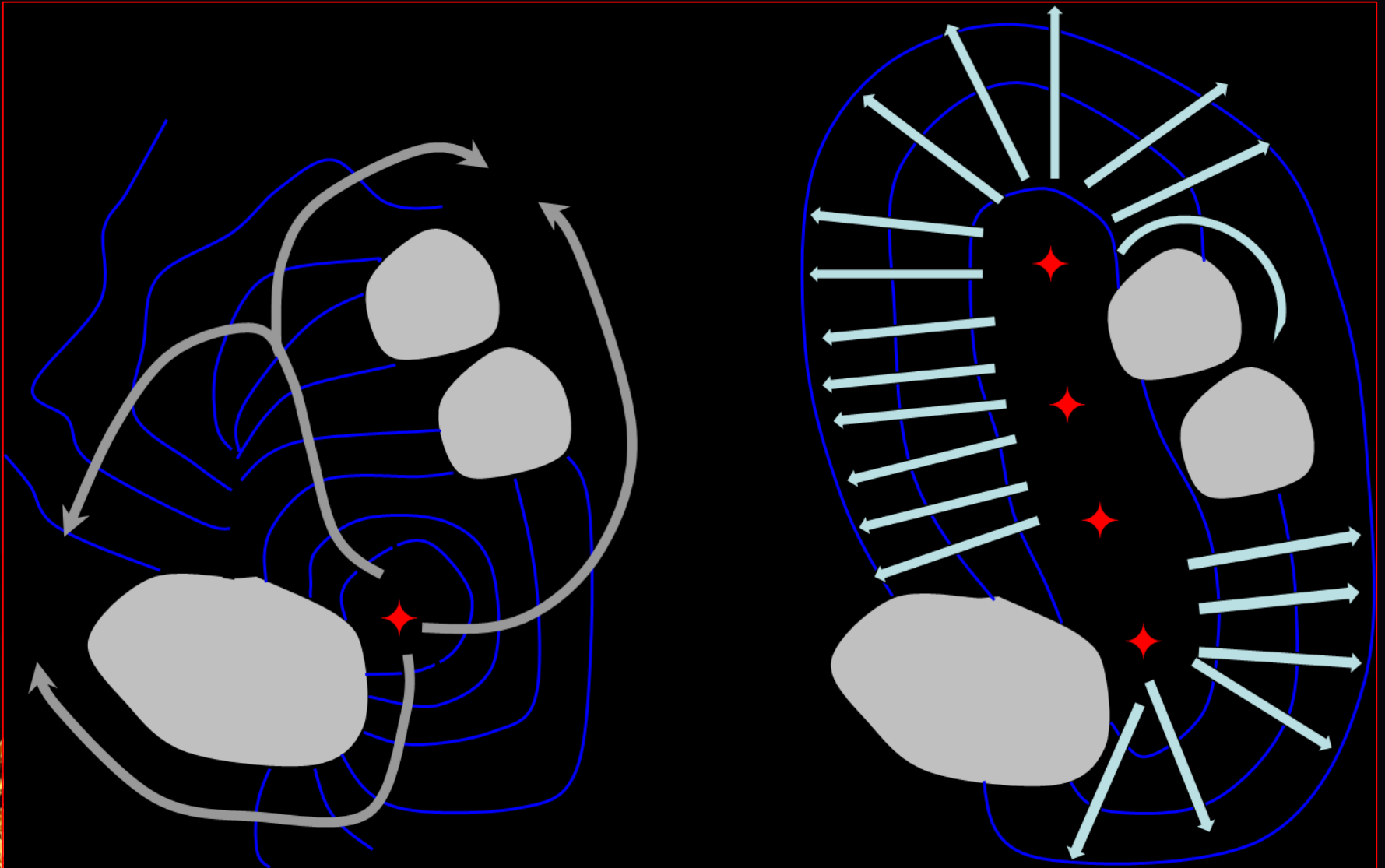
Homogeneous  
 septal-to-lateral  
 activation

Block with dis-  
 persed septal-to-  
 lateral activation

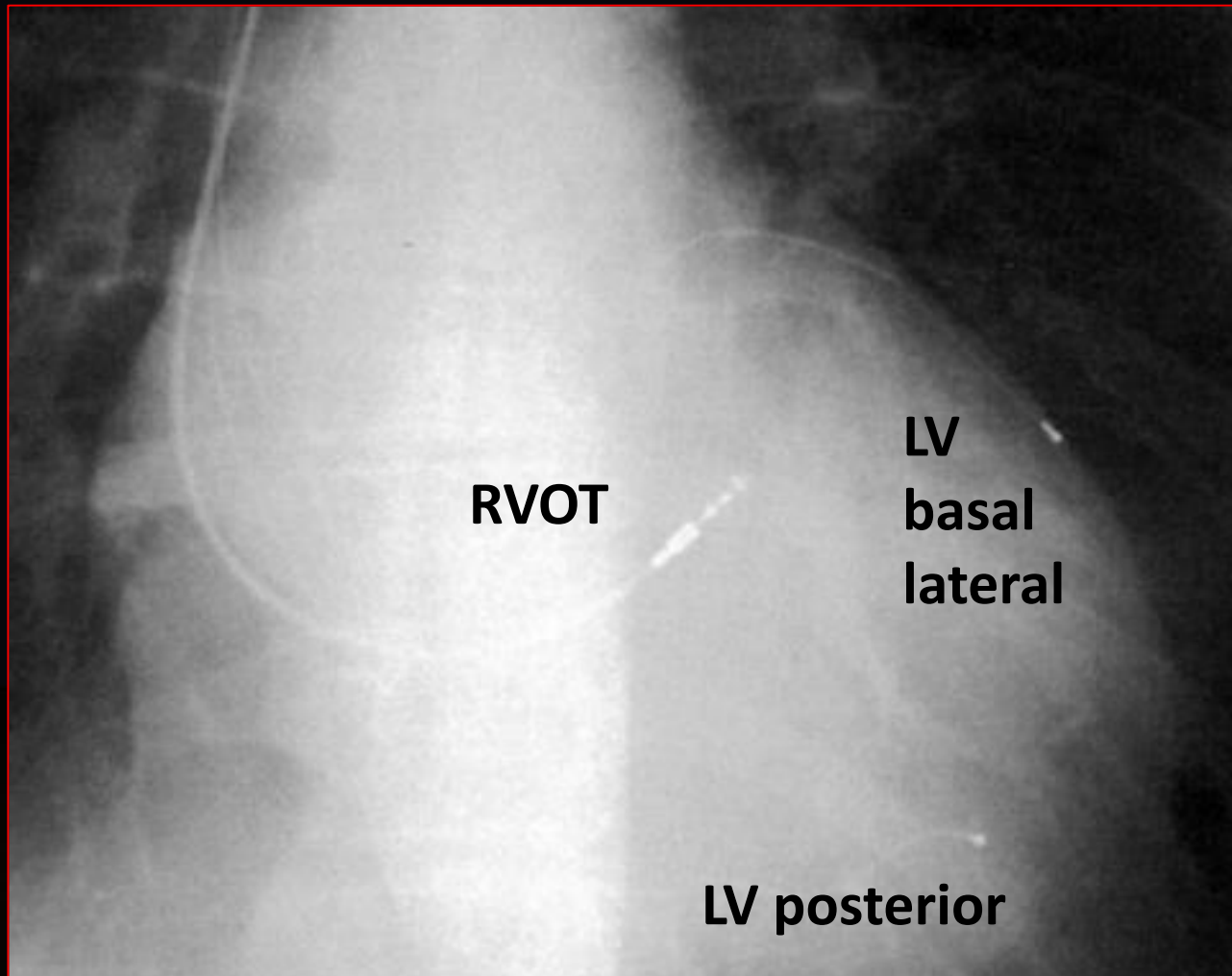
Ginks, Circ Arrhythm  
 Electrophysiol 2012;  
 5:889-897



# Multipoint Pacing and Scars



# CRT with 2 LV Leads (Triple-Site Pacing)

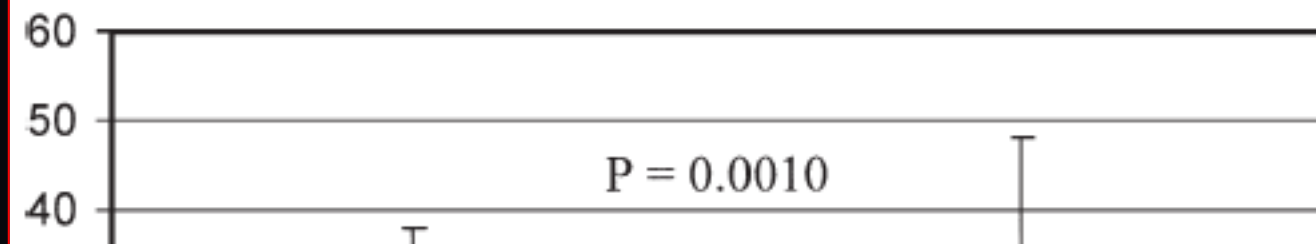




# TRIP-HF Study

LVESV (ml)

LVEF (%)



Variable	2-V	3-V	p Value
<b>Left ventricular</b>			
End-diastolic volume, cm <sup>3</sup>	213.2 ± 83.6	198.5 ± 95.7	0.2639
End-systolic volume, cm <sup>3</sup>	157.4 ± 69.0	134.4 ± 75.2	0.0191
Ejection fraction, %	27 ± 11	35 ± 13	0.0010
End-diastolic diameter, mm	66.4 ± 8.2	65.1 ± 8.5	0.1773
End-systolic diameter, mm	57.0 ± 11.9	53.9 ± 10.2	0.0242
Aortic velocity time integral, cm	16.0 ± 7.3	15.1 ± 6.0	0.9527
Fractional shortening, %	16 ± 11	18 ± 9	0.0196

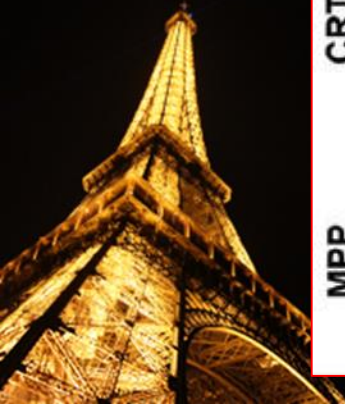
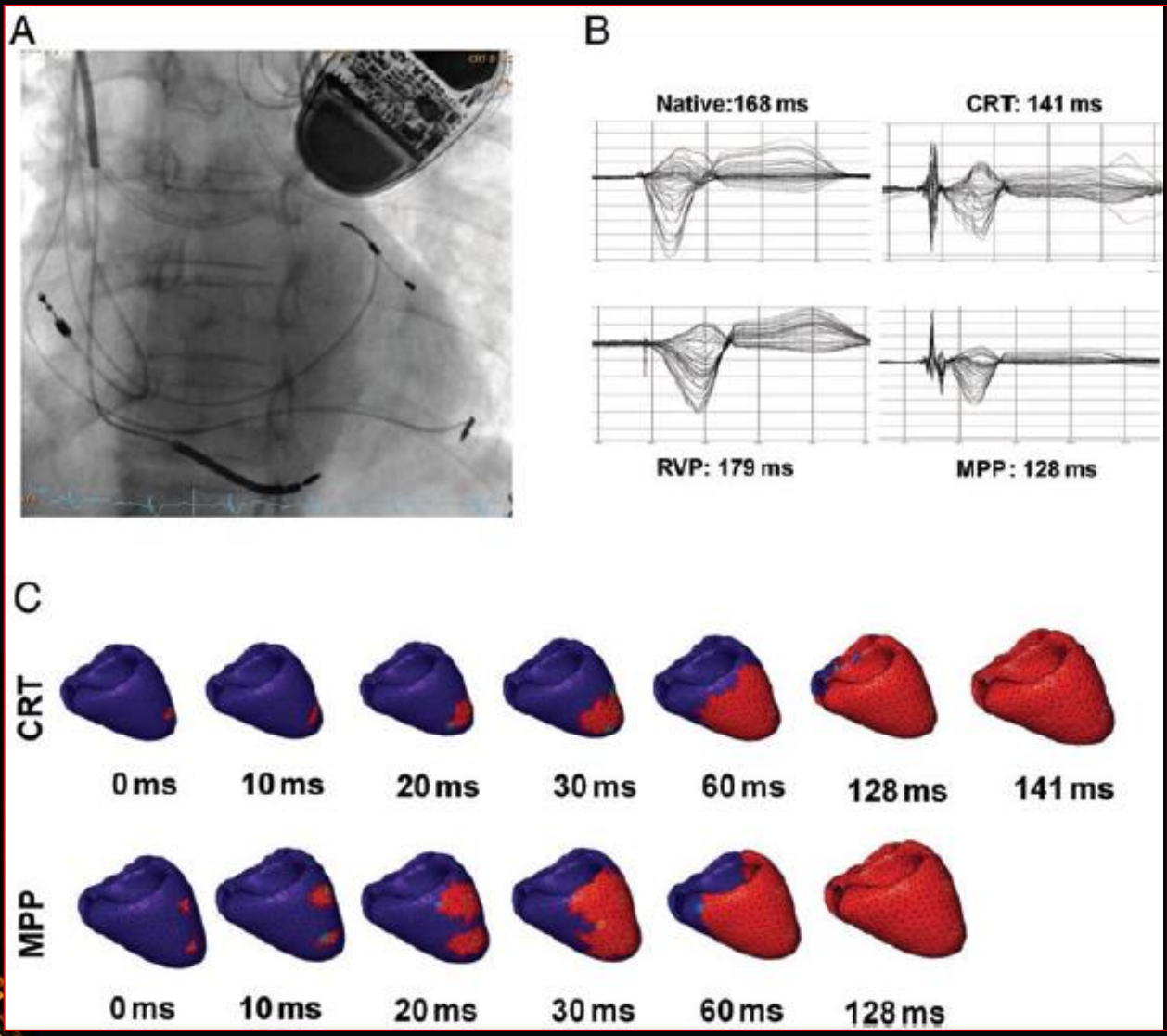
# RCTs with Triple-Site Pacing

