Physiologic rather than anatomic criteria to choose LV lead position

Michael R Gold, MD, PhD
Medical University of South Carolina
Charleston, SC

Disclosures:
Consultant, Clinical Trials, Speaking Fees-
BSC, Medtronic, St Jude

October 16 - 18
14th EDITION 2015

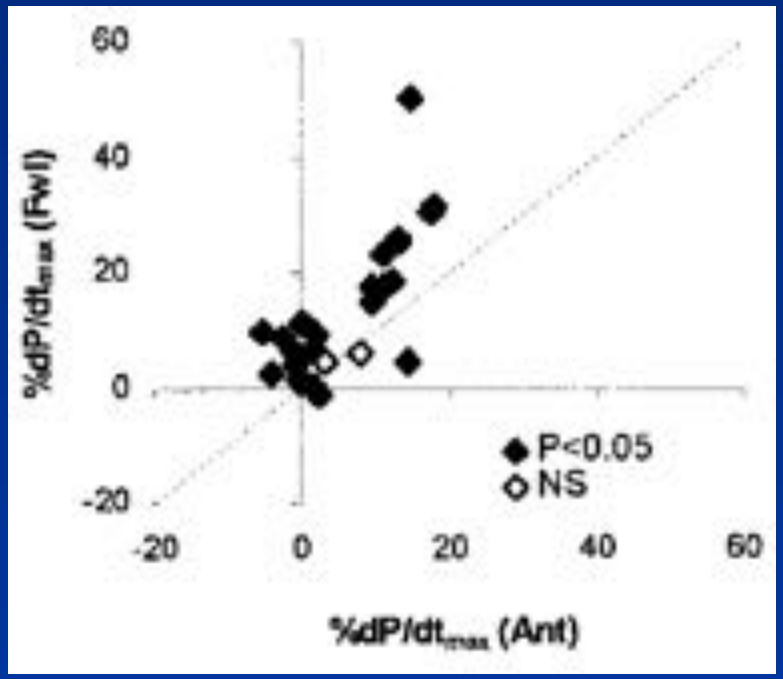
MY CONFLICTS OF INTEREST ARE

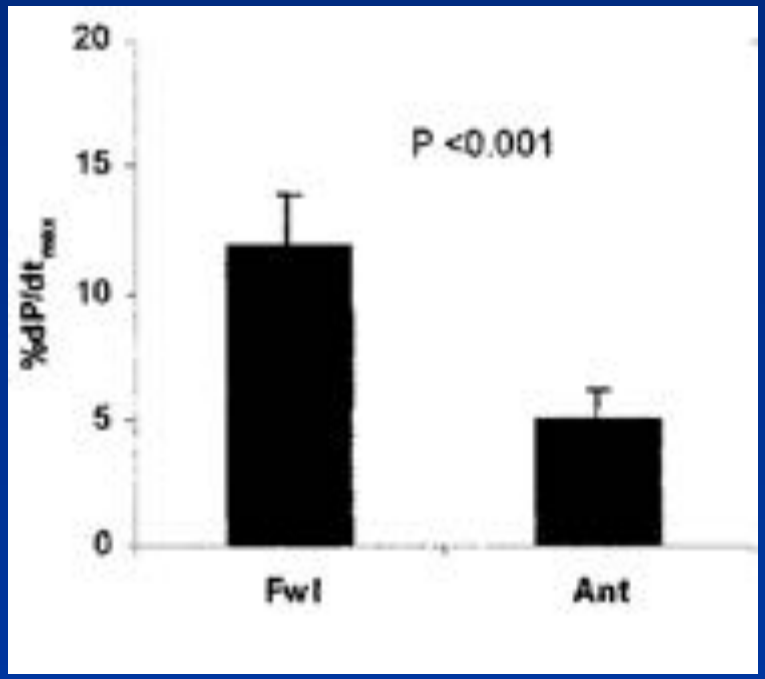
Consultant, Clinical Trials,
Speaking Fees-
BSC, Medtronic, St Jude

INTRODUCTION

- Traditionally, LV leads are placed on the lateral wall of the left ventricle via the coronary sinus for CRT
- However, nonresponder rates are about 30% which may be due in part to lead position
- This has led to renewed interest in exploring alternative (nonanatomic) approaches to pacing site

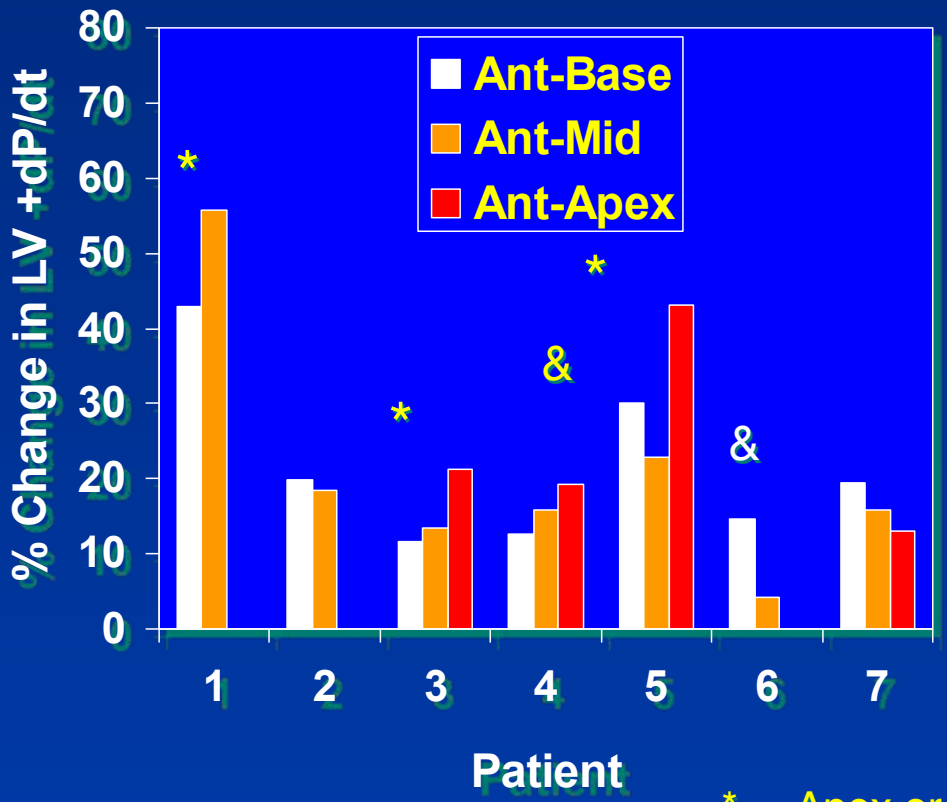
Hemodynamic Effects of LV Pacing Site

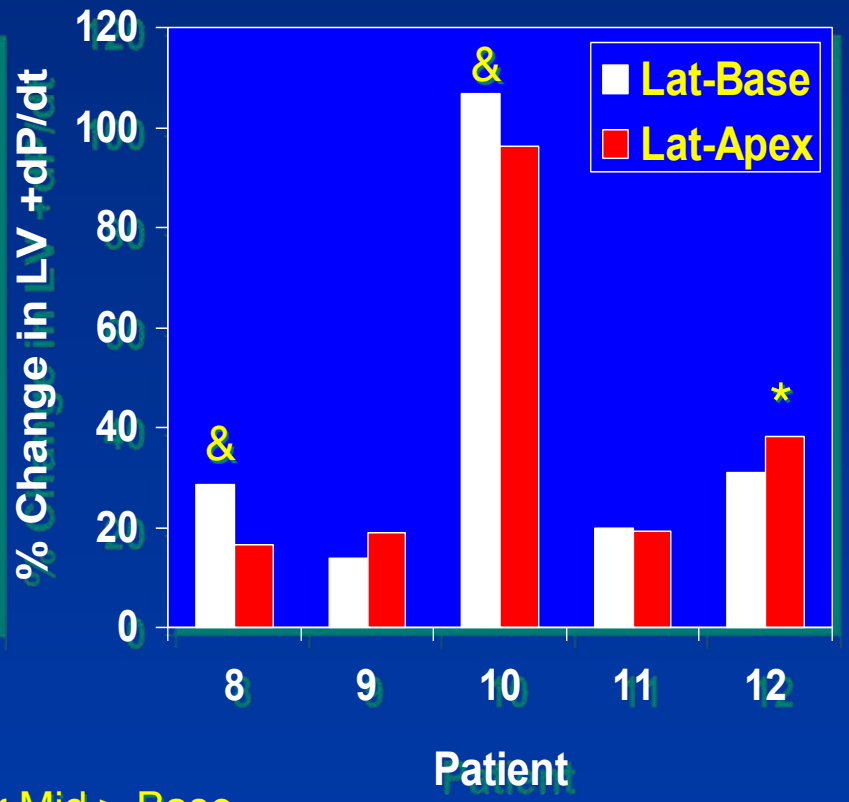




Butter et al. Circulation 2001;104:3026-3029

Comparison Pacing Sites Within a Vein





* Apex or Mid > Base

& Apex or Mid < Base

Gold et al, Heart Rhythm 2005

Is the Left Ventricular Lateral Wall the Best Lead Implantation Site for Cardiac Resynchronization Therapy?

MAURIZIO GASPARINI, MASSIMO MANTICA, PAOLA GALIMBERTI, MONICA BOCCIOLONE, LUCA GENOVESE, MAURIZIO MANGIAVACCHI, UGO LA MARCHESINA, FRANCESCO FALETRA, CATHERINE KLERSY,* ROBERT COATES, and EDOARDO GRONDA

From the Department of Cardiology Humanitas Clinical Institute Rozzano, Milano, and the *Servizio di Biostatistica IRCCS Policlinico San Matteo, Pavia, Italy

Table III.

