



## ***CRT: Presente e Futuro***

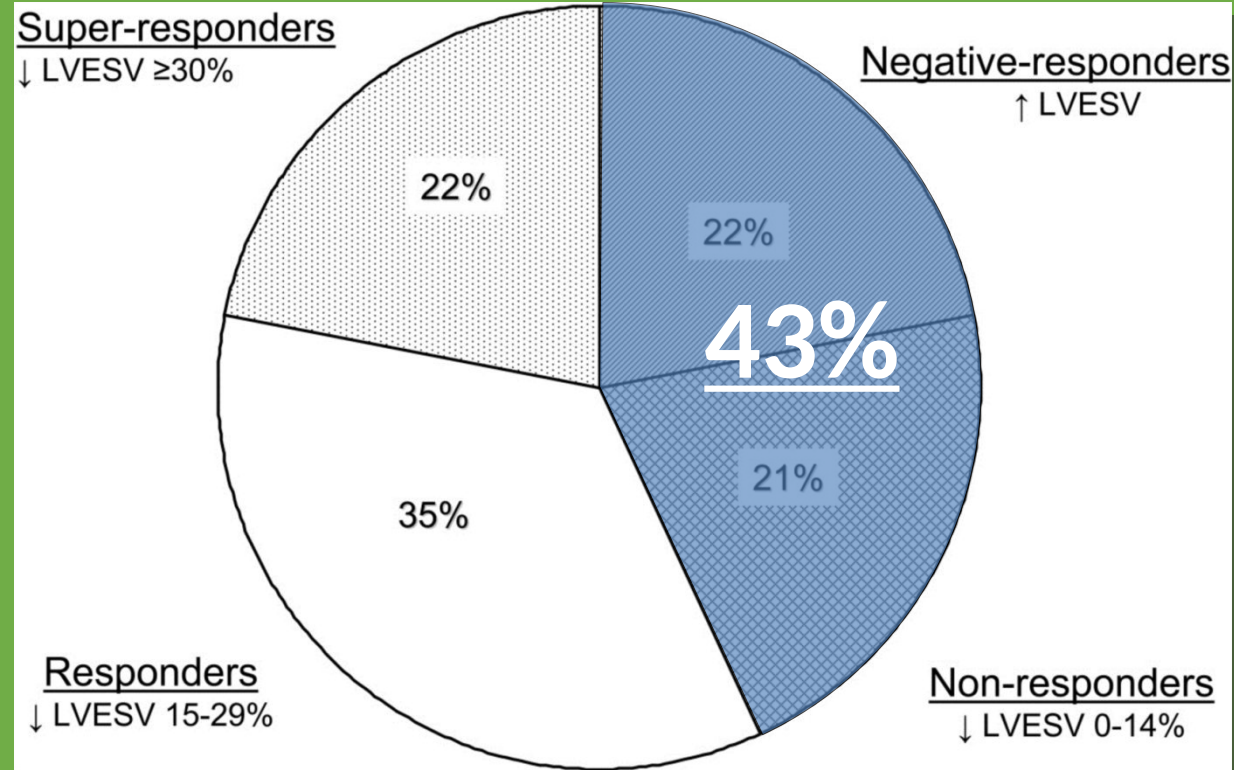
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**Section Head, Cardiac Pacing and Electrophysiology Unit.**  
**Azienda Ospedaliera - Polo Universitario- “Luigi Sacco”**  
**Milano. Italy**

# The clinical evidence for CRT

- CRT improves **survival** and hospitalization
- CRT improves functional capacity and QoL
- Strong evidence for reverse remodeling
  - ↓ LV volumes and dimensions
  - ↑ LV ejection fraction
  - ↓ Mitral regurgitation

# CRT non-responder patient: Epidemiology










**43%** CRT patients are classified as **non-responder** or **negative-responder** referred to LVEDV after 6 months (N=302)