First author, year	n*	Study population	Lead configuration	Benefits of multisite pacing
Pappone, 2000 (67)	14	NYHA III/IV, sinus rhythm, LBBB, QRS >150 ms	Two coronary sinus leads (posterior base & lateral wall)	Increased peak dP/dt, higher aortic pulse pressure, shorter QRS duration
Leclercq, 2008 (71)	40	NYHA III/IV, permanent AF, LVEF ≤35%	Two coronary sinus leads (widest distance)	Higher LVEF
Padeletti, 2008 (68)	12	NYHA III/IV, LVEF ≤35%, QRS ≥120 ms	Two coronary sinus leads (lateral/posterolateral & anterior/anterolateral)	None
Lenarczyk, 2009 (72)	27	NYHA III/IV, LVEF ≤35%, QRS ≥120 ms	Two coronary sinus leads (widest distance)	Lower NYHA, increased VO <sub>2</sub> max & 6MWD, higher LVEF, less dyssynchrony, more responders
Ginks, 2012 (69)	22	Conventional CRT criteria	Two coronary sinus leads (widest distance)	Increased peak dP/dt
Rogers, 2012 (64)	43	NYHA II/III/IV, LVEF ≤35%, QRS ≥150 ms	Two coronary sinus leads (widest distance)	Increased 6MWD, MLWHF score and LVEF
Lenarczyk, 2012 (73)	48	NYHA III/IV, sinus rhythm, LVEF ≤35%, dyssynchrony on echocardiography	Two coronary sinus leads (widest distance)	Lower NYHA
Ogano, 2013 (75)	22	NYHA III/IV, LVEF ≤35%, QRS ≥120 ms	Two coronary sinus leads (best hemodynamic response)	Less ventricular arrhythmia

\* Number of patients who actually underwent multisite pacing



# Ventricular Activation in Triple-Site Pacing



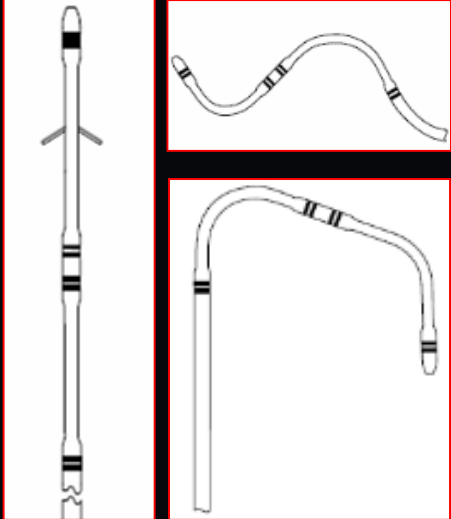


# Quadripolar Leads

Biotronik Sentus QP



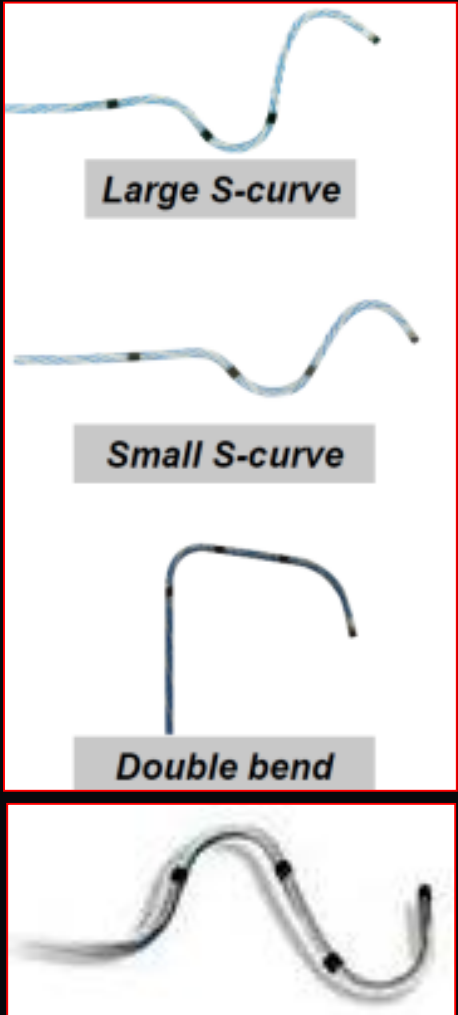
Medtronic  
Attain  
Performa



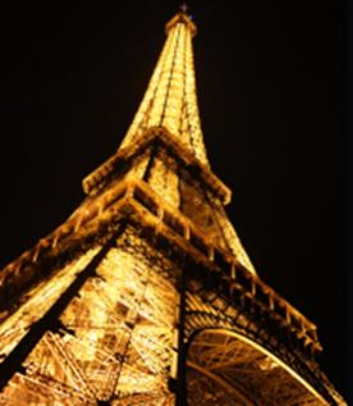
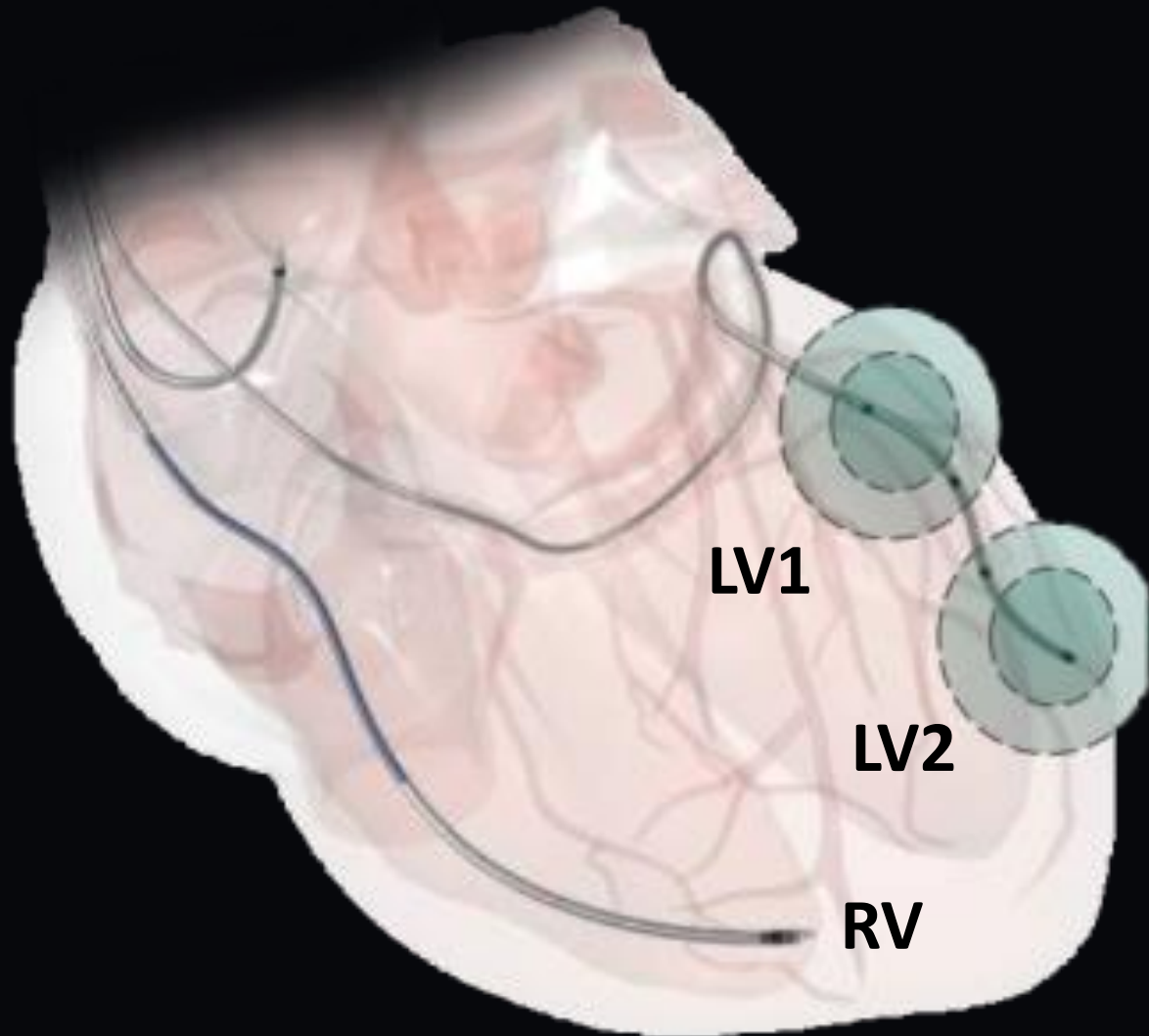
Boston Scientific  
Acuity X4