Changes Over Time of Cardiac Performance (LVEF, LVESV, and Distance at 6MWT) While Accounting for Site of Pacing

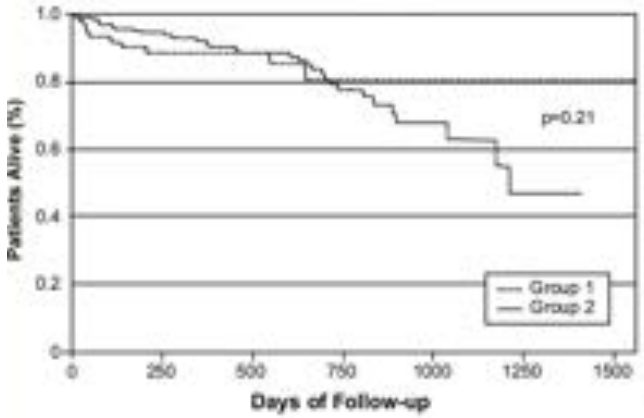
Variable	n	Mean (SD) Lateral	n	Mean (SD) Septal	Model P Value	Site P Value	Time Change P Value & Post-Hoc P Values*	LVEF	<0.0001	0.397	<0.0001
Baseline	133	30.1 (7.3)	24	27.9 (4.5)							
3 months	115	35.8 (9.3)	22	32.9 (10.0)			vs bas: <0.001; vs 6: 0.002; vs 12: 0.306				
6 months	94	37.9 (11.4)	19	36.2 (9.8)			vs bas: <0.001; vs 12: 0.229				
12 months	53	38.6 (12.4)	13	40.8 (11.6)			vs bas: <0.001				
LVESV					<0.0001	0.960	<0.0001				
Baseline	117	147.5 (61.1)	23	142.1 (77.6)							
3 months	107	124.3 (66.3)	22	131.9 (101.3)			vs bas: <0.001; vs 6: 0.024; vs 12: 0.549				
6 months	90	114.7 (59.2)	19	123.5 (100.5)			vs bas: <0.001; vs 12: 0.478				
12 months	51	114.0 (58.4)	13	103.2 (85.8)			vs bas: <0.001				
6MWT					<0.0001	0.539	<0.0001				
Baseline	128	323.3 (137.6)	24	313.9 (140.9)							
3 months	73	420.3 (94.1)	15	426.1 (109.6)			vs bas: <0.001; vs 6: 0.004; vs 12: 0.507				
6 months	71	444.7 (103.5)	15	484.2 (75.2)			vs bas: <0.001; vs 12: 0.333				
12 months	31	458.1 (109.3)	12	494.4 (76.0)			vs bas: <0.001				

*For Bonferroni correction, statistical significance for post-hoc tests. LVEF = left ventricular ejection fraction; LVESV = left ventricular end-systolic volume; 6MWT = 6-month walk test

(PACE 2003; 26[Pt. II]:162–168)

Impact of Coronary Sinus Lead Position on Biventricular Pacing: Mortality and Echocardiographic Evaluation During Long-Term Follow-Up

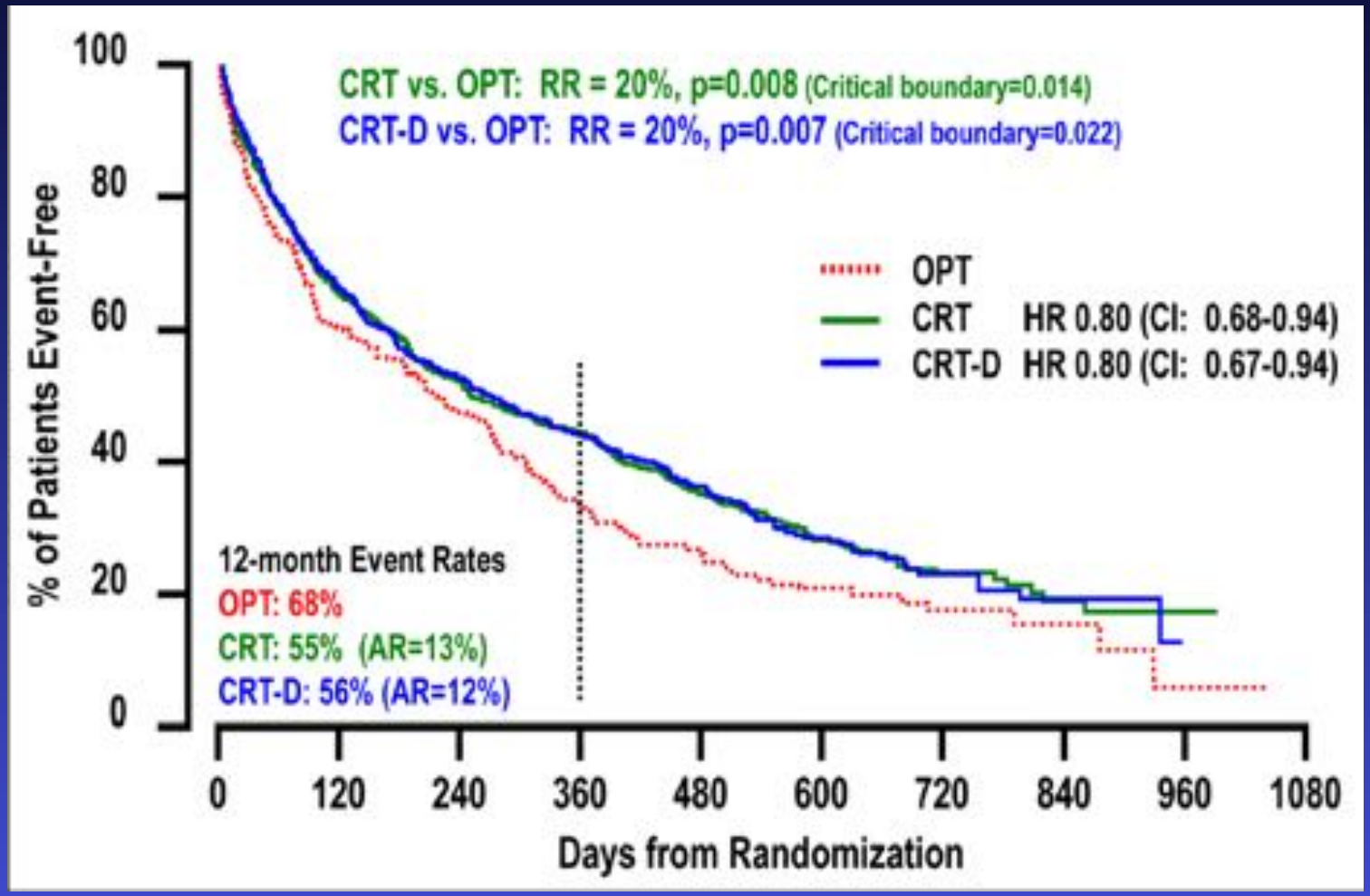
ANTONIO ROSSILLO, M.D., ATUL VERMA, M.D.,* EDUARDO B. SAAD, M.D.,* ANDREA CORRADO, M.D., GIANNI GASPARINI, M.D., NASSIR F. MARROUCHE, M.D.,* ALI REZA GOLSHAYAN, M.D.,* RICHARD McCURDY, M.D.,* MANDEEP BHARGAVA, M.D.,* YAARIV KHAYKIN, M.D.,* J. DAVID BURKHARDT, M.D.,* DAVID O. MARTIN, M.D.,* BRUCE L. WILKOFF, M.D.,* WALID I. SALIBA, M.D.,* ROBERT A. SCHWEIKERT, M.D.,* ANTONIO RAVIELE, M.D., and ANDREA NATALE, M.D.*



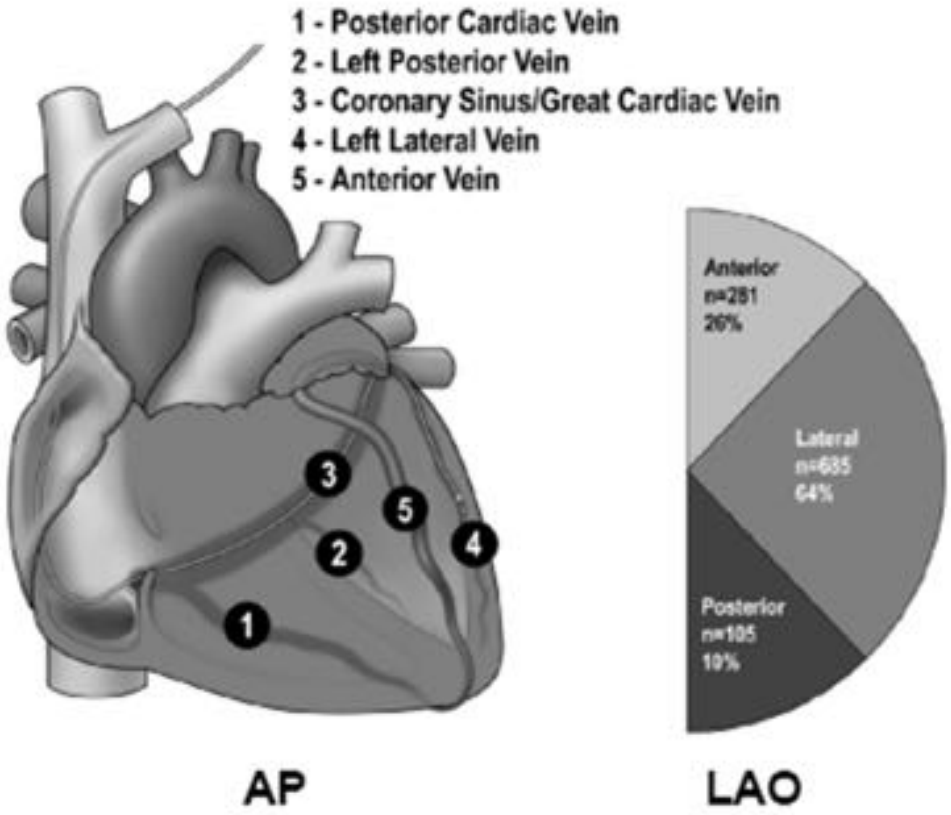
Group 1: anterior anterolateral
Group 2: lateral posterolateral

(J Cardiovasc Electrophysiol, Vol. 15 pp. 1120-1125, October 2004)

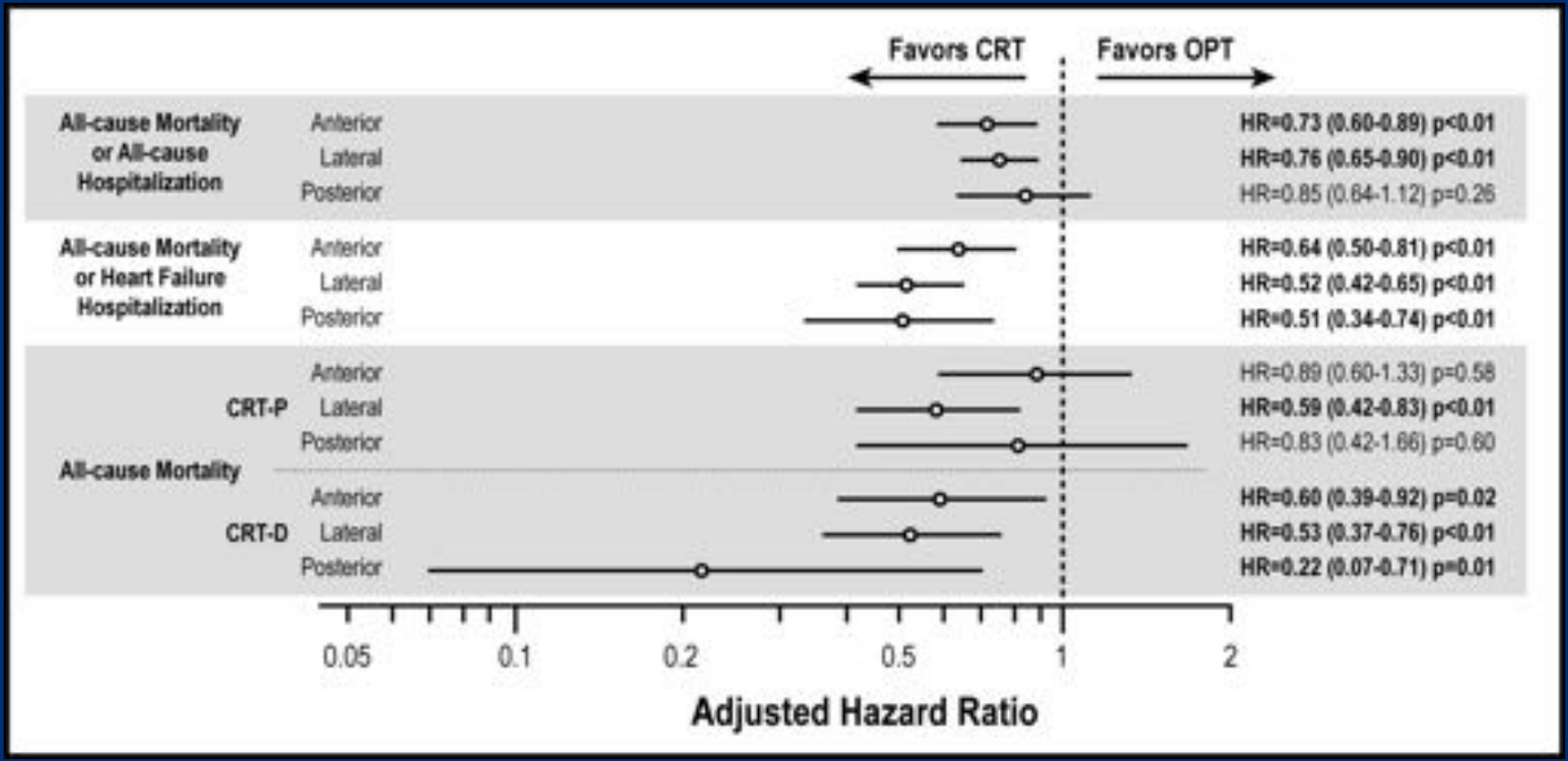
COMPANION: Primary Endpoint Death or Any Hospitalization