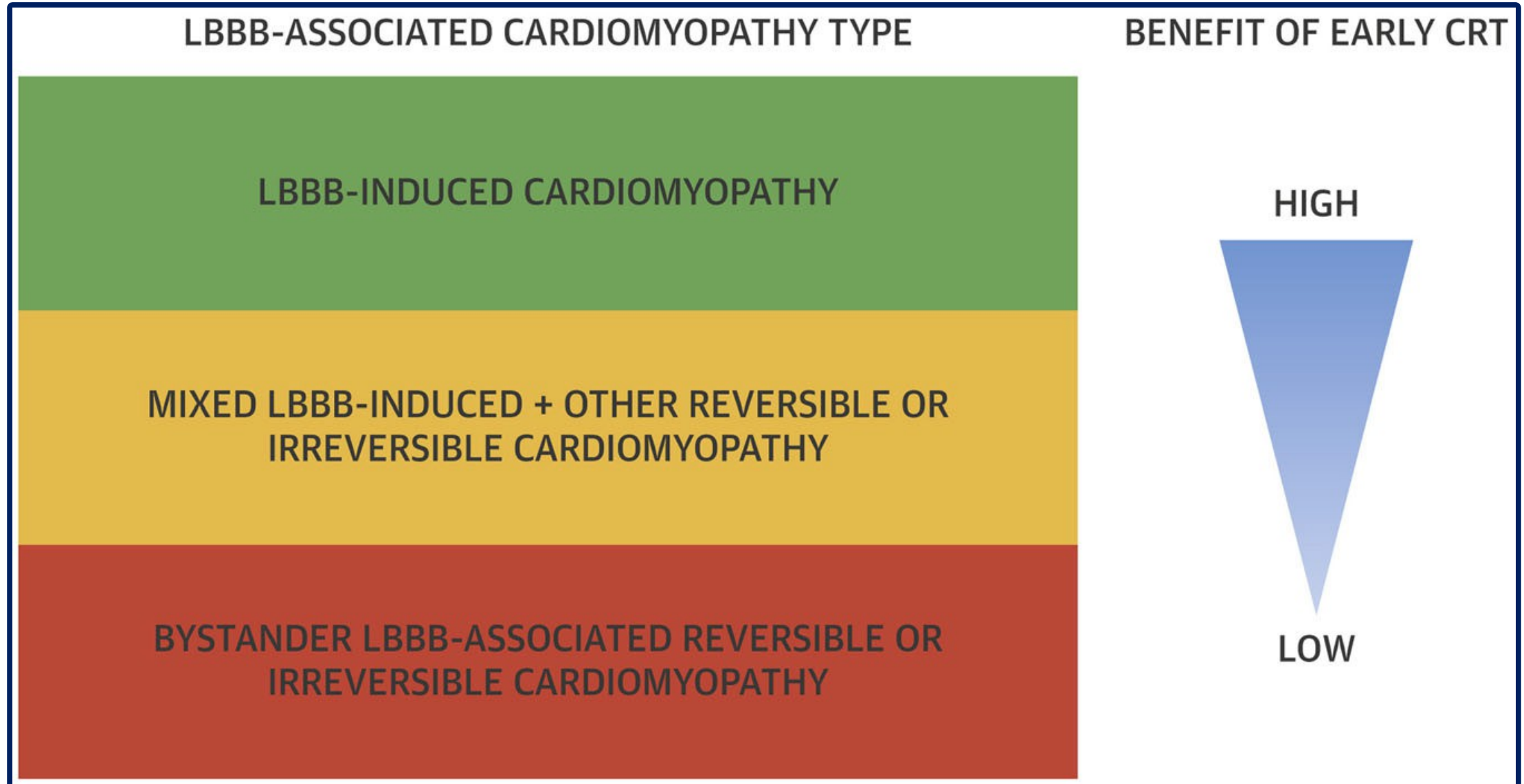
## *Strategies to address the challenge of non-responsiveness*

- **Careful selection of patients**
- **Optimal device implantation**
- **Post-implant device programming with long-term monitoring.**
- **New pacing forms, especially physiological pacing (HBP and LBBP).**

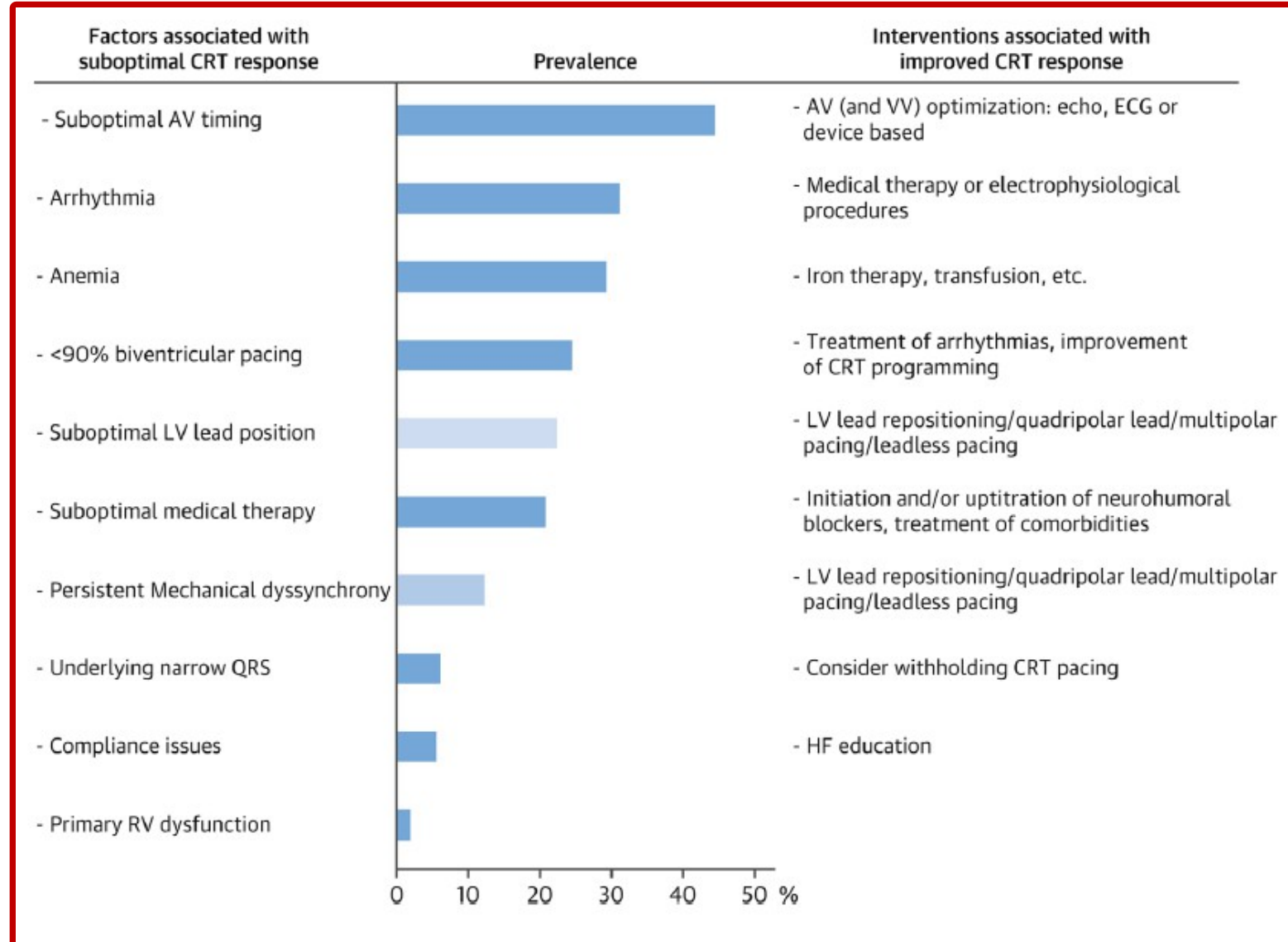
## *How to Select a Patient for CRT Implantation*