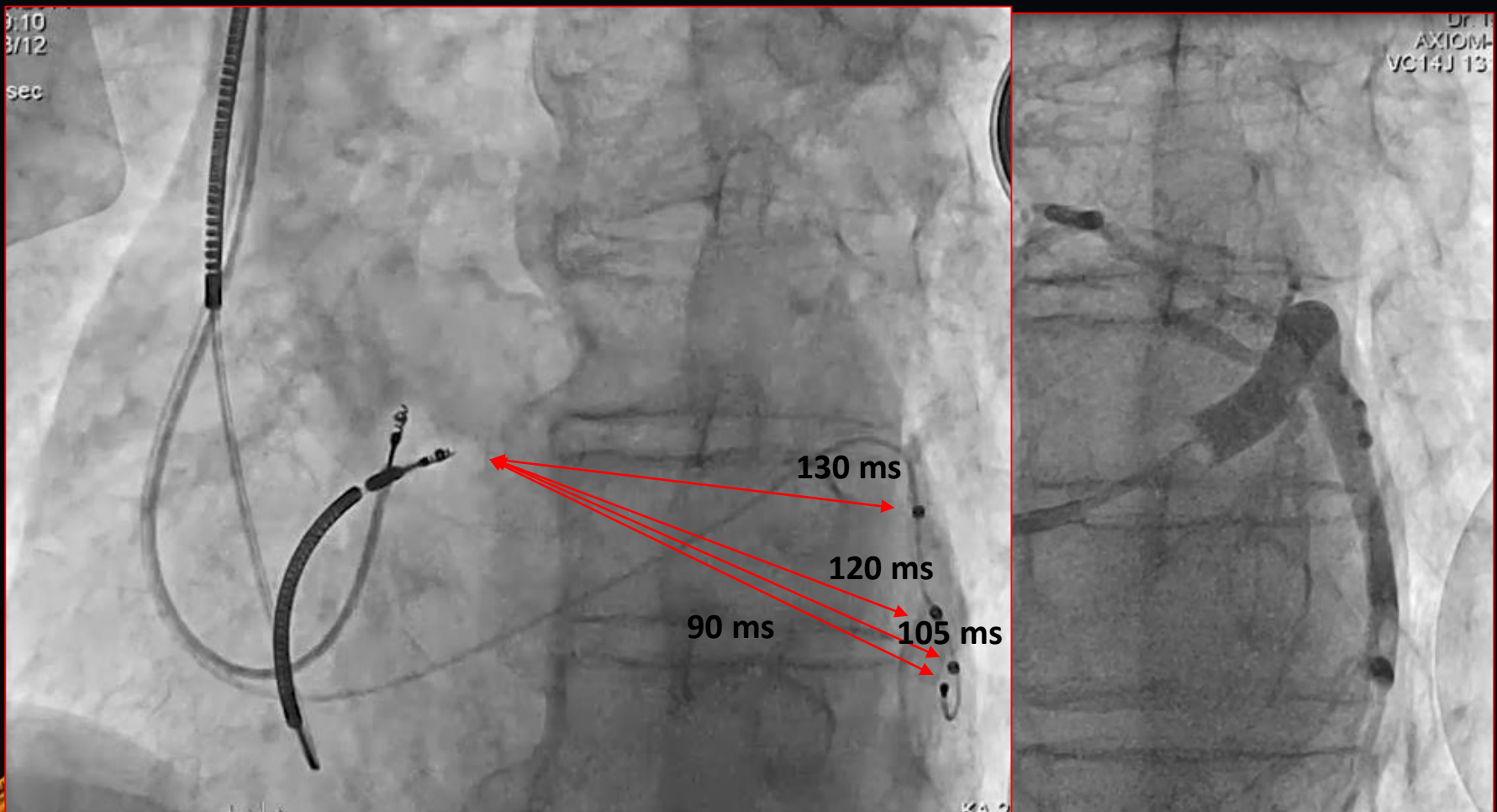
SJM Quartet



# Multipoint Pacing (MPP)

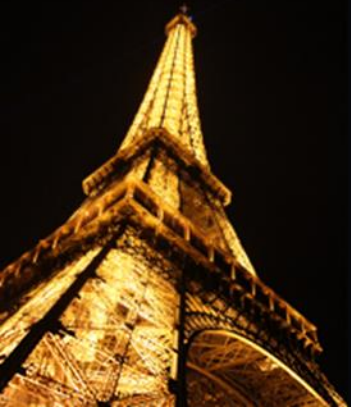
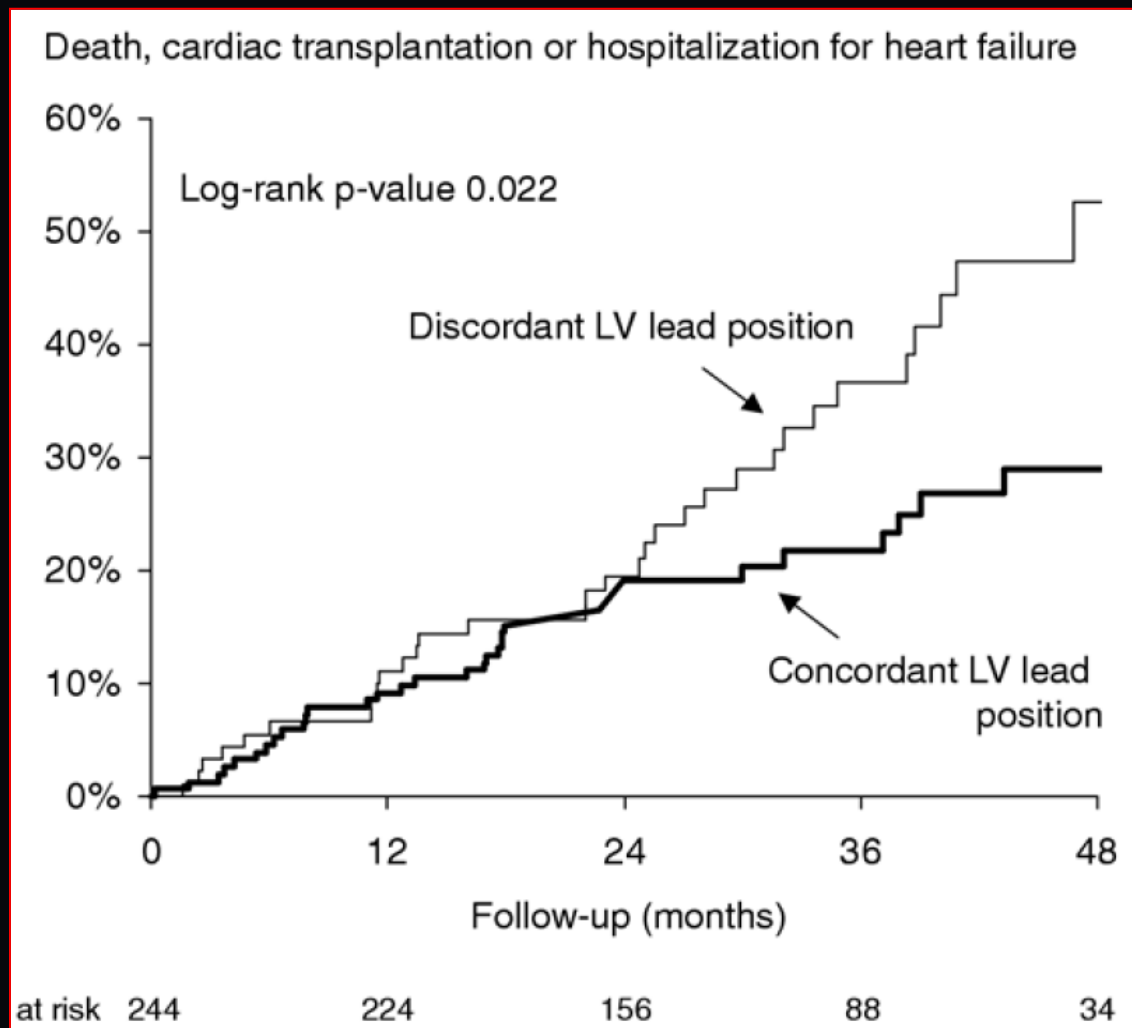


# Optimal LV Pacing Site

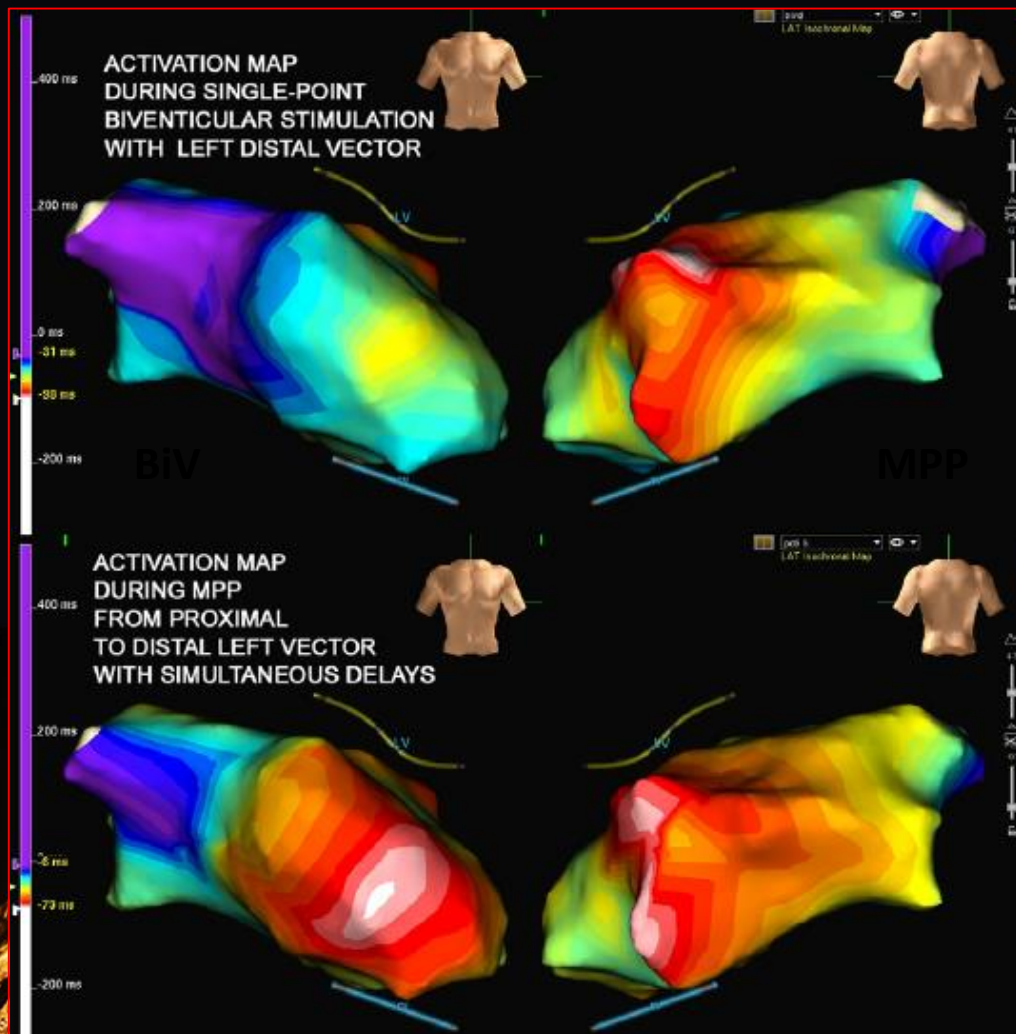


CTO-LF 5	2) Apical position of the LV lead should be avoided when possible.	IIa	B
3	3) LV lead placement may be targeted at the latest activated LV segment.	IIb	B