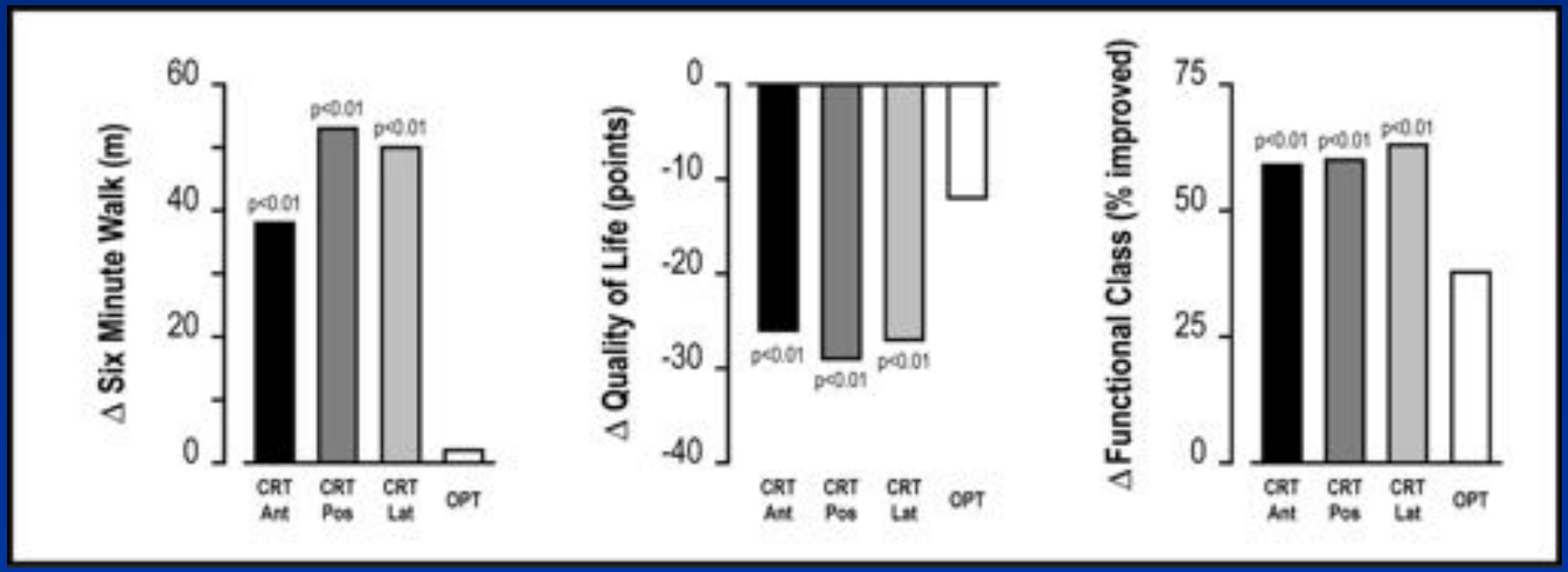
COMPANION


1 - Posterior Cardiac Vein
2 - Left Posterior Vein
3 - Coronary Sinus/Great Cardiac Vein
4 - Left Lateral Vein
5 - Anterior Vein
1
2
3
4
5
AP
Anterior
n=281
20%
Lateral
n=685
64%
Posterior
n=105
10%
LAO