	Best candidate	Worst candidate
 QRS duration	>150 msec	<120 msec
 QRS morphology	LBBB	non-LBBB
 Scar and Dyssynchrony	(-)	(+)
 Etiology	CAD (-)	CAD (+)
 Gender	f	m
 Atrial Fibrillation	(-)	(+)
 Renal Dysfunction	(-)	(+)

## ***Magnitude of BIV-CRT response: all LBBBs are not equal***



# ***Factors associated with sub-optimal CRT response***





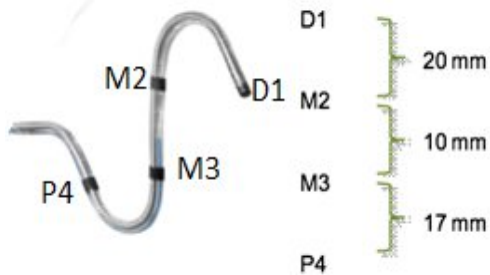
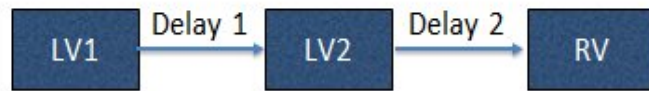
# Quadripolar LV leads:... a base for a new CRT era: The Multipoint Pacing

FROM MULTIPOLAR LEADS...

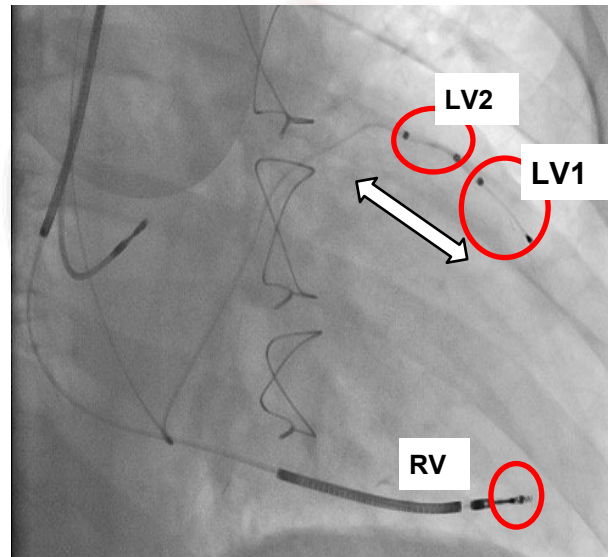
...TO MULTIPOINT PACING

MultiPoint™ Pacing (MPP) allows delivery of Cardiac Resynchronization Therapy (CRT) by **two sequential stimuli from different cathodes** of a quadripolar left ventricular (LV) lead.