# LV Pacing at the Site of Latest Activation



# Acute Hemodynamics and Activation Time in Multipoint Pacing

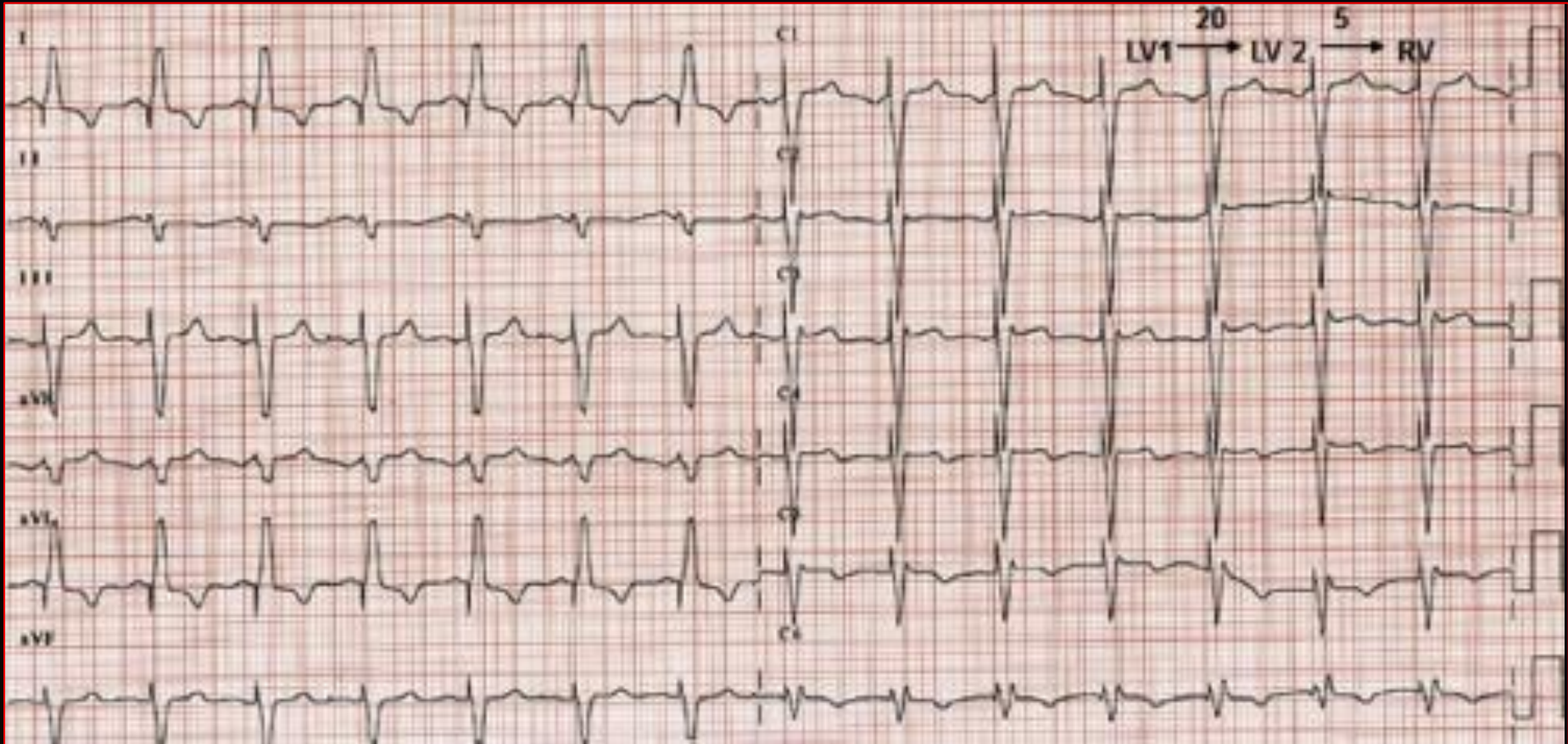


## Multipoint pacing

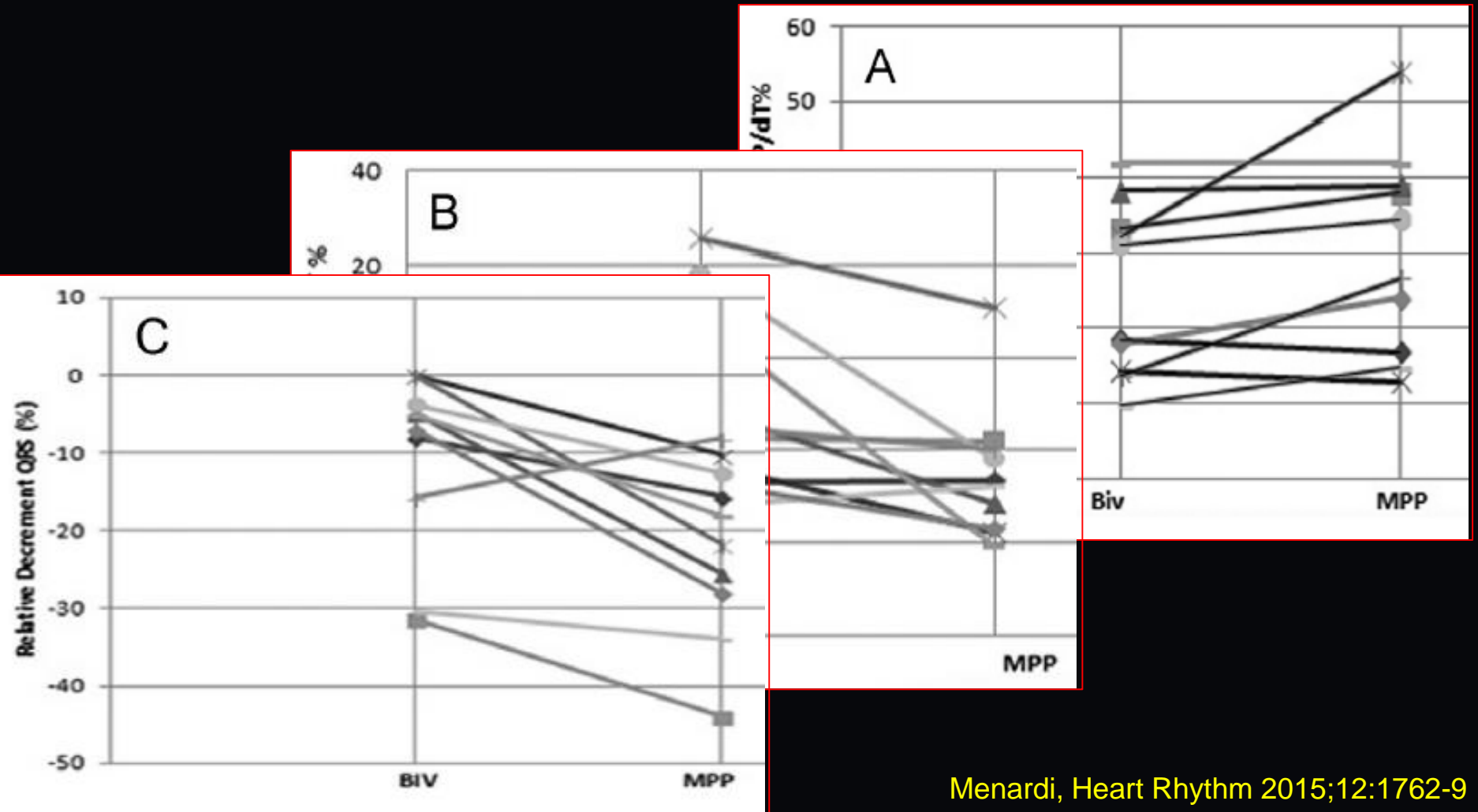
- more uniform wavefront propagation throughout the LV compared to conventional biventricular pacing
- better electrical activation
- better acute hemodynamic response to CRT



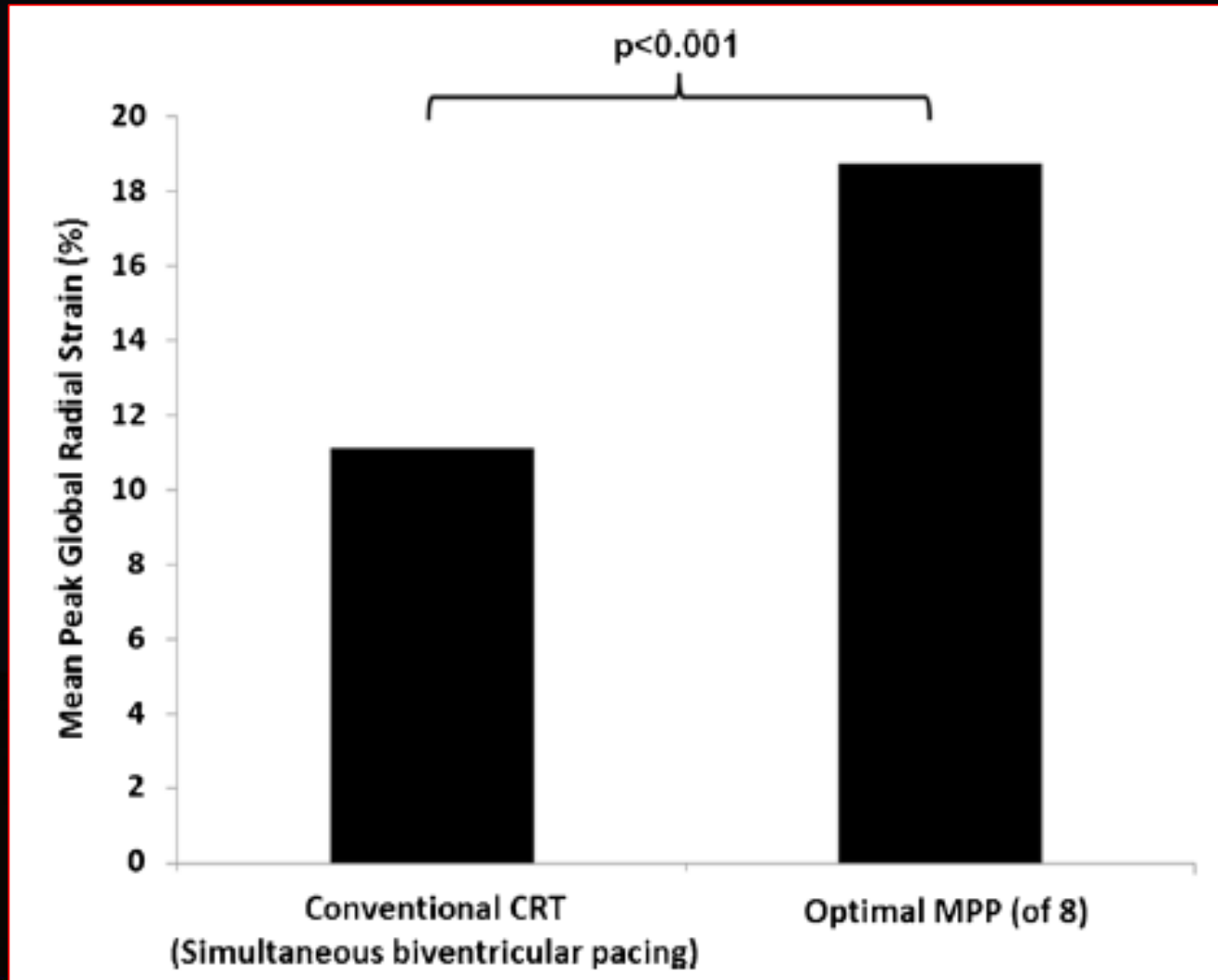
# MPP Optimization: QRS Width



# MPP: Acute Hemodynamics and Activation Time

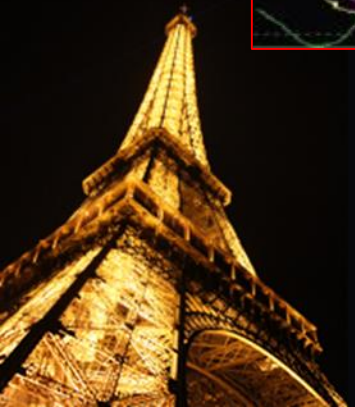
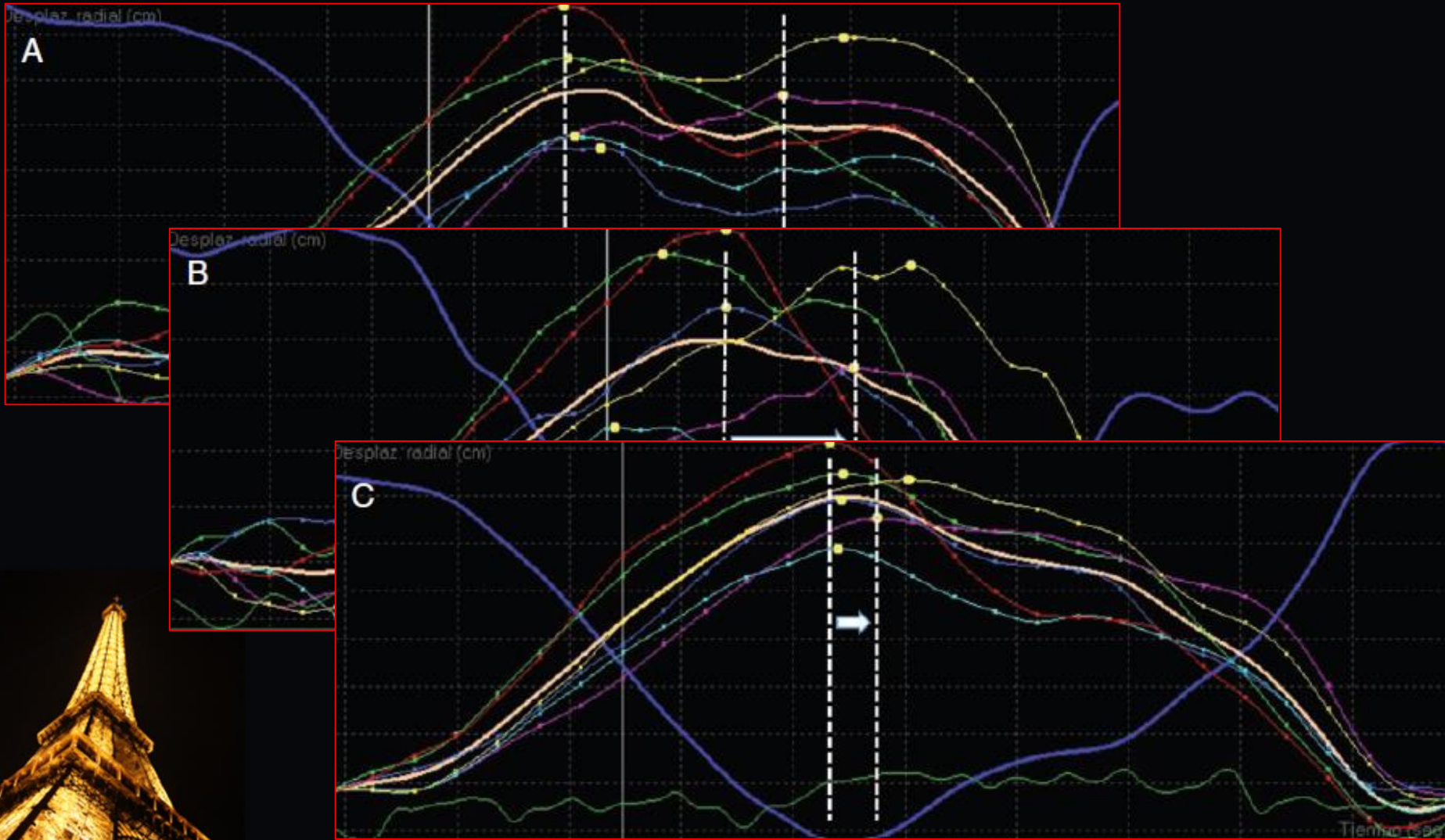