COMPANION Endpoints

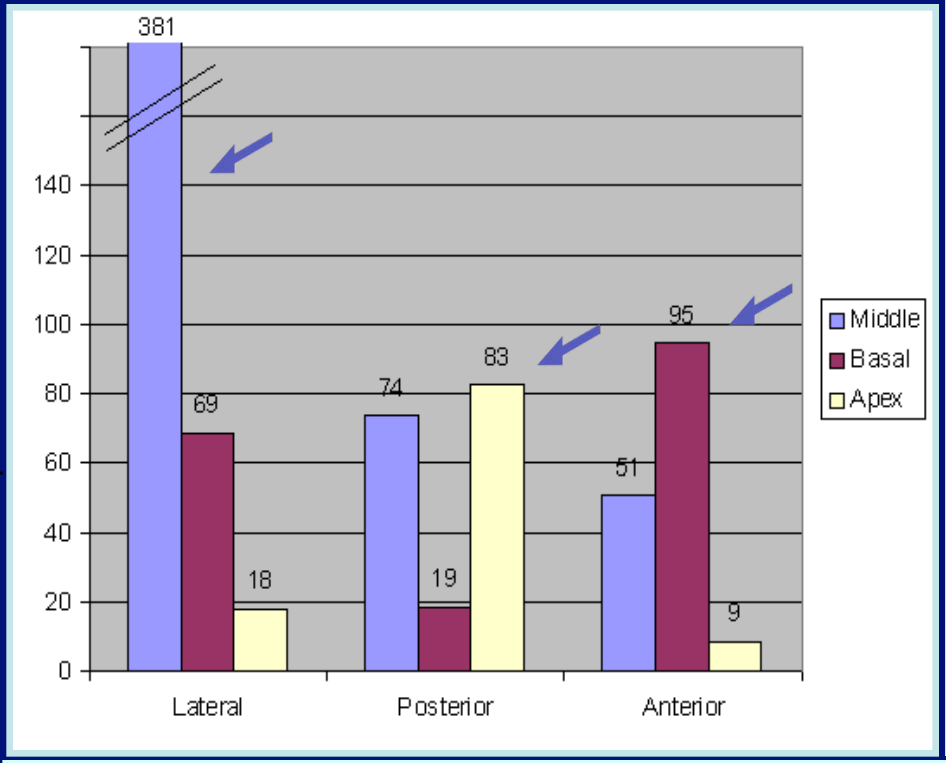


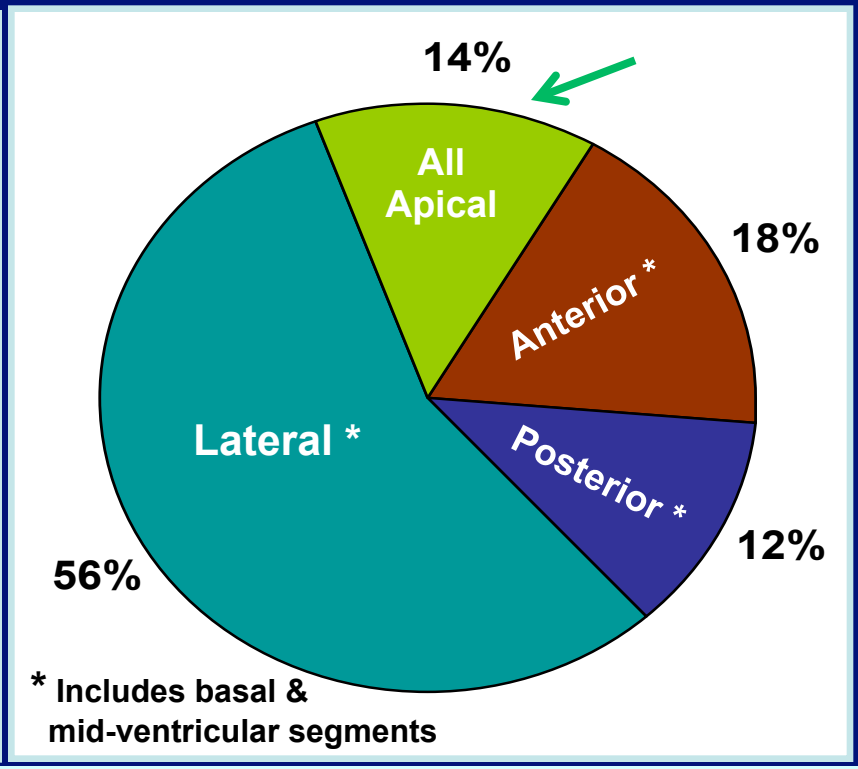
COMPANION LV Lead Analysis



Saxon et al, JCE 2009

LV Lead positions in MADIT-CRT

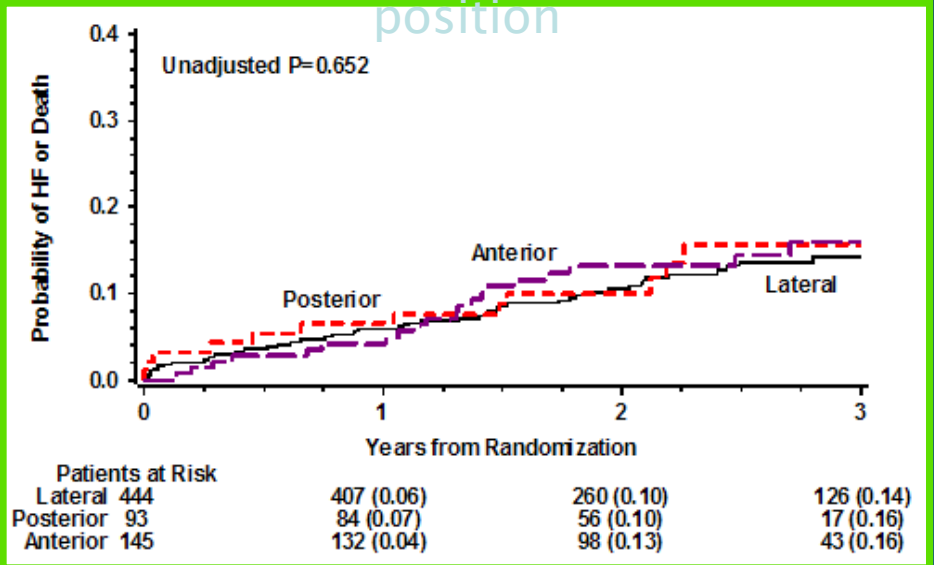




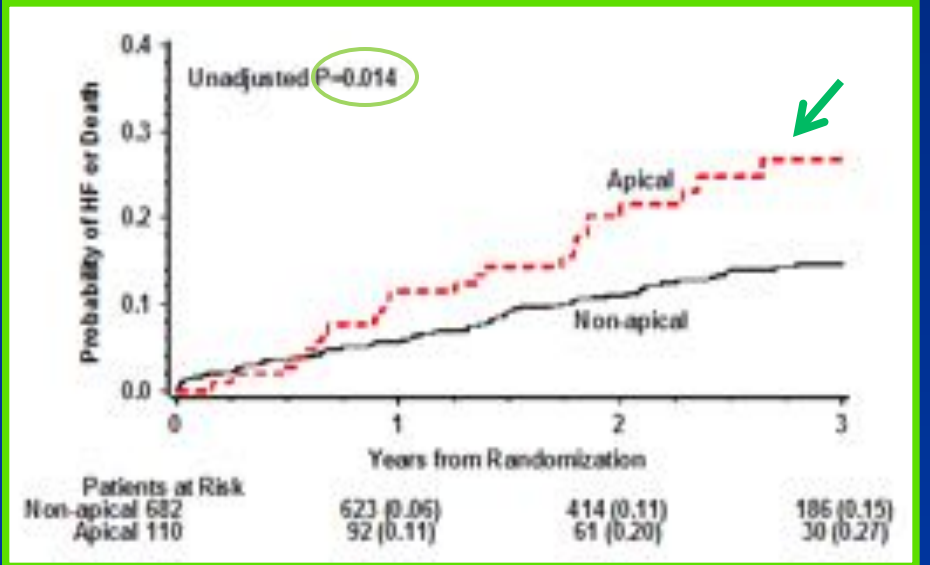
- Commonest lead position: lateral wall
- Predominant segmental placements: Lateral-mid; Anterior-basal and Posterior-apical
- Segmental Distribution
  - Apical segment: 14%; Basal: 23%; Mid-ventricular: 63%

LV Lead Position & Clinical Outcome
Death &/or Heart Failure

Anterior, posterior and lateral position

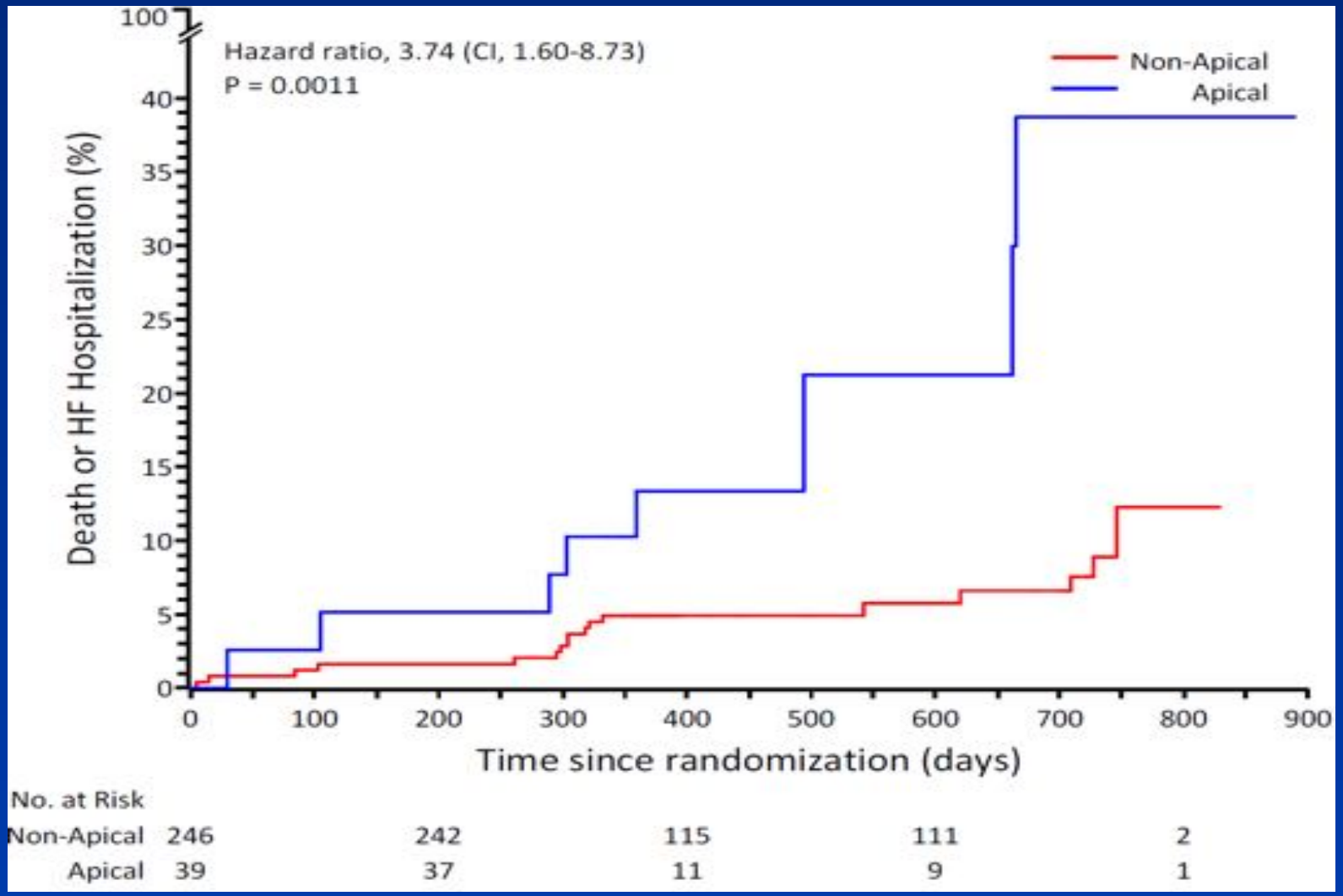


Apical versus Non-apical position



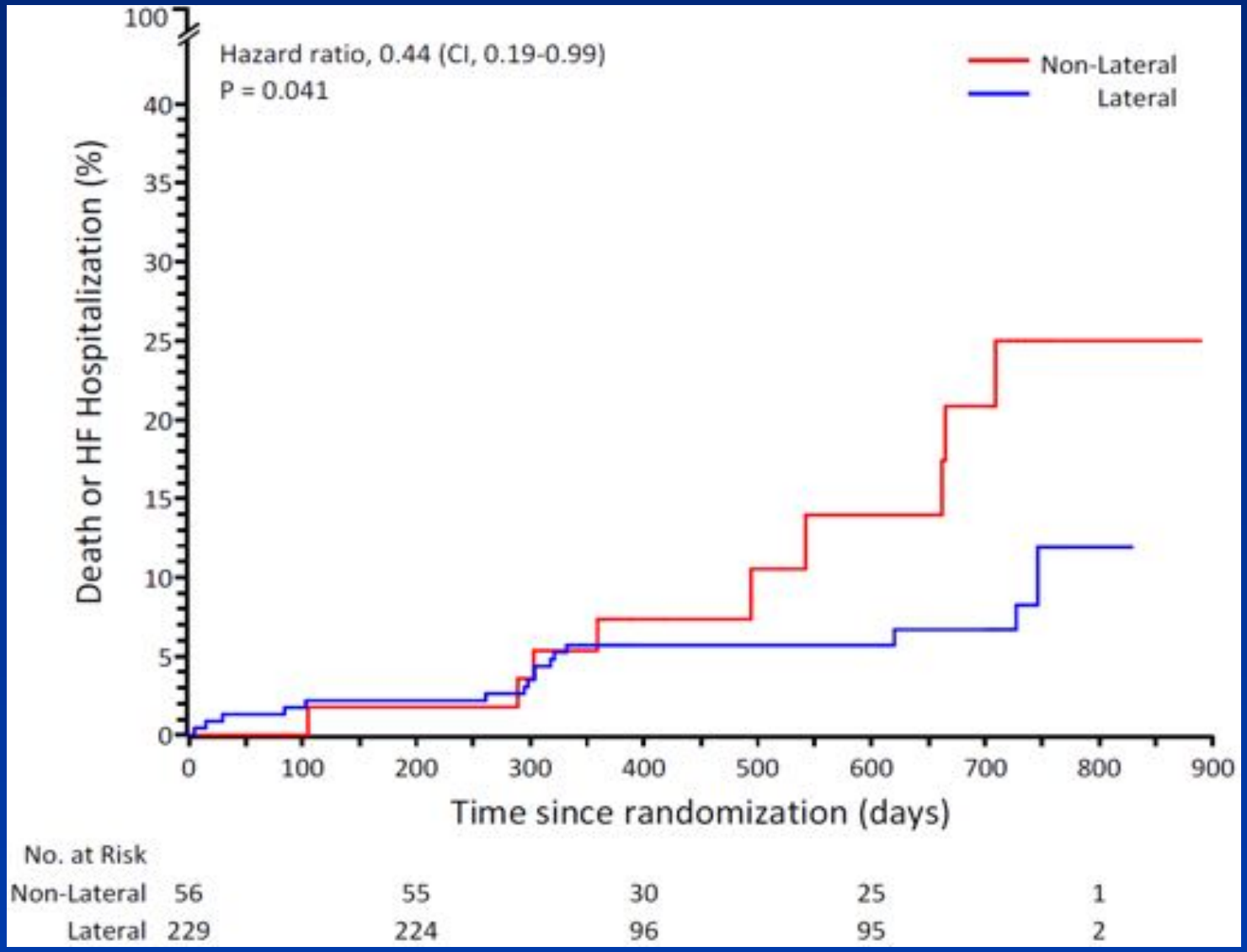
- No difference amongst Anterior, Posterior and Lateral lead positions
- Apical lead positions associated with a significantly worse clinical outcome
- Differences maintained even after non-apical leads sub-stratified into mid-ventricular and basal