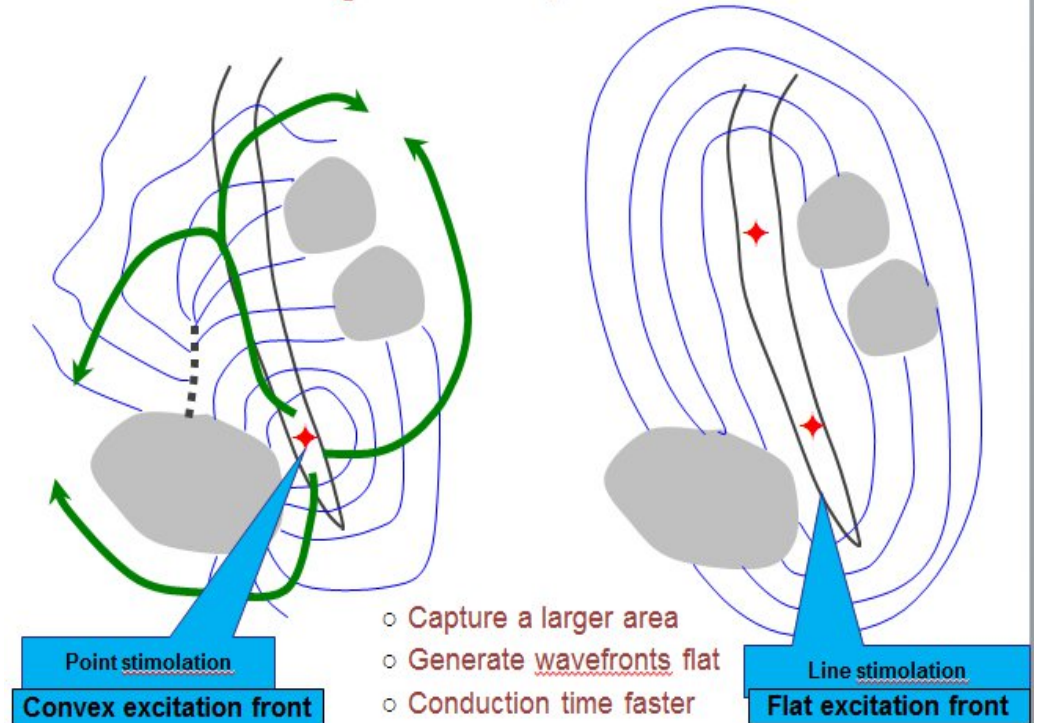
Ability to pace from **2 LV sites** with a **single LV lead** with **programmable delays**



Quartet™ LV Lead 1458Q



Possible Patterns of Wavefront Propagation with conventional LV Pacing vs. MPP in HF, Scarred Heart