# MPP: Better Synchronicity

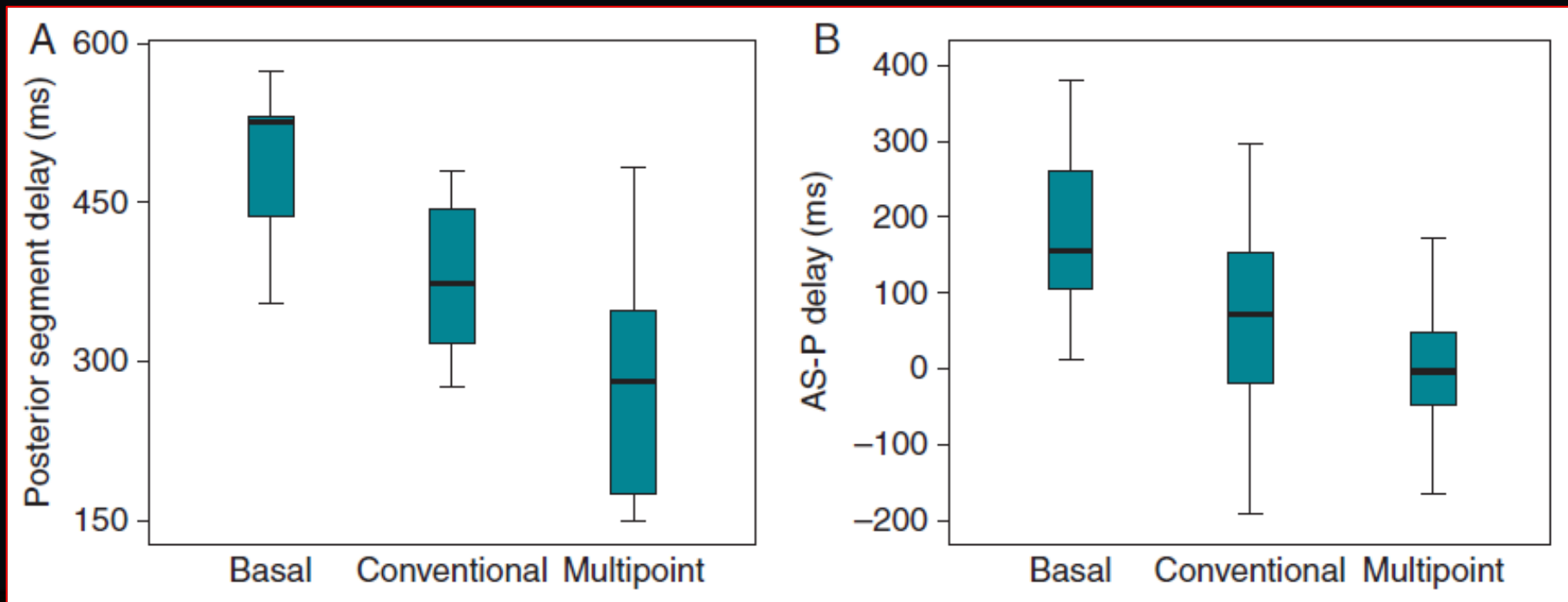




# MPP: Better Synchronicity



# MPP: Better Synchronicity



n = 27

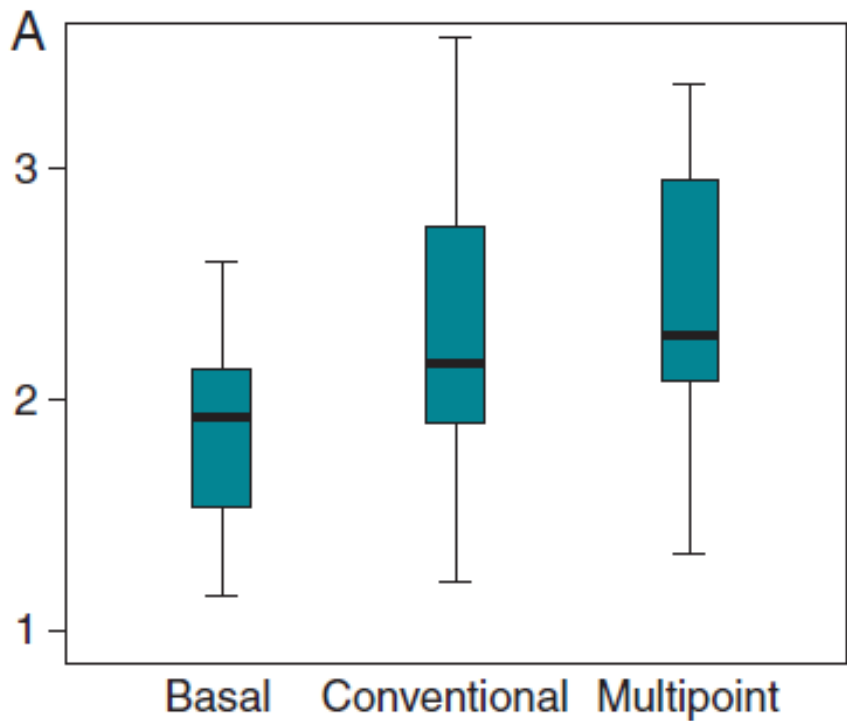
AS-P: Activation septal-posterior



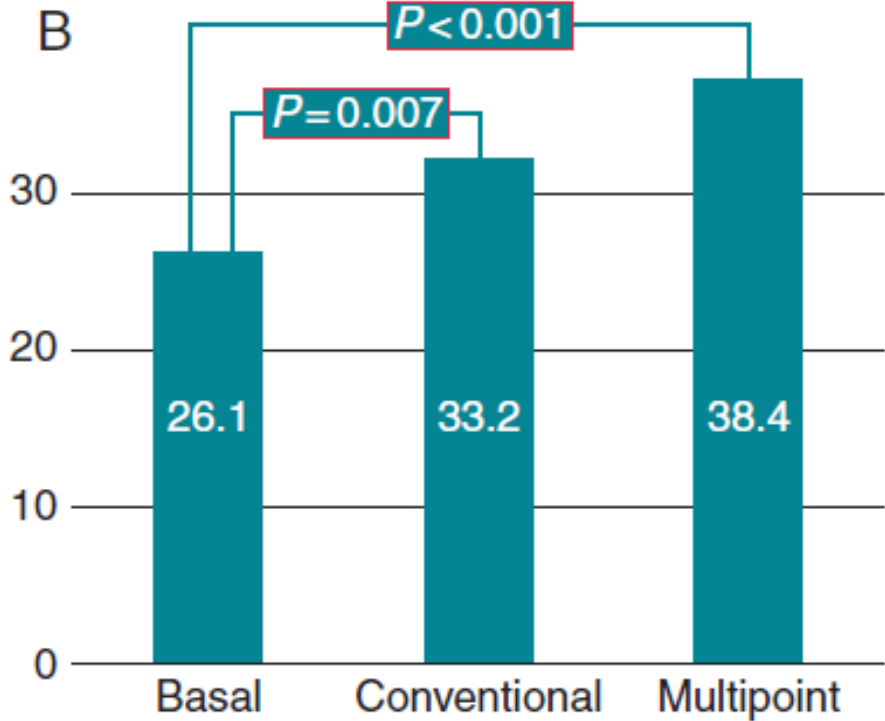


# MPP: Better Echo-Response

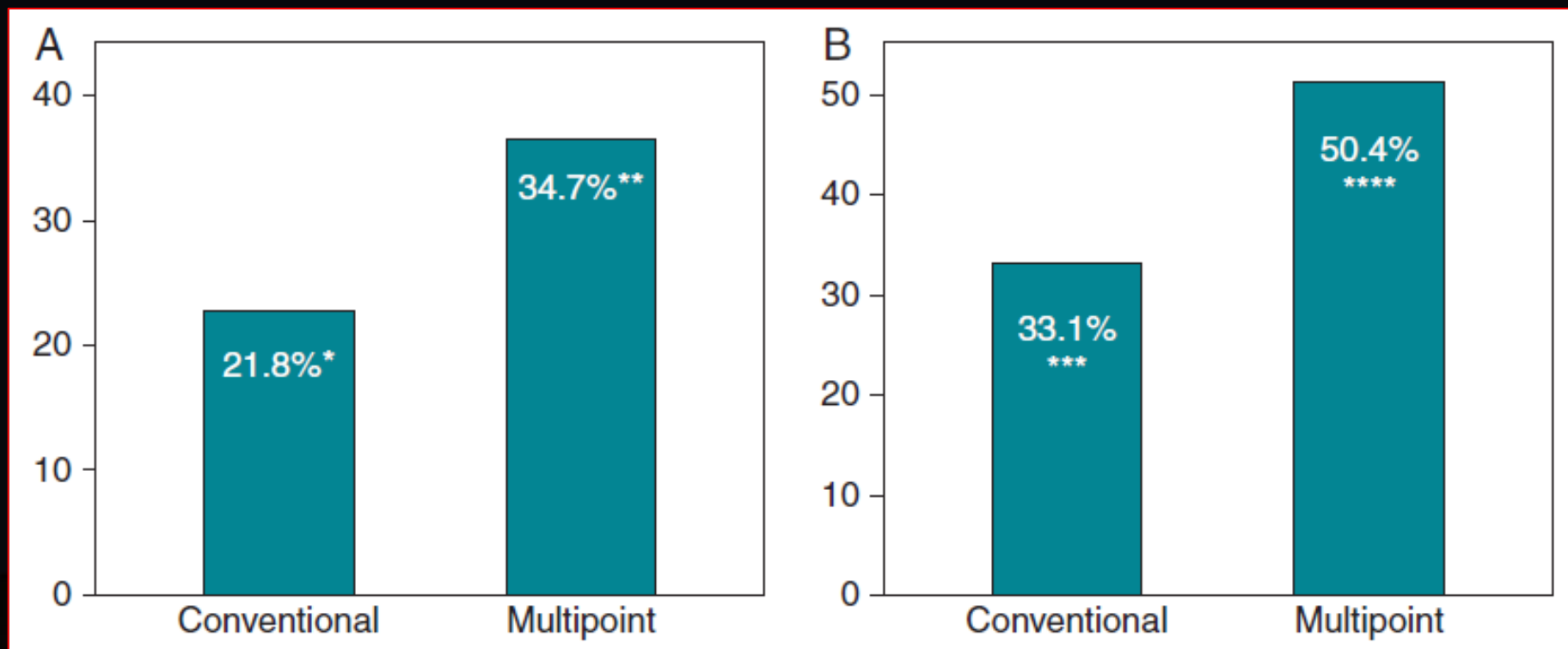
Cardiac index according to LV pacing group (l/min/m<sup>2</sup>)



LVEF according to LV pacing group (%)