REVERSE LV Lead Analysis: Apical vs Non-Apical



C Thébault et Al Eur Heart J 2012

Comparison LV lateral vs LV Non-lateral

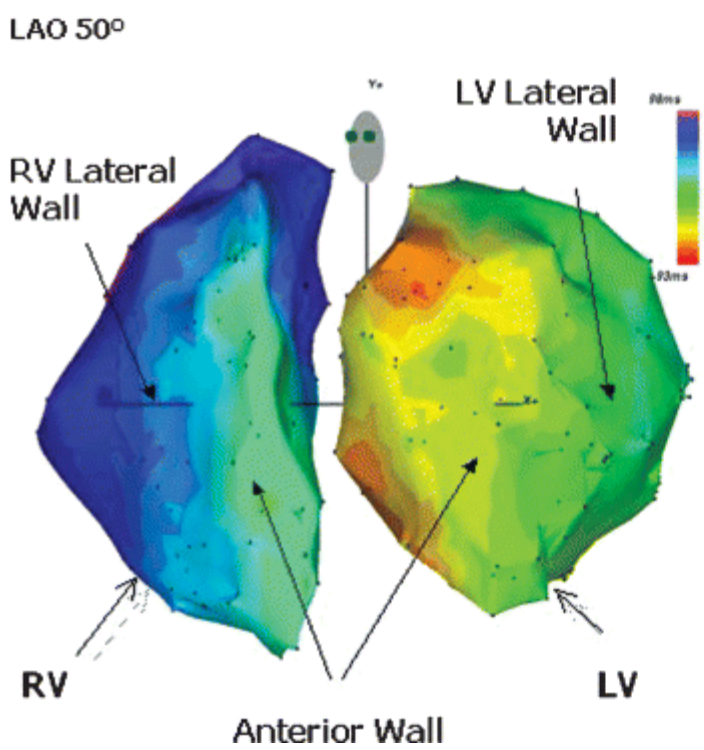


CThébault et Al Eur Heart J 2012

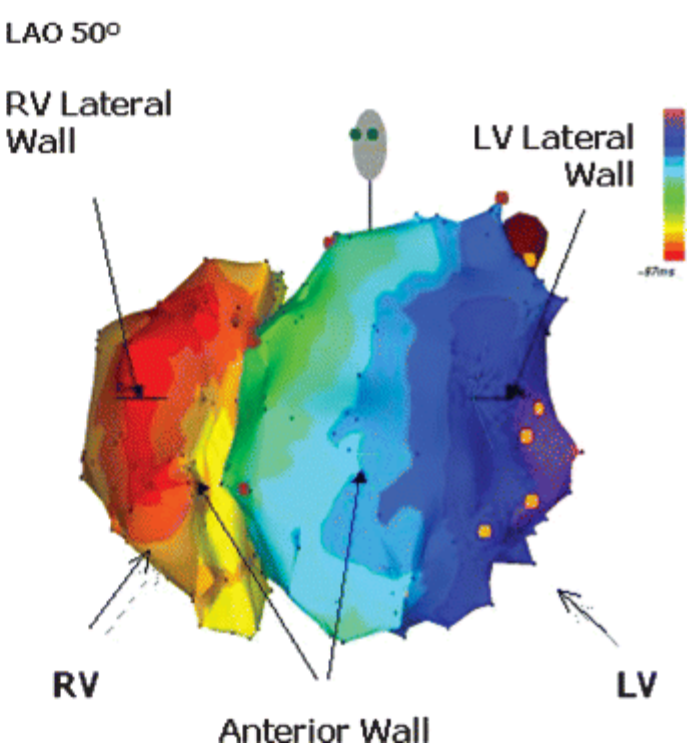
Why is Anatomic Positioning of LV Leads Suboptimal

- CRT is a pacing therapy that changes ventricular activation which results in changes in conduction patterns and LV contraction
- In dilated left ventricles with abnormal contraction patterns and scars, activation is unpredictable
- Therefore, physiologic guidance of LV leads is needed
- We are electrophysiologists not electroanatomists!!