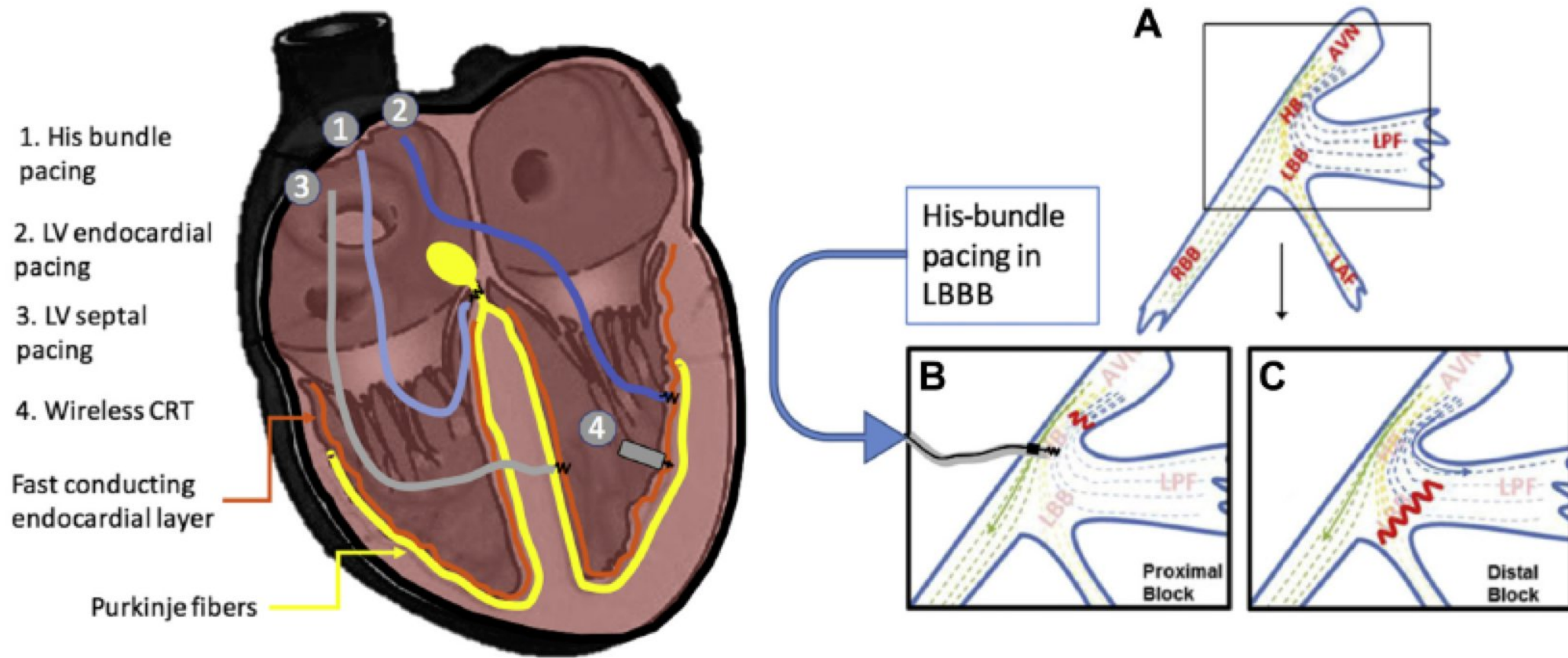


# ***CRT: New pacing forms***

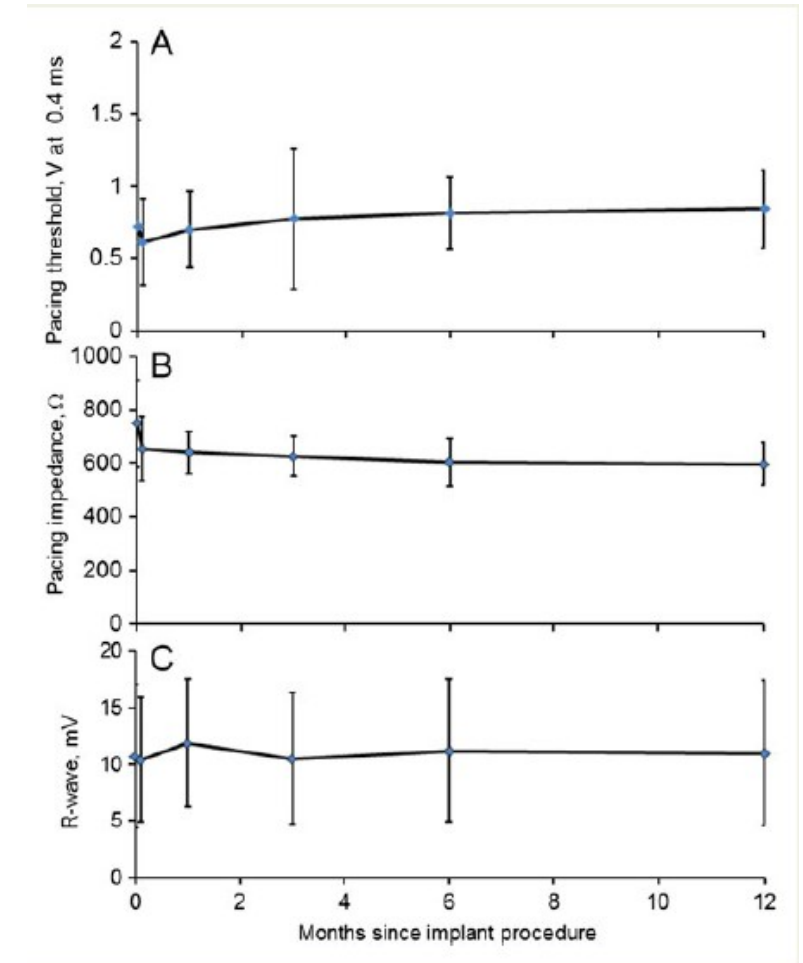
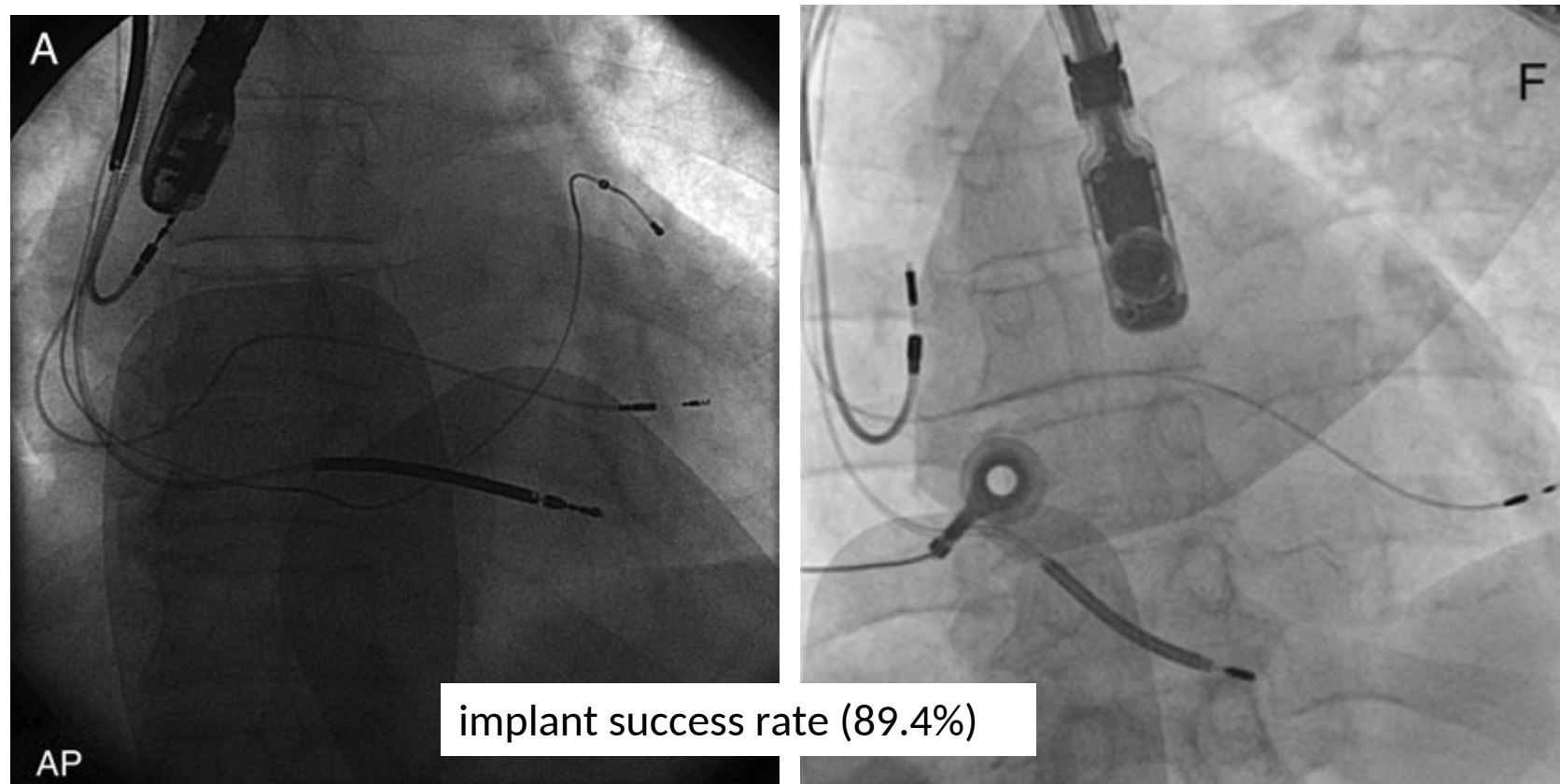
- **Left-ventricular endocardial pacing (LVEP)**
- **Physiological pacing: Conduction system pacing**
  - **His bundle pacing**
  - **Left bundle branch area pacing**