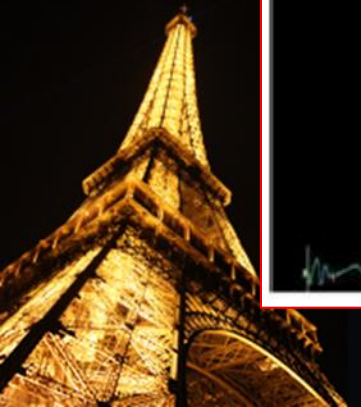
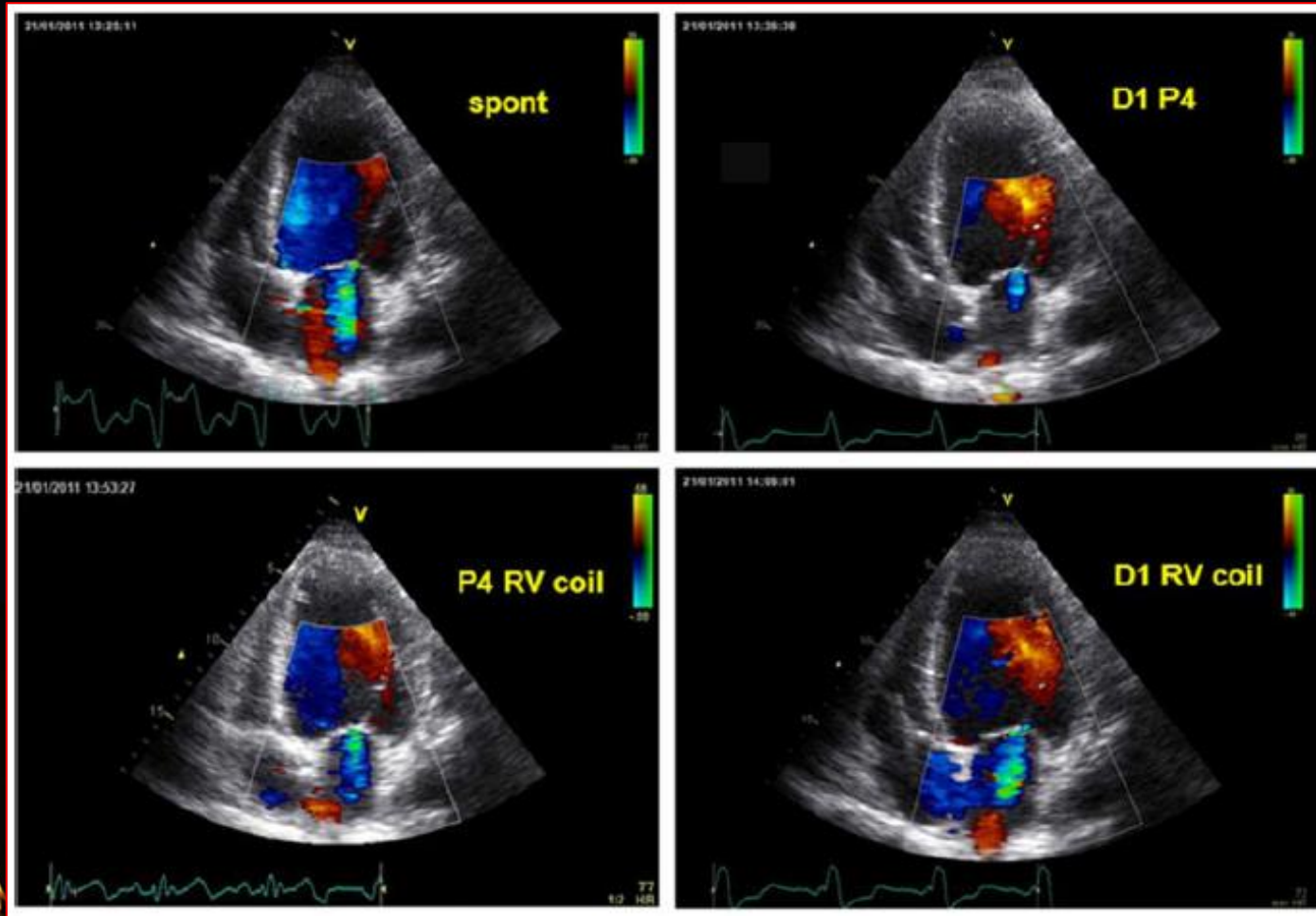
# MPP: Better Echo-Response



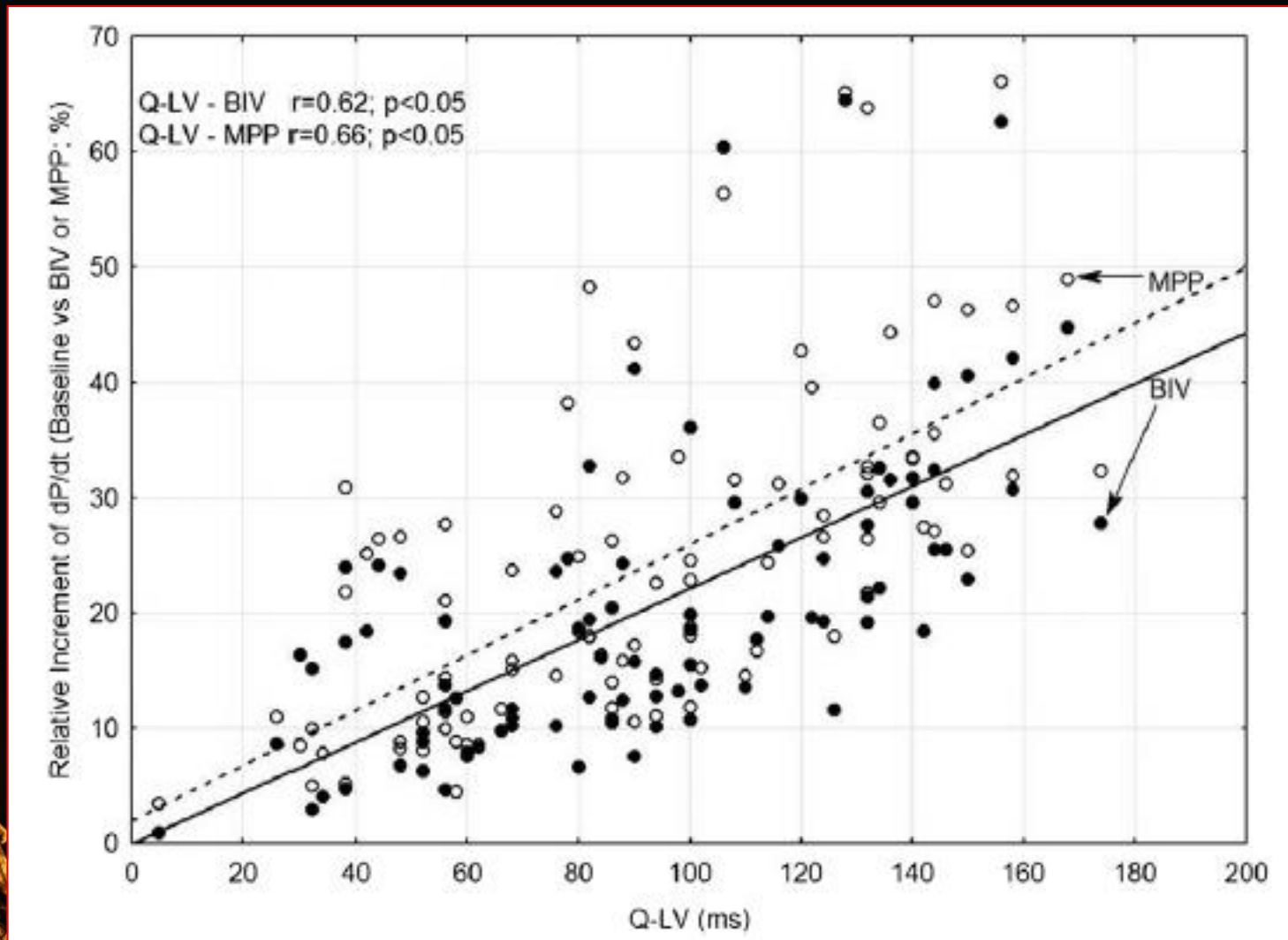
Mean percent change in (A) cardiac index and (B) LVEF

n = 27

# Quadripolar LV Leads: Mitral Regurgitation

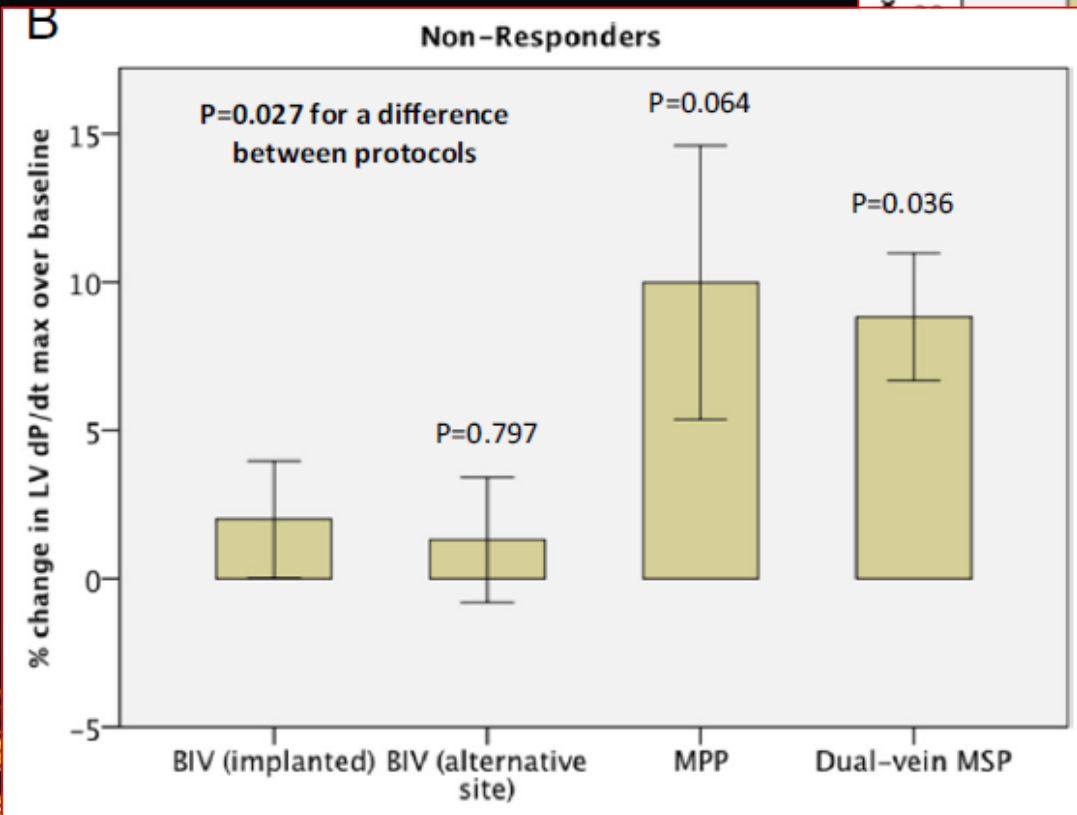
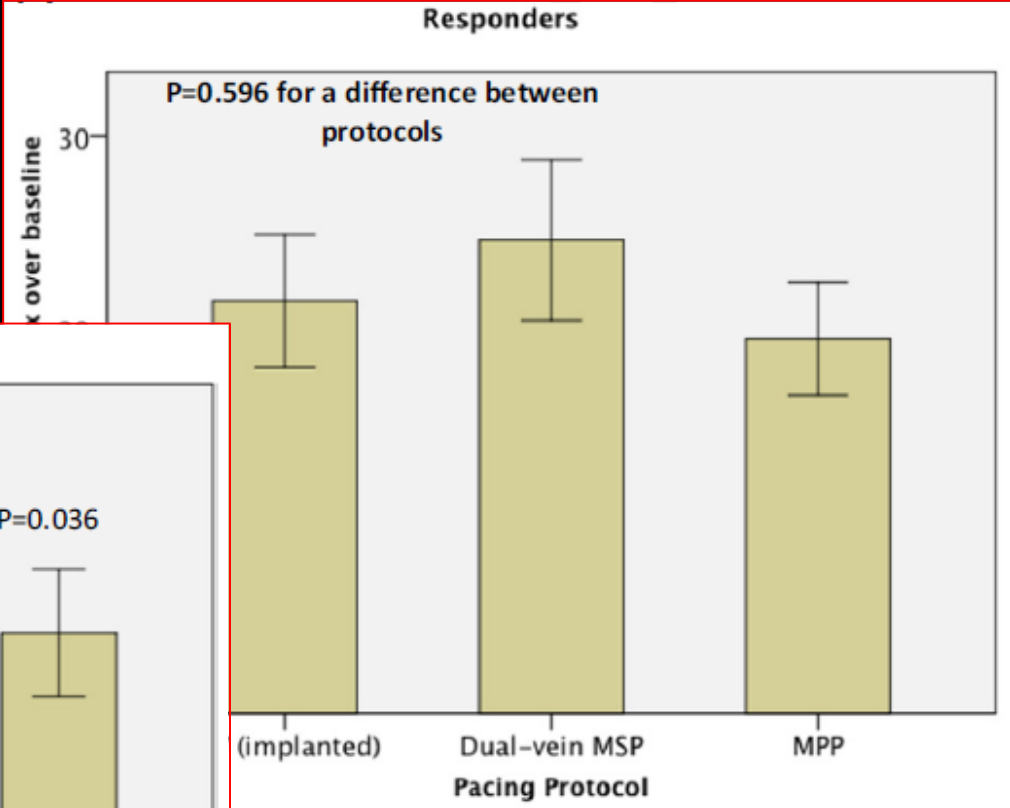