Right Bundle Branch Block

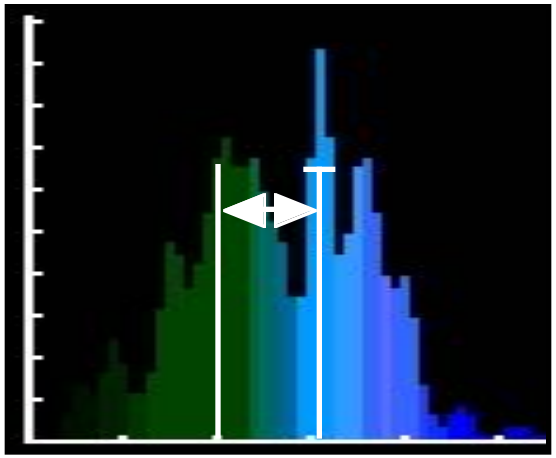


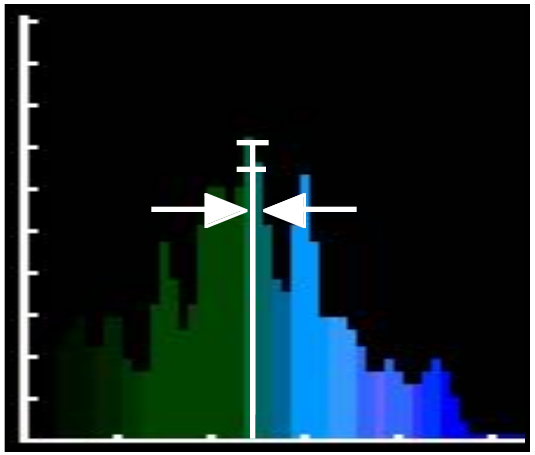
Left Bundle Branch Block



Fantoni C et al. J Cardiovasc Electrophysio 2. 2005 Feb;16(2):112-9

Measures of Ventricular Dysynchrony/Improves with BVS

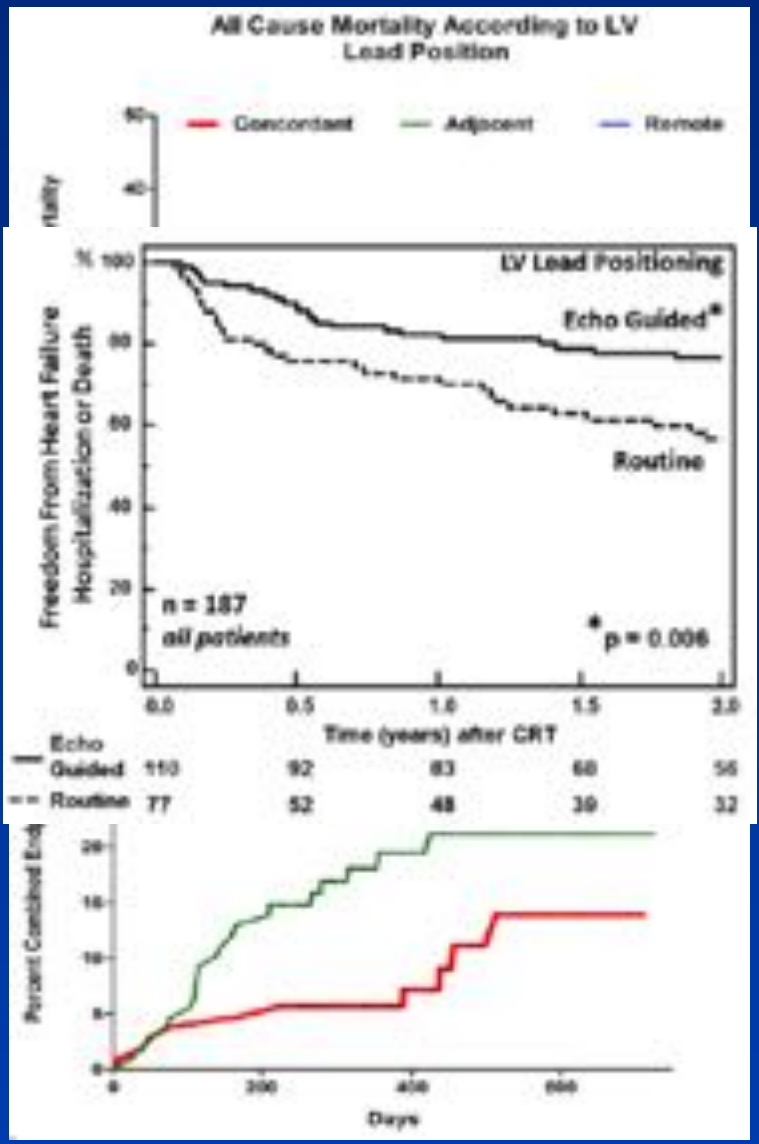




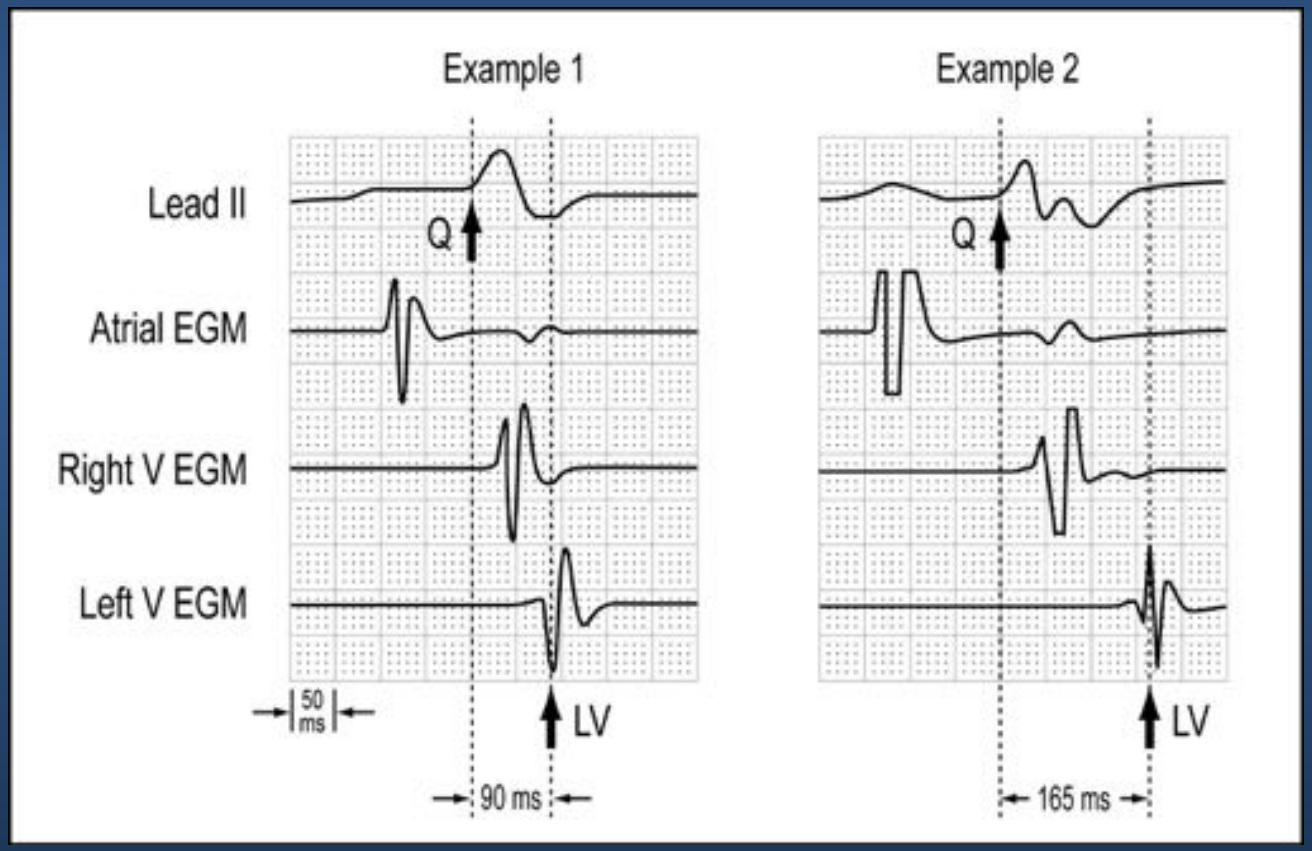
Kerwin JACC 2000;35

Imaging Guided LV Lead Positioning
TARGET & STARTER

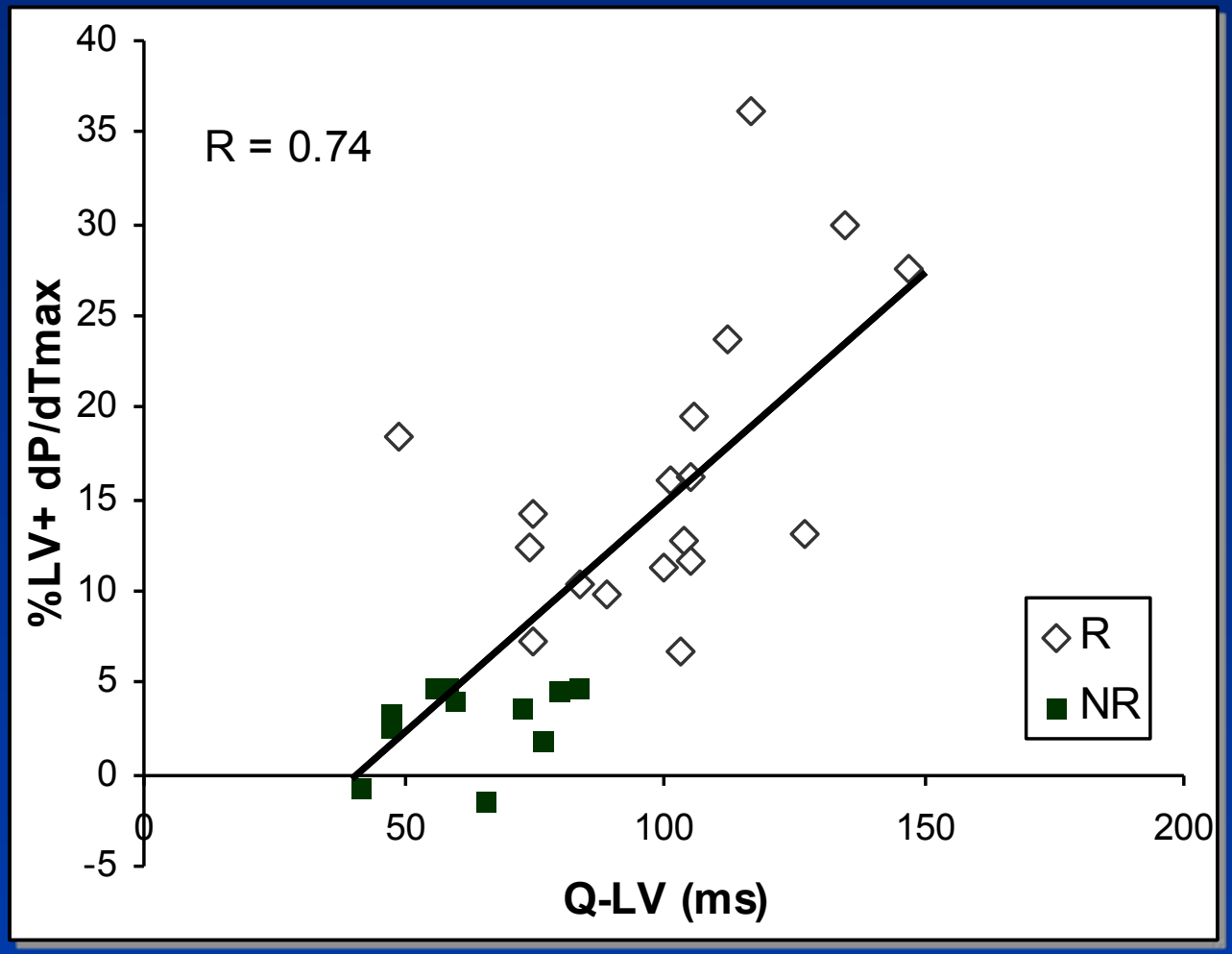
- TARGET: Khan *JACC* 59:1509, 2012
  - RCT of 220 CRT pts
    - Control: post-lat / lat CS branch
    - Targeted: 2D echo speckle-tracking: latest activated segment
  - LV pacing concordance
    - Control: 47%
    - Targeted: 63%
- STARTER: Saba *Circ HF* 6:427, 2013
  - RCT of 187 CRT pts
  - Also used speckle-tracking ECHO
  - LV pacing concordance
    - Control: 66%
    - Targeted: 85%



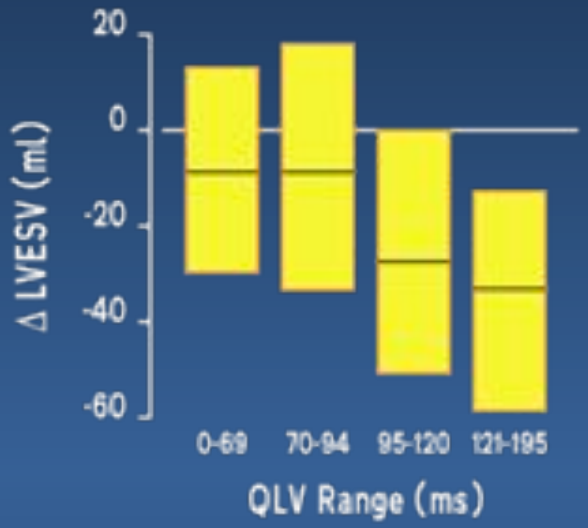
Physiologic Guided Lead Positioning: QLV Interval Measurement