# Novel pacing approaches for CRT

aim at creating activation patterns that are more physiological than transvenous CRT



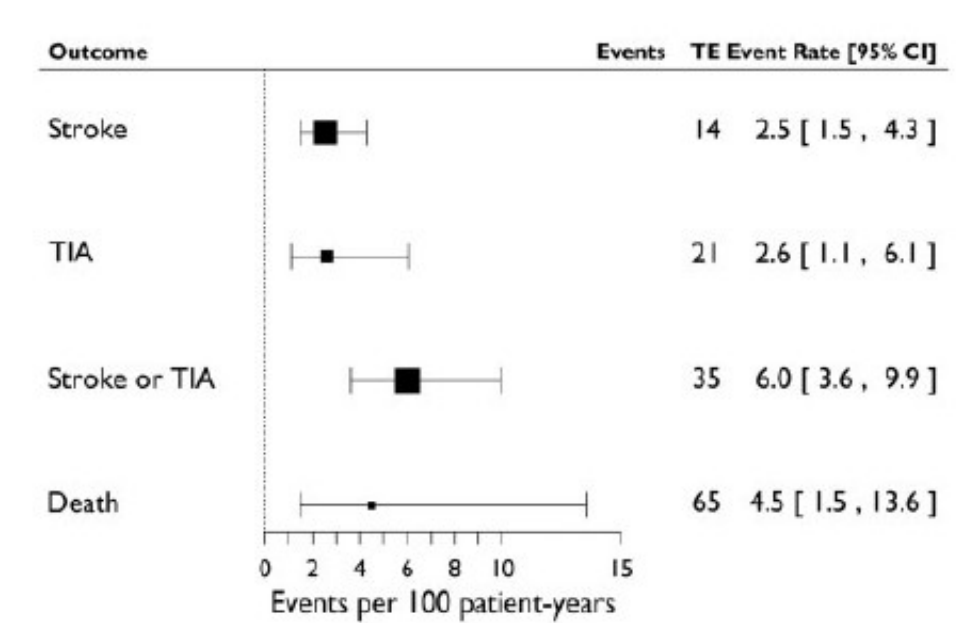
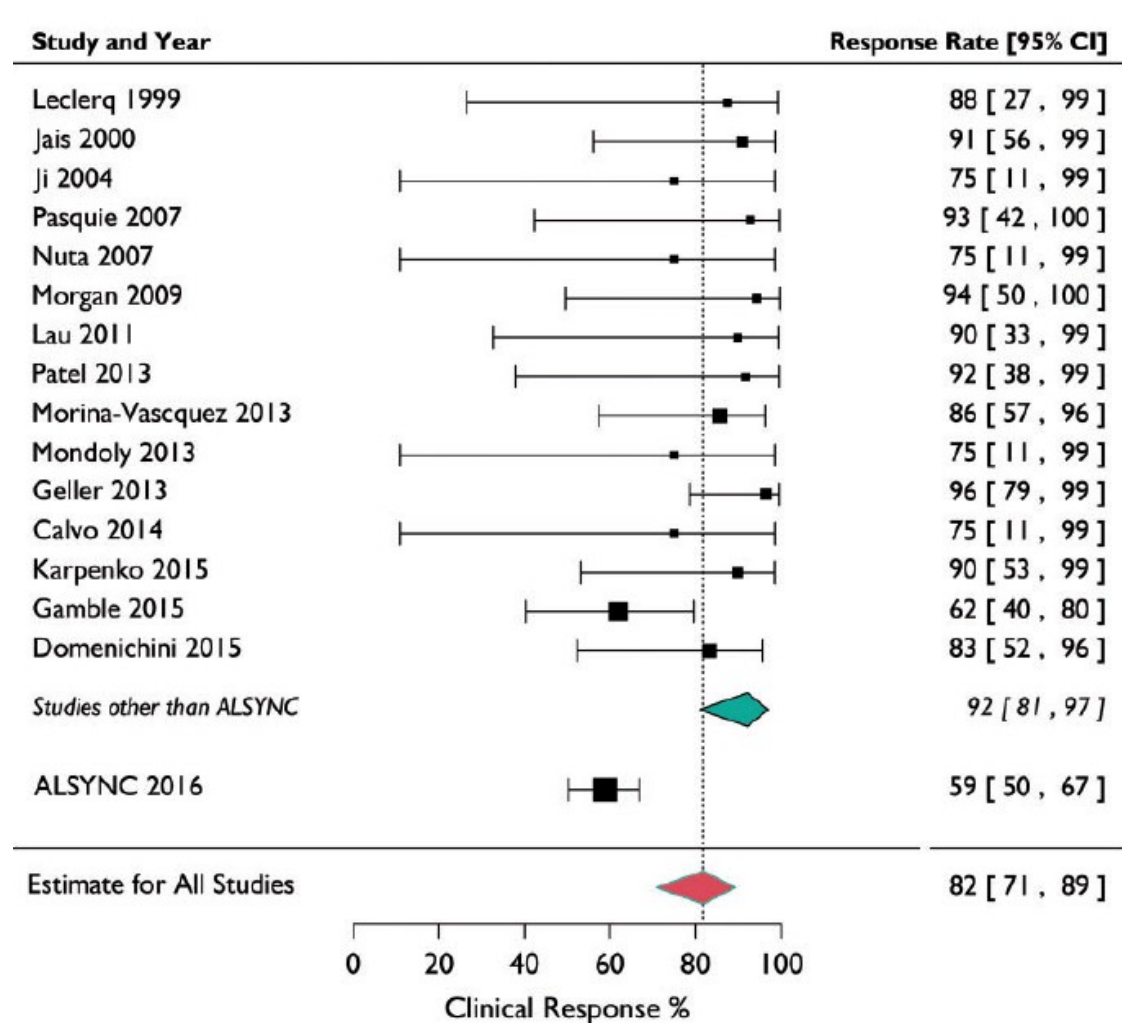
# LV endocardial pacing: ALSYNC study