# Hemodynamics and Electrical Delay



# Multipoint Pacing in Non-Responders

7 of 9 patients with acute hemodynamic response (>10%) had a strict LBBB



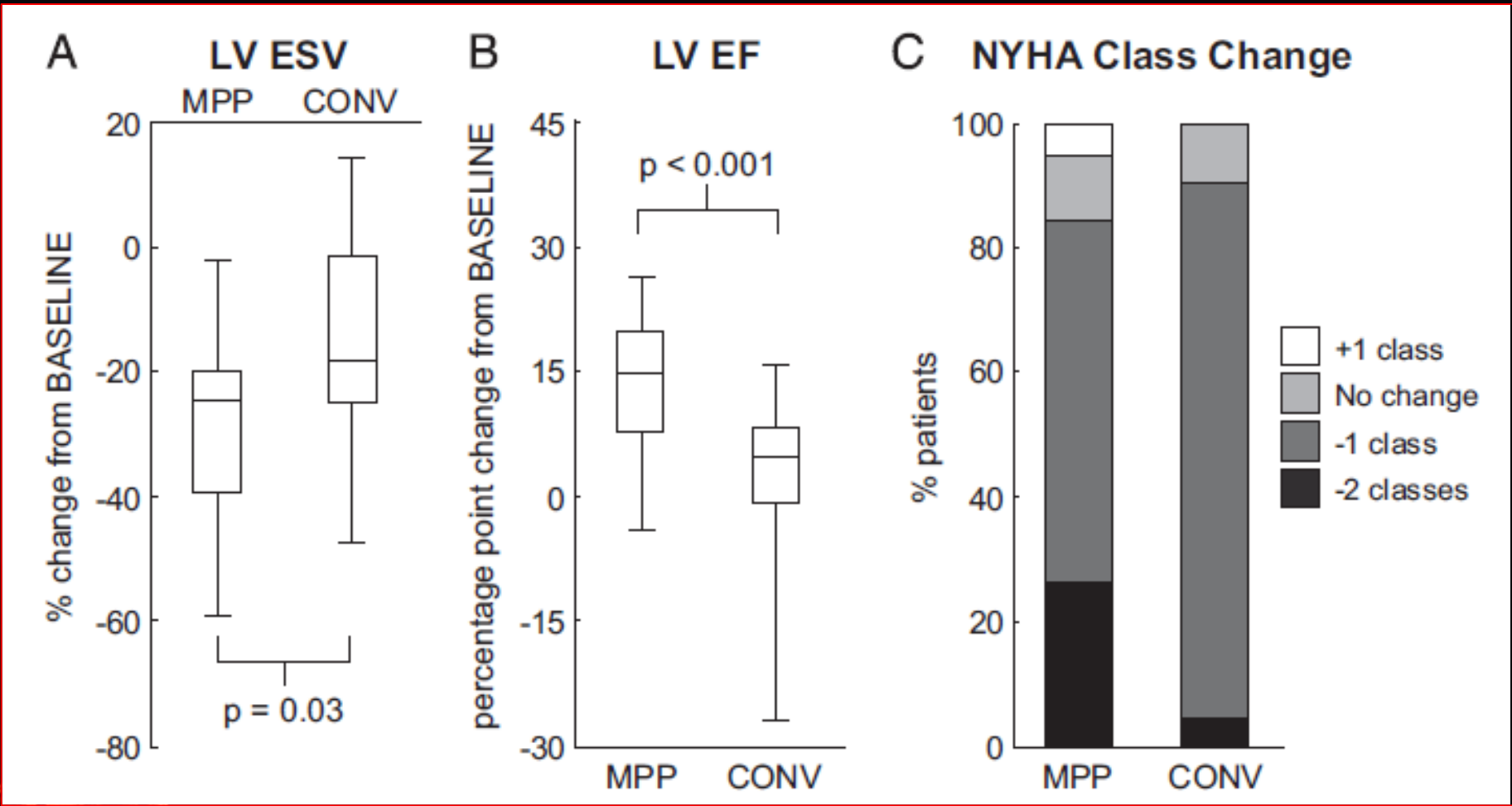
All 7 acute non-responders (AHR <10%) had a no strict LBBB



# RCTs with Multipoint Pacing

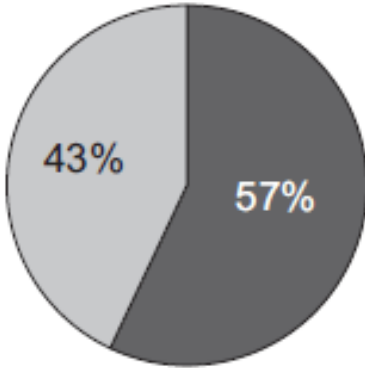
First author, year	n	Comparison	Study findings
Thibault, 2013 (88)	19	Distal electrode versus 4 multisite pacing configurations	Invasive dP/dt better with multisite pacing in 72% (mostly through combined proximal and distal electrode stimulation)
Rinaldi, 2013 (89, 91)	41/40	Distal electrode versus 8 multisite pacing configurations	<ol style="list-style-type: none"> <li>1. Dyssynchrony by tissue Doppler echocardiography reduced in 63% with multisite pacing</li> <li>2. Radial strain &gt;20% higher in 63% with multisite pacing</li> </ol>
Pappone, 2014 (90)	44	Distal/proximal electrode versus 7 multisite pacing configurations	Acute improvement in hemodynamic parameters and significant decrease in NYHA with more pronounced reverse remodeling after 3 months in multisite pacing group

# Multipoint-Pacing: 12 Month Results

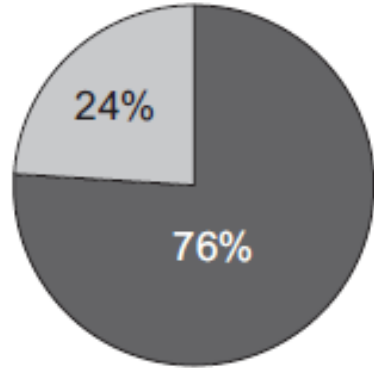


# Multipoint-Pacing: 12 Month Results

**A CONV Group**

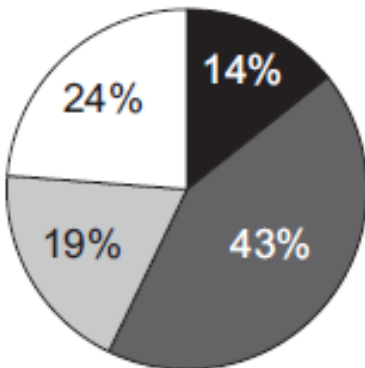


**MPP Group**

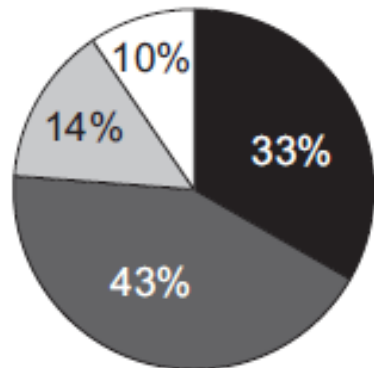


- Responders (ESV reduction  $\geq 15\%$ )
- Non-responders (ESV reduction  $< 15\%$ )

**B CONV Group**

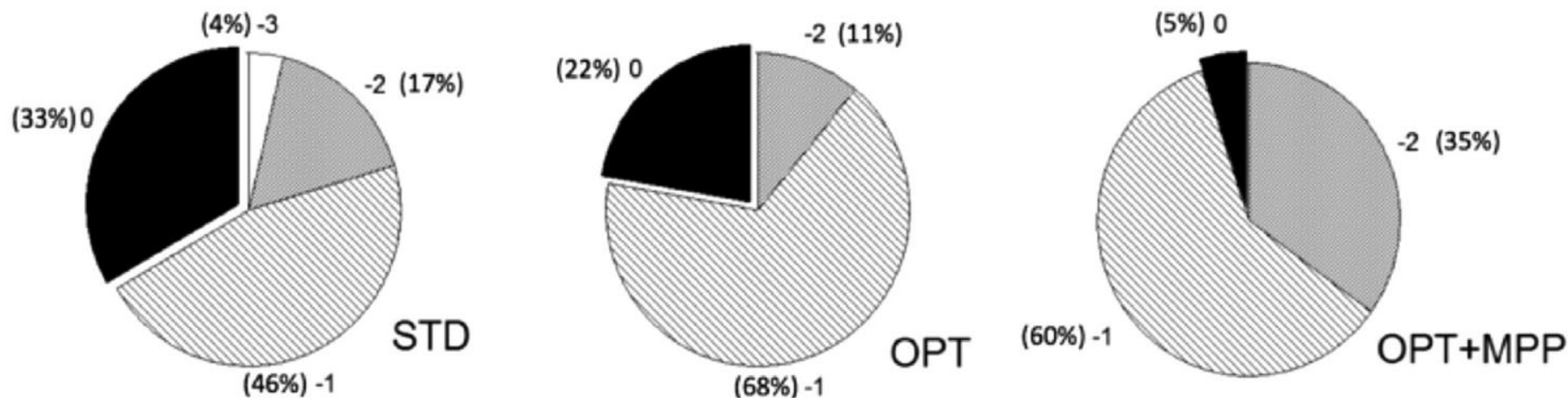


**MPP Group**



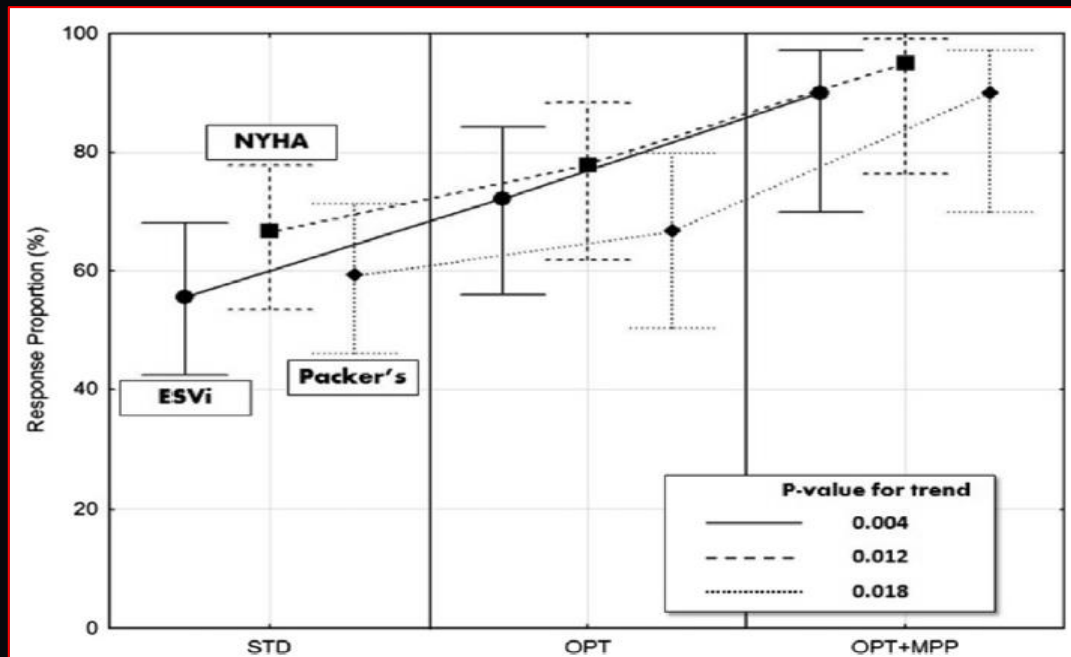
- Super-responders (ESV reduction  $\geq 30\%$ )
- Responders (ESV reduction  $\geq 15\%$  and  $< 30\%$ )
- Non-responders (ESV reduction  $\geq 0\%$  and  $< 15\%$ )
- Negative responders (ESV increase)

# MPP: NYHA at 1 Year



- Conventional CRT(STD), n = 54
- Hemodynamic/electrical optimization of the LV pacingsite (OPT), n = 36
- OPT combined with MPP (OPT+MPP), n = 20