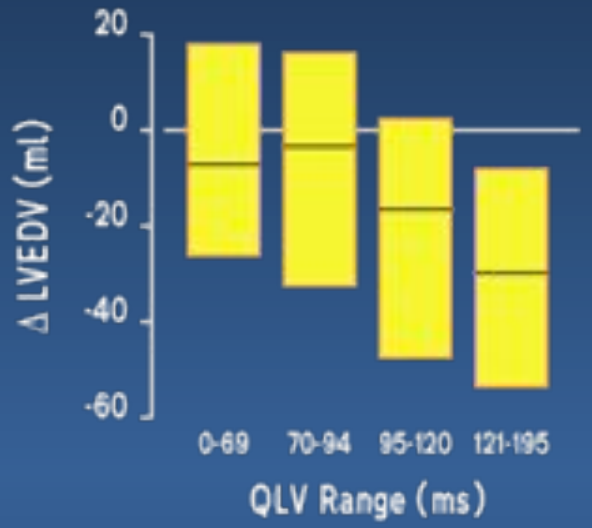


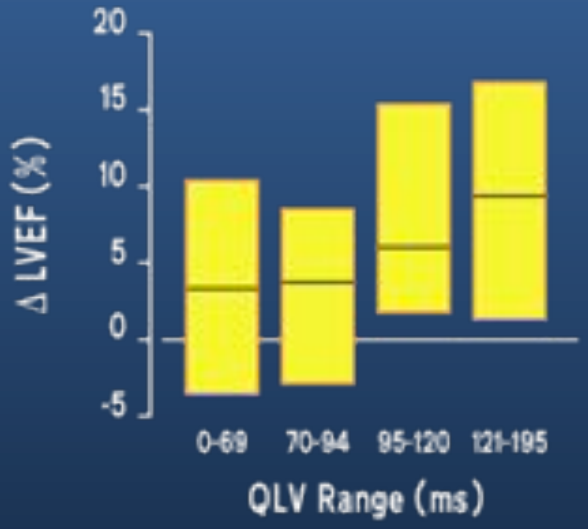
Q-LV Interval to Predict Acute Response

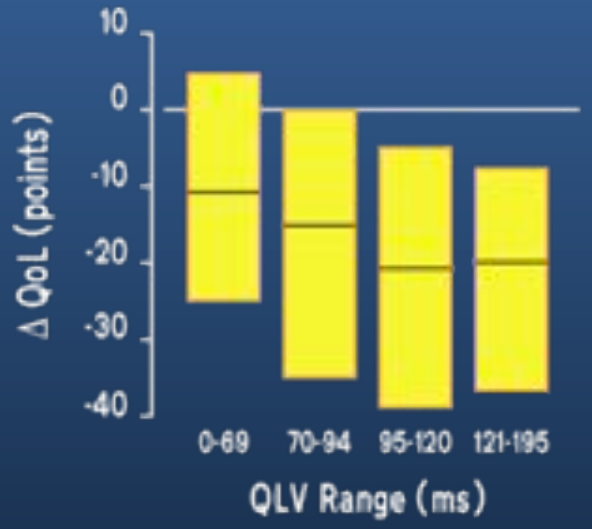


Results: CRT Response By QLV Quartiles







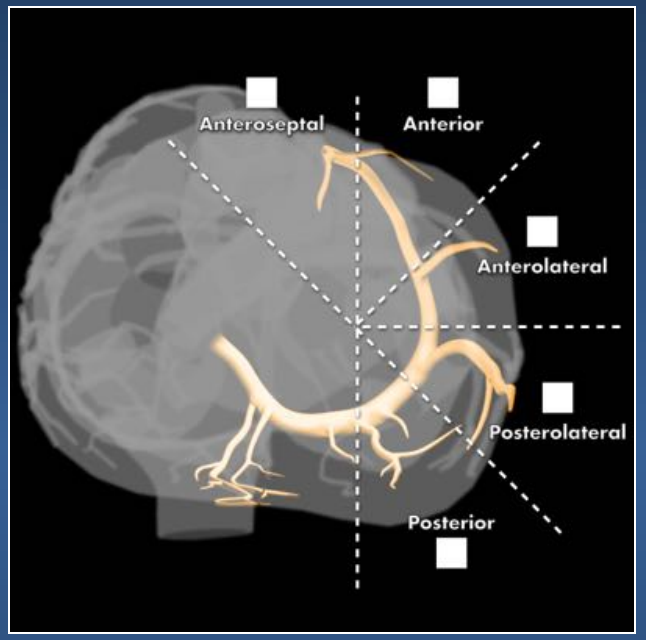


All p<0.001
Kruskal-Wallis test

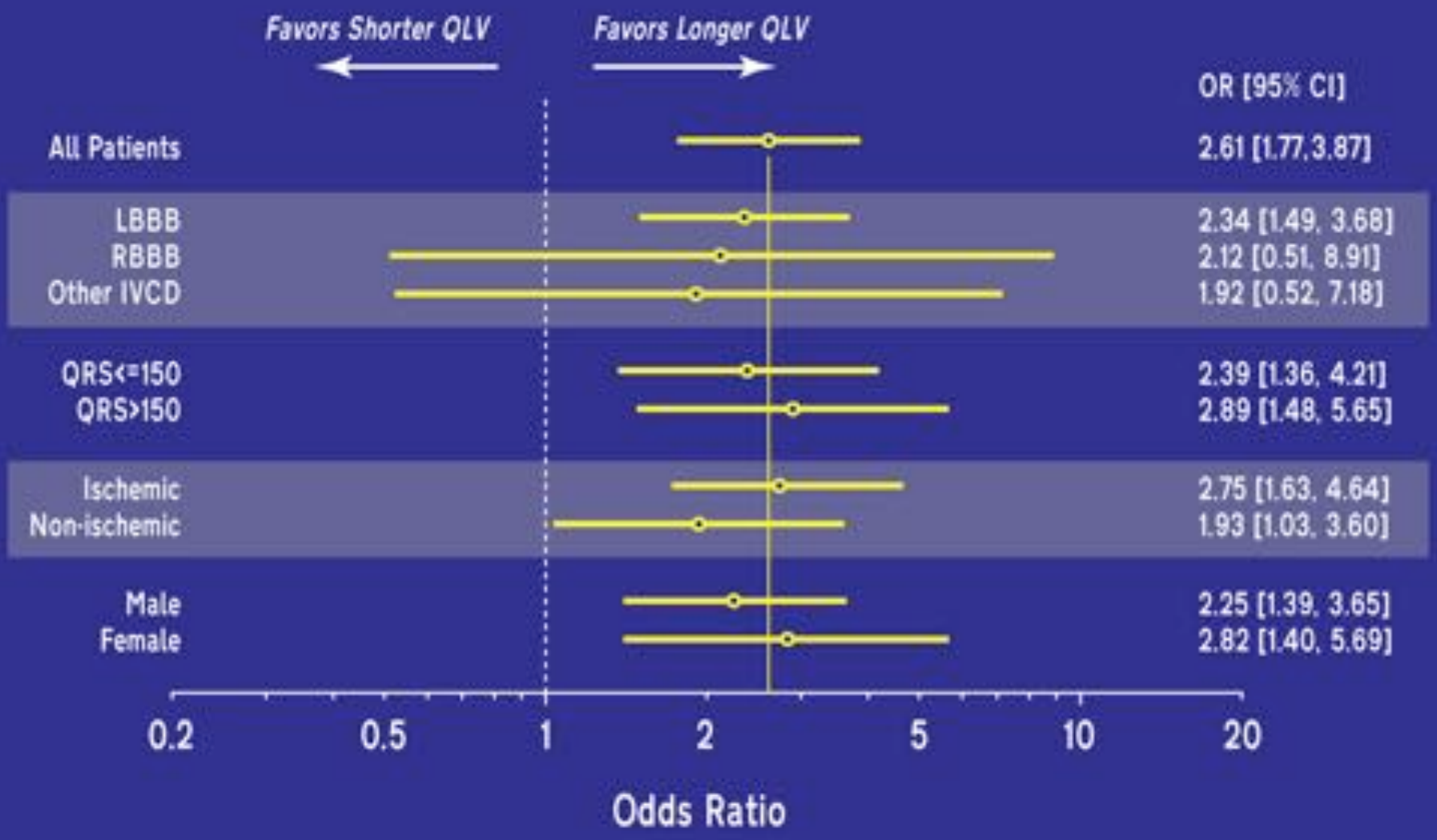
Data presented as median ± inter-quartile range

Relationship between Electrical Intervals and Anatomical Locations

- The location of the LV lead was not controlled in this study
  - Most leads were placed in the anterolateral or posterolateral veins, as reported by the implanting physicians
- 46 of 426 (11%) had apical leads
- 13 of 426 (3%) had anterior or septal leads
- These small numbers preclude any meaningful analysis of the impact of lead location on QLV or response rate
- However, even in similar vein locations, there was marked variation in QLV
  - Mid-anterolateral (n=89): QLV range = 10 – 195 ms
  - Mid-posterolateral (n=230): QLV range = 15 – 195 ms



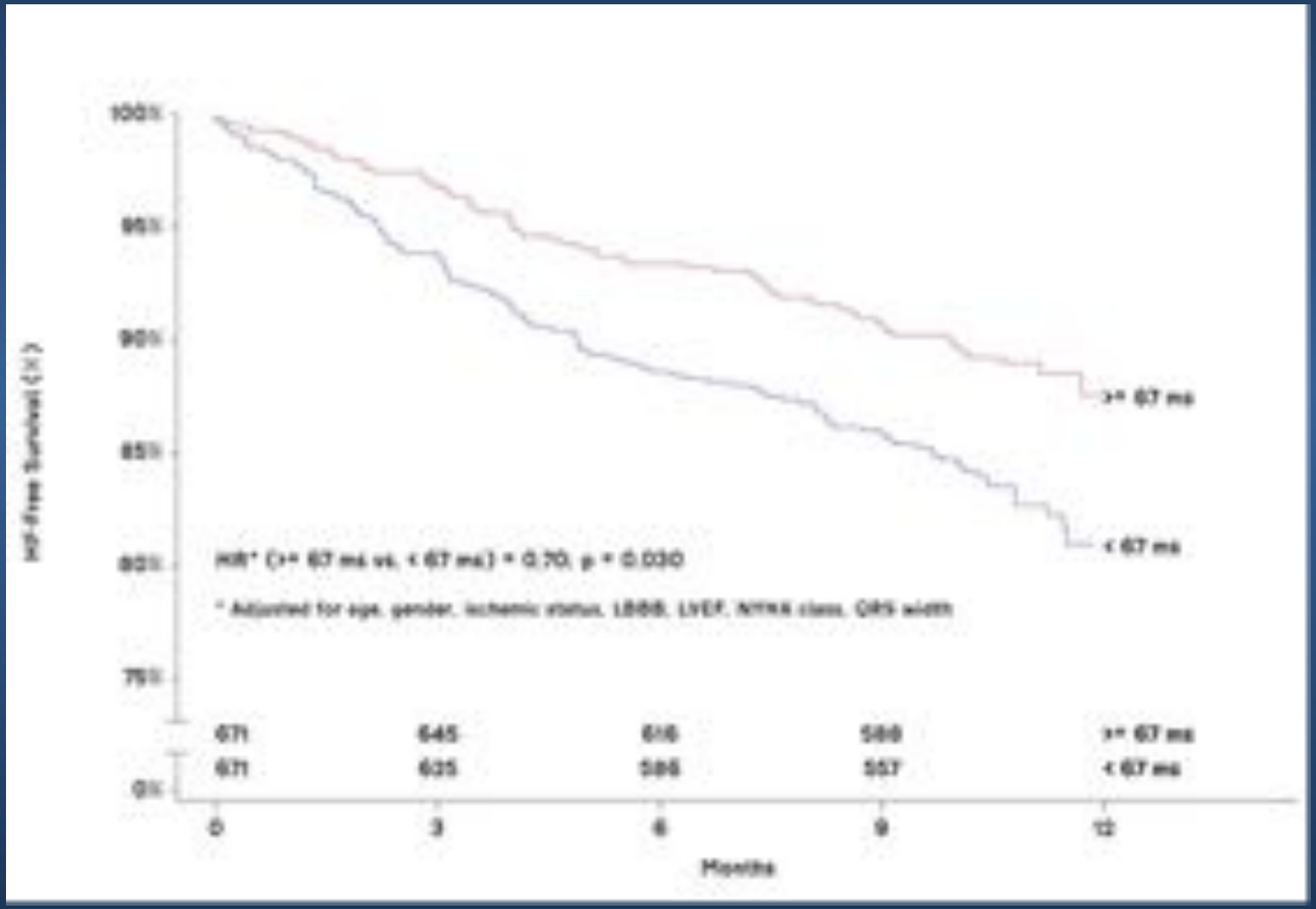
LVESV Response by Subgroup



Interventricular Conduction Delay

- The electrical time between RV and LV leads is a surrogate for QLV (LV delay)
- It measures the electrical resynchronization that will occur with biventricular stimulation
- It is a simple measure that can be manually or automatically measured by devices
- RV-LV delay has also been shown to predict response to CRT

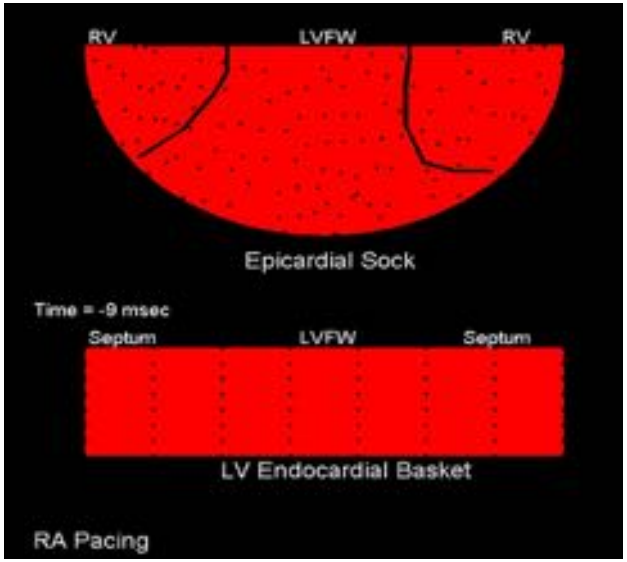
PEGASUS

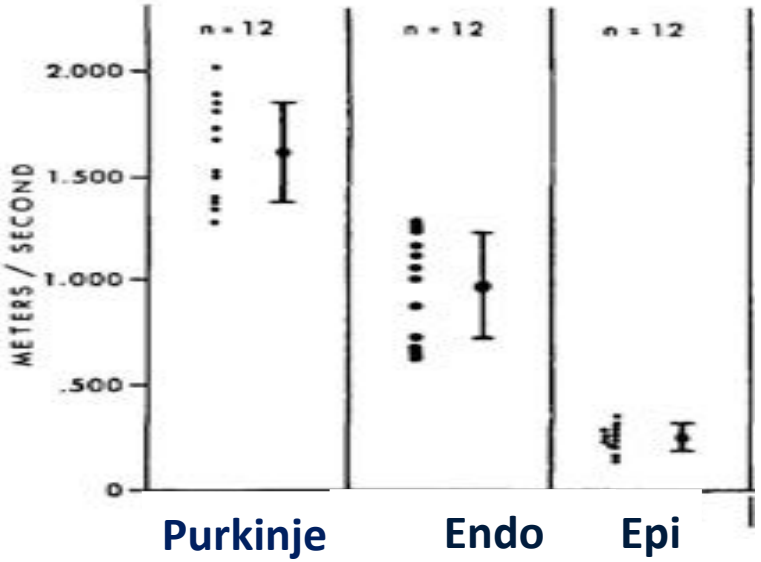


Gold et al, ESC 2014

Rationale to LV Endocardial Pacing

- Access to all regions of the LV (theoretical)
- Electrophysiological advantages:
  faster activation and more homogeneous transmural activation/repolarization