Clinical and echocardiographic improvement was 59 and 55% respectively in 138 pts with prior non-response

# LV endocardial pacing

## Endocardial left ventricular pacing for cardiac resynchronization: systematic review and meta-analysis



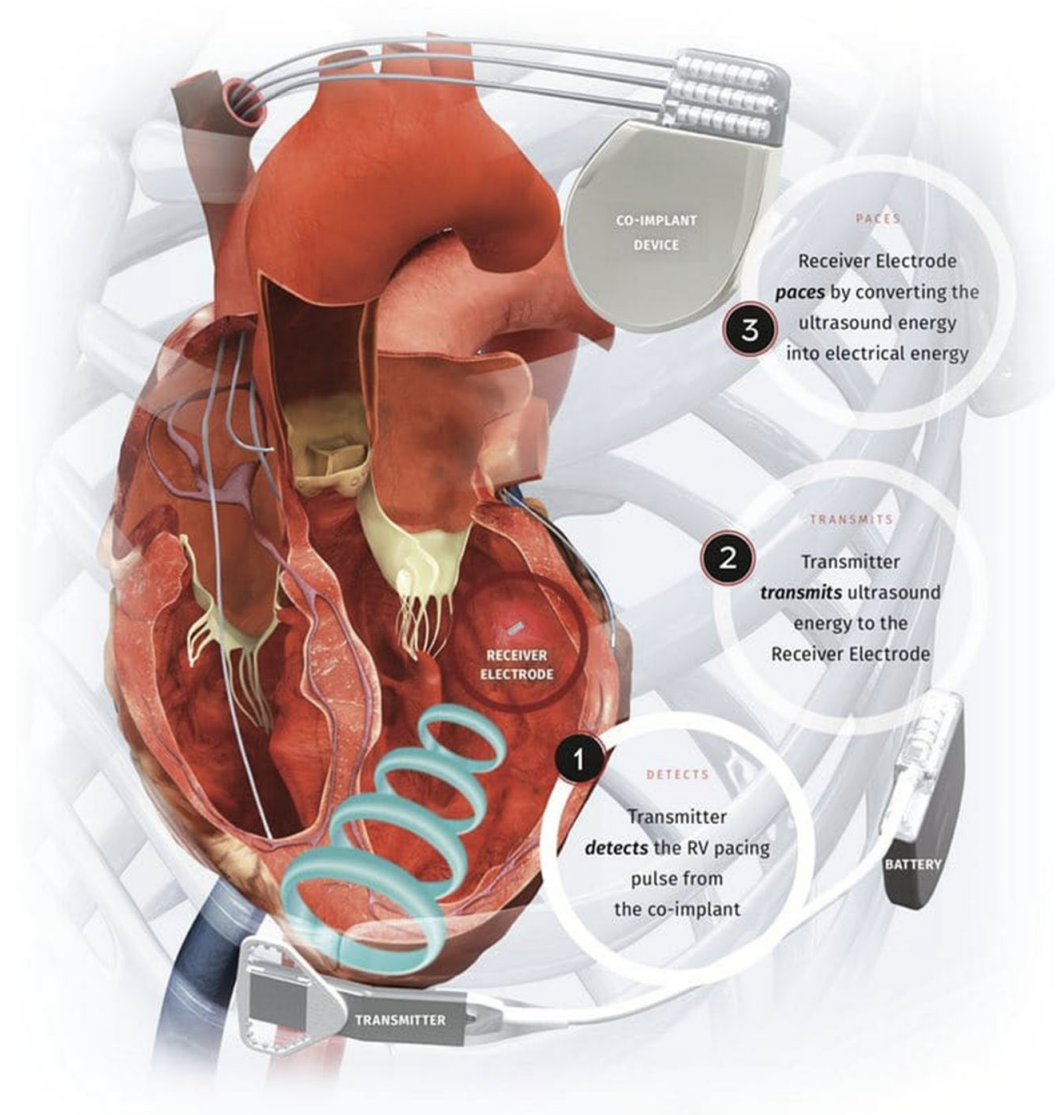
- Procedural success rates > 95%
- Clinical response of 82%
- The rate of stroke was 2.5 events per 100 patient years