# MPP: 1 Year Results



	STD (54) (%; 95% CI)	OPT (36) (%; 95% CI)	OPT + MPP (20) (%; 95% CI)	P
ESVi response	30 (55.6%; 42.4-68.0)	26 (72.2%; 56.0-84.2)	18 (90%; 69.9-97.2)	$\chi^2 = 0.015^\dagger$ LT = 0.004
NYHA response	36 (66.7%; 53.4-77.8)	28 (77.8%; 61.9-88.3)	19 (95.0%; 76.4-99.1)	$\chi^2 = 0.039^\dagger$ LT = 0.012
PACKER's response	32 (59.3%; 46.0-71.3)	24 (66.7%; 50.3-79.8)	18 (90.0%; 69.9-97.2)	$\chi^2 = 0.043^\dagger$ LT = 0.018

- Conventional CRT(STD), n = 54
- Hemodyn./electrical optimization of LV pacing site (OPT), n = 36
- OPT with MPP (OPT+MPP), n = 20



# IRON-MPP Registry

## MPP Programmability

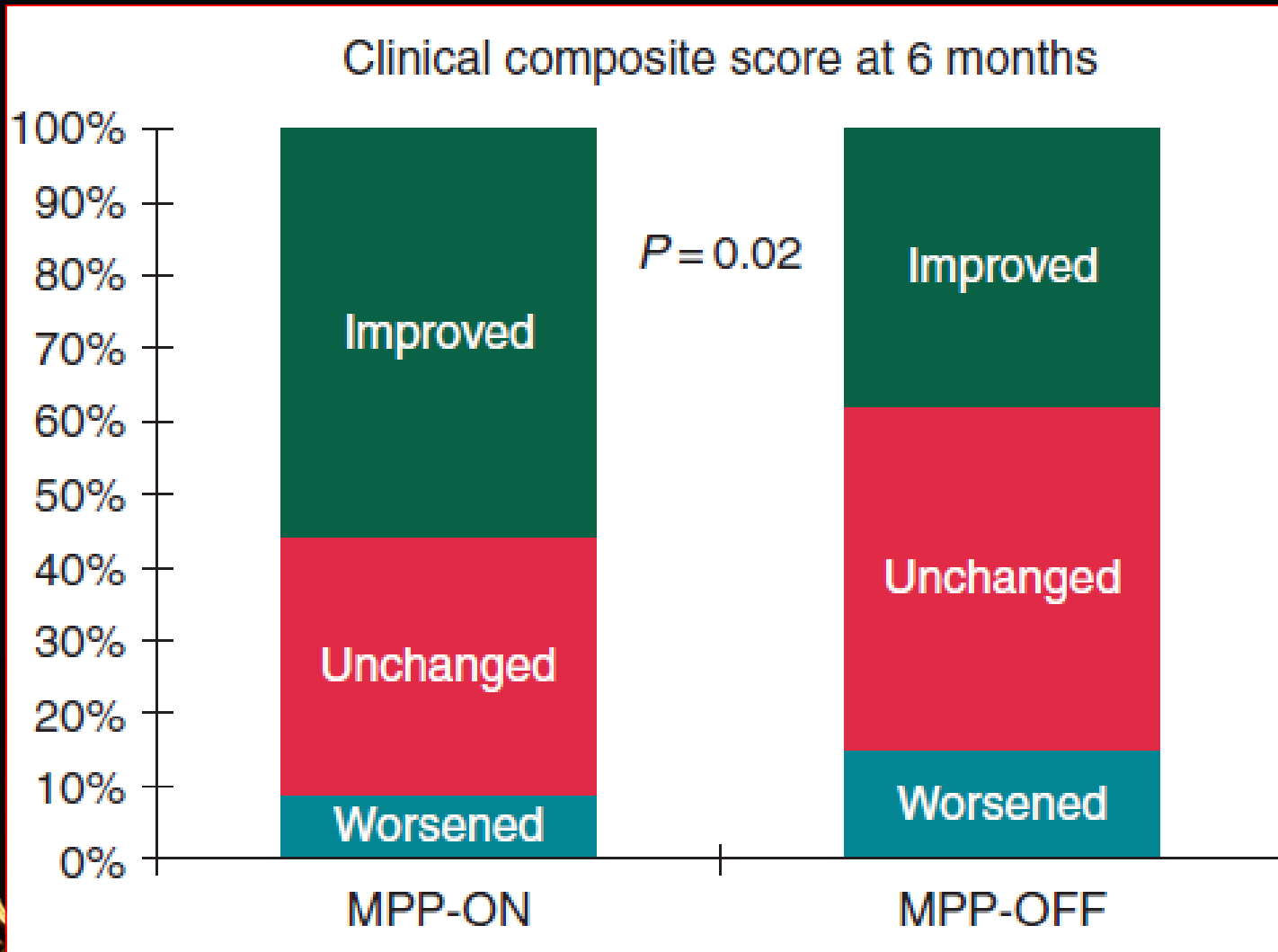
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CT in at least two MPP vectors $< 5$ V	98.6%
CT in at least two MPP vectors $< 5$ V without PNS <sup>a</sup>	97.4%
CT in at least two MPP vectors $< 3$ V	88.5%
CT in at least two MPP vectors $< 3$ V without PNS <sup>a</sup>	87.5%

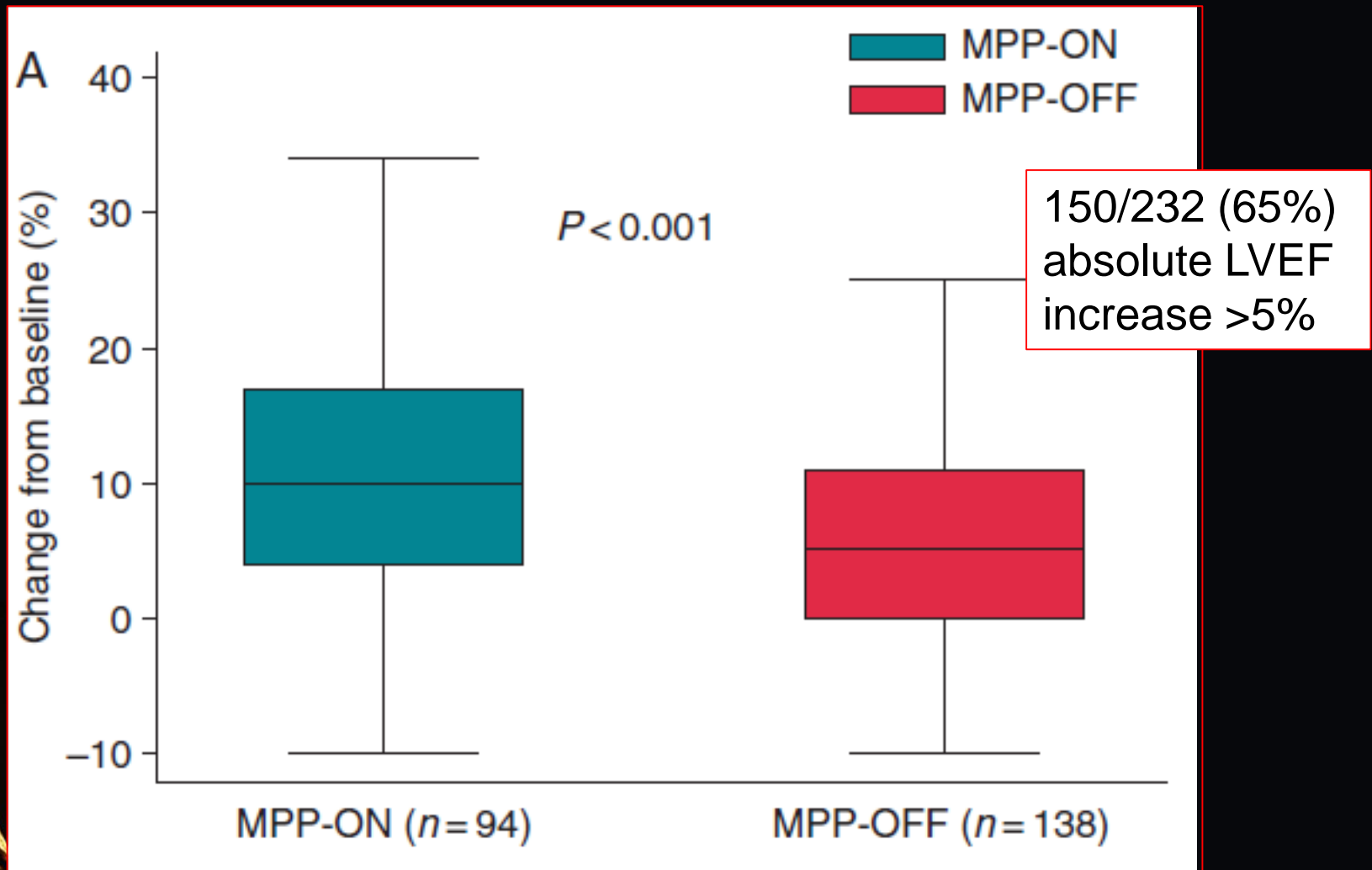
N = 507



# IRON-MPP Registry

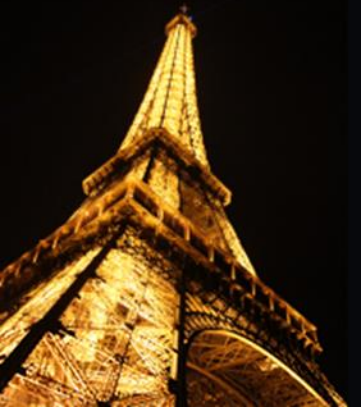


# IRON-MPP Registry: LVEF@6 Months



# Multisite LV Pacing for CRT

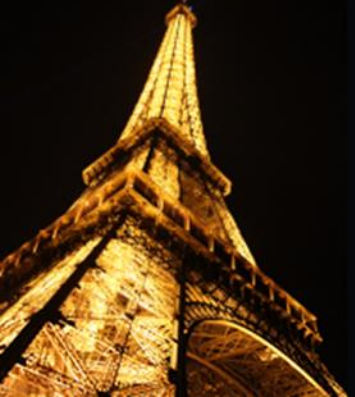
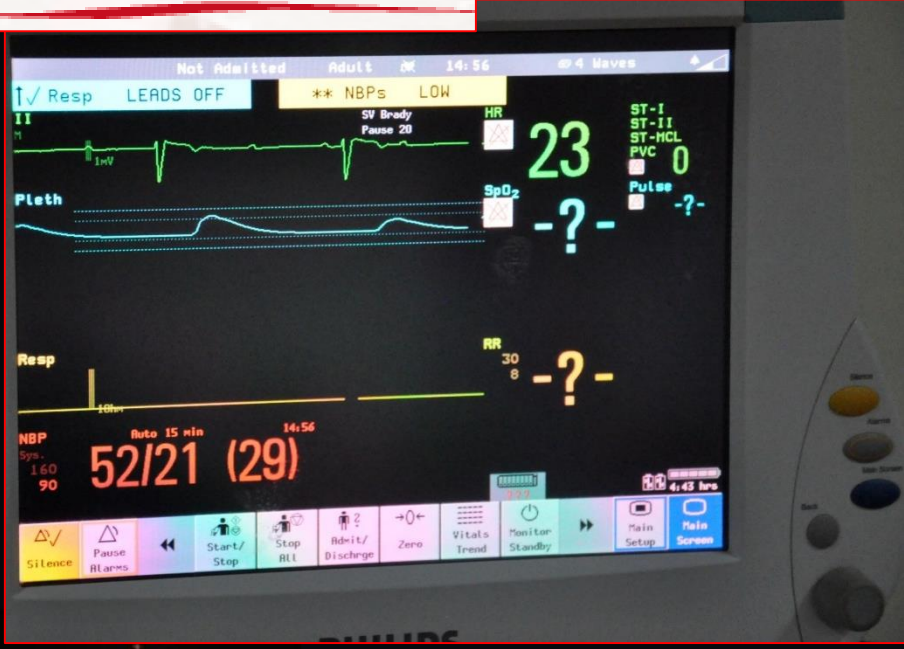
- Very solid data of better response to CRT
- Not for free (battery longevity ↓)
- Patient selection not yet clear
- Optimization (LV1, LV2, RV) not yet clear





# East African Heart Rhythm Project

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# Thank You for Your Attention!