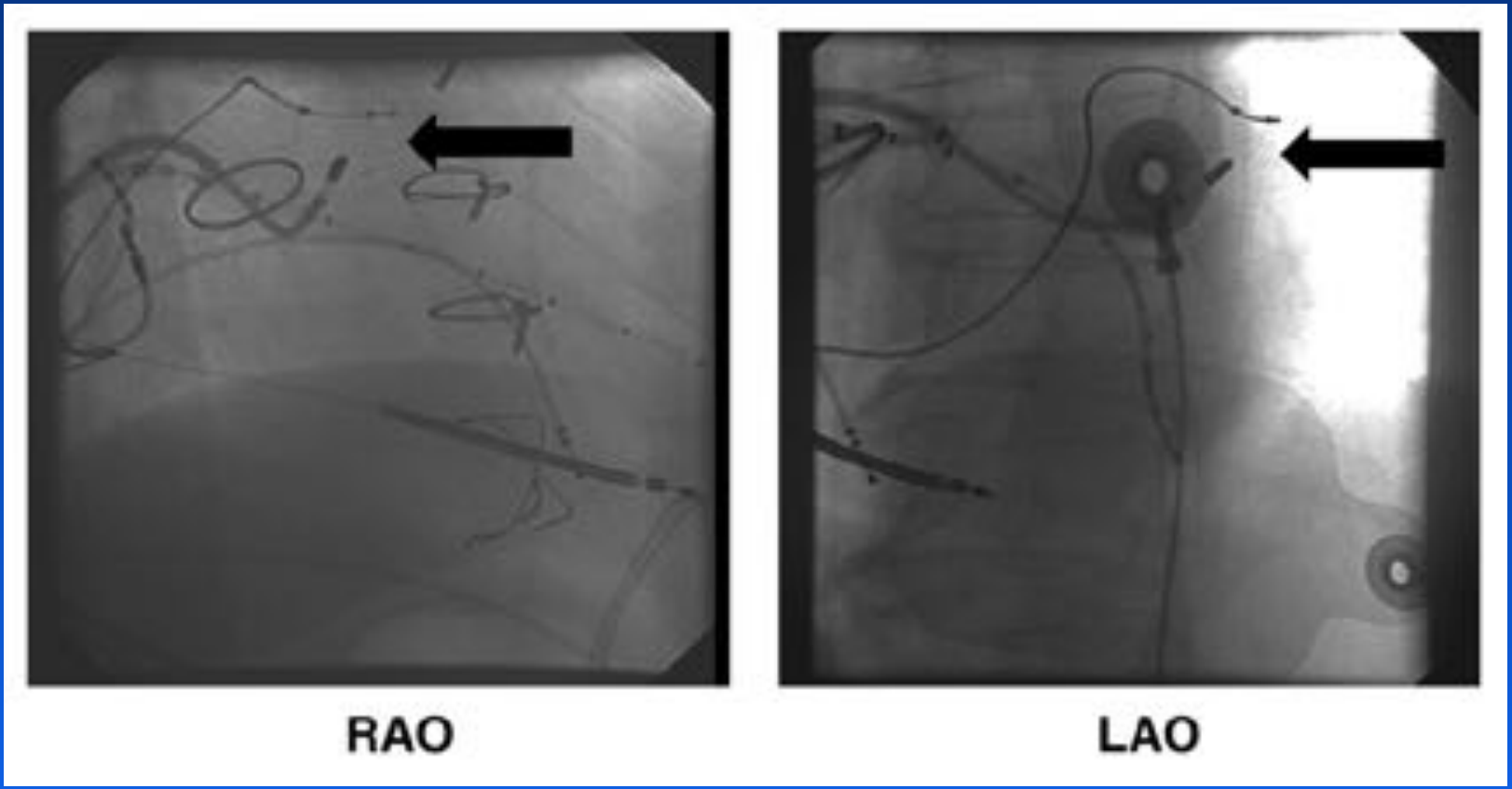




Myerburg et al., Circ. Res. 1978

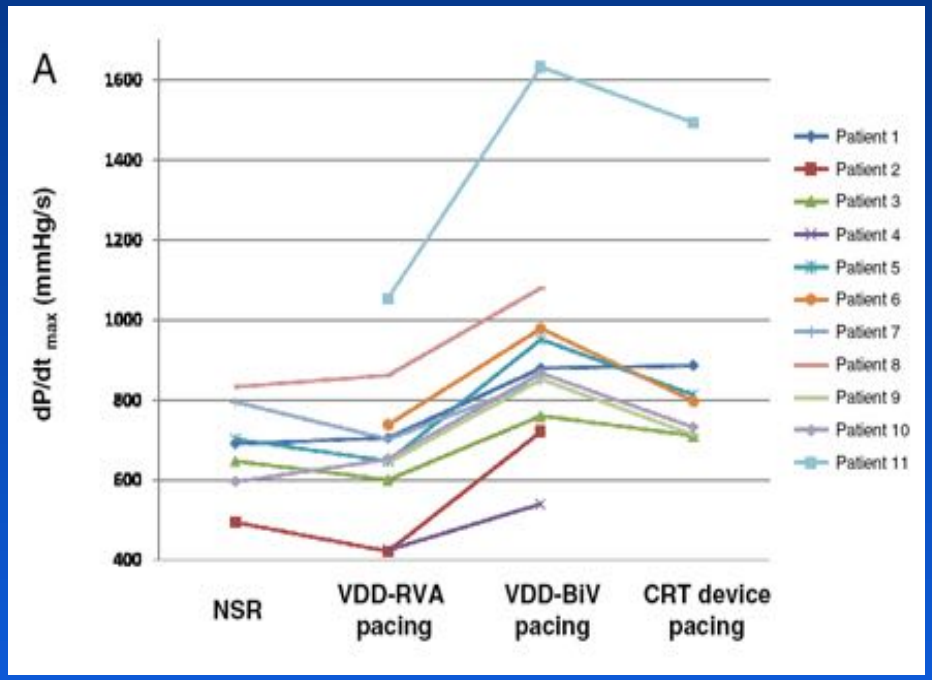
- Mechanical response: greater and less site-dependent

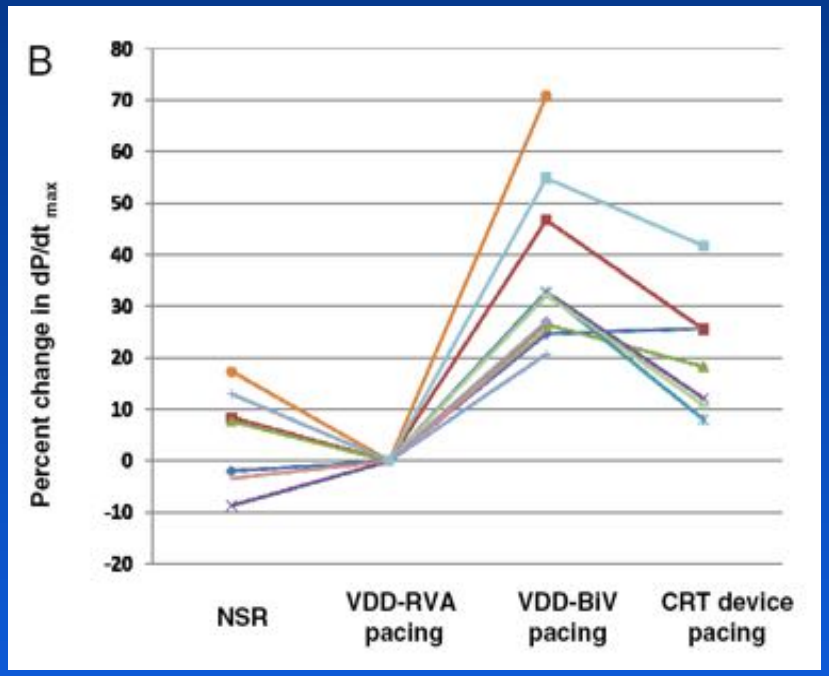
Endo vs Epi Pacing



Spragg et al JACC 2010;56:774–81

Endo vs Epi Pacing



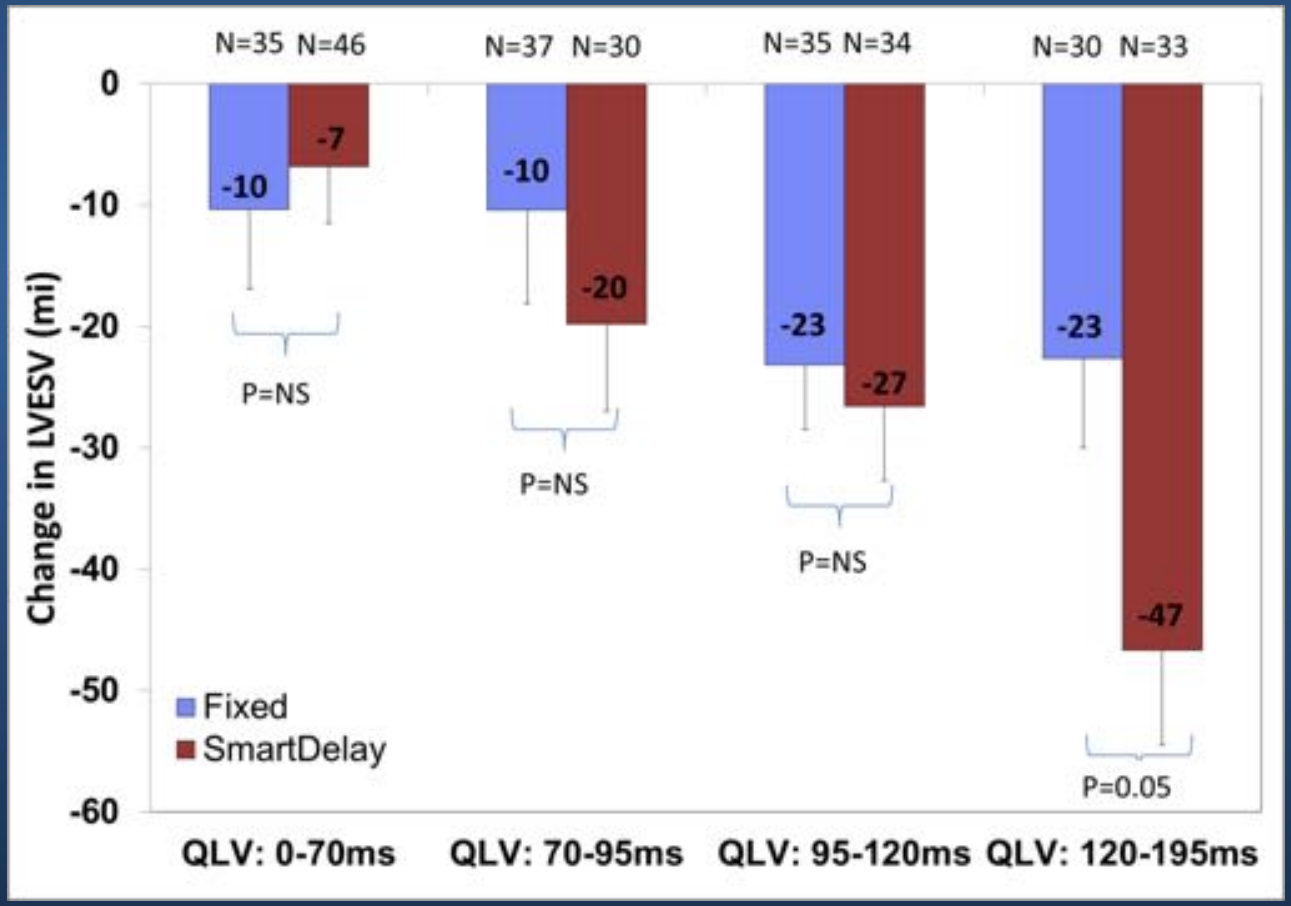


Spragg et al JACC 2010;56:774–81

Are We Thinking About AV Optimization Wrong?

- We can not always turn lemons into lemonade! A nonresponder may be a nonresponder (narrow QRS, RBBB, scar, lead position)
- However, optimal pacing may maximize a positive response

Changes in LVESV as a function of QLV and AV optimization



SUMMARY

- Traditionally, LV leads are placed on the lateral wall of the left ventricle via the coronary sinus based on acute hemodynamic studies
- More recently, studies have shown the importance of physiologically guided lead placement, based on mechanical or electrical delay
- Pacing at sites of electrical delay improves clinical outcomes, increases remodeling and is enhanced further with AV optimization, even among subgroups that that traditionally have low response rates