# Leadless pacing systems

EF < 35%  
BBSx  
CRT-Non responders

- Small receiver-electrode in LV.
- Ultrasound (USS) pulse generator, implanted subcutaneously in an intercostal space
- The pulse generator is triggered by RV pacing, resulting in near simultaneous (within 3 ms) LV and RV endocardial activation.
- Anticoagulation is not required

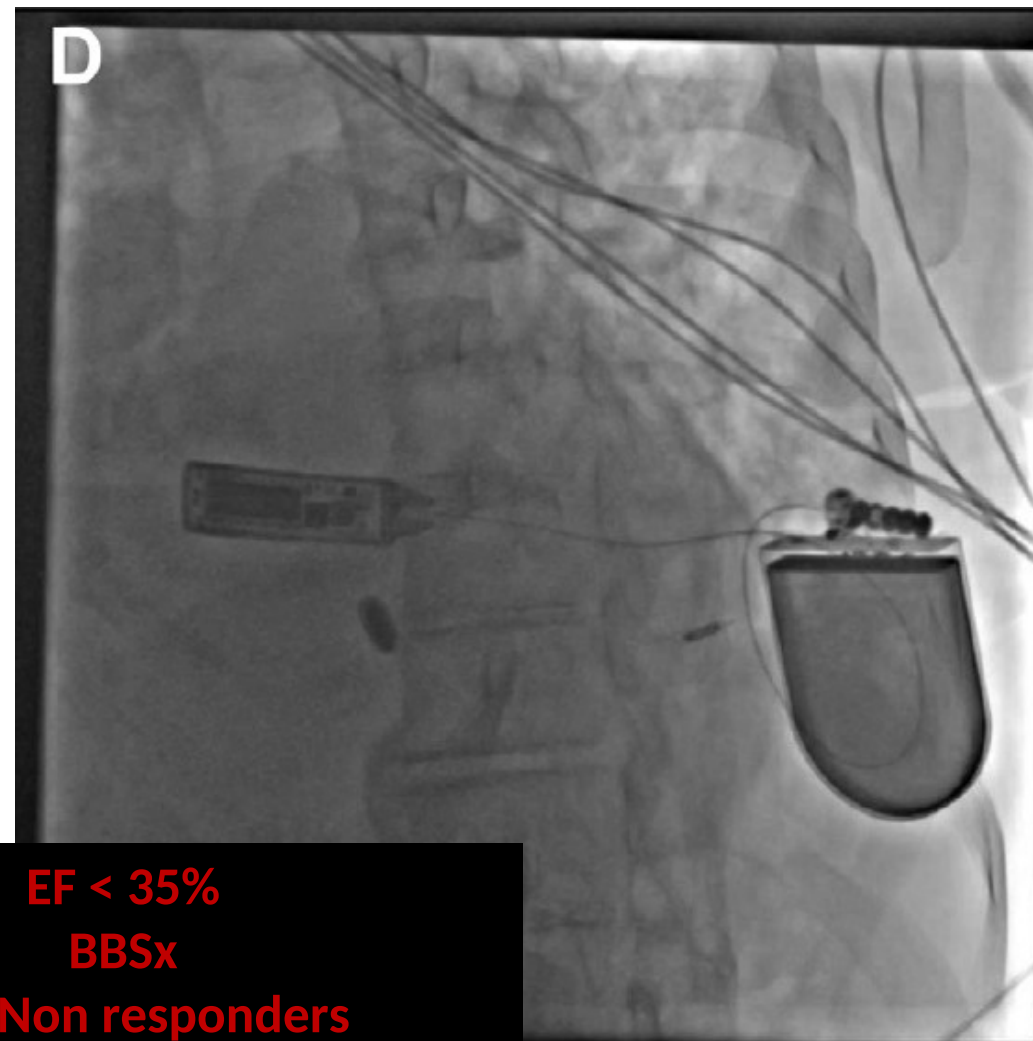


# Leadless pacing systems

- 90 patients from 14 EU centers
- 94.4% success rate
- 70% of patients had improvement in HF
- 3 procedure related death

Complication data	No. (%)
Patient deaths within the registry	5 (5.6)
Procedure related	3
Nonprocedure related	2
Acute (<24 h)	4 (4.4)
Cardiac tamponade	2
Pneumothorax/pleural effusion	2
Intermediate (>24 h–1 mo)	17 (18.8)
Death	1
Arterial access complication	4
Pocket hematoma (generator)	4
Postprocedure chest sepsis	3
Pocket infection (generator)	3
Acute kidney injury	2
Chronic (1–6 mo)	6 (6.7)
Death	4
CVA	1
Extrastimulation during TTE	1

Real-world experience of leadless left ventricular endocardial cardiac resynchronization therapy: A multicenter international registry of the WiSE-CRT pacing system <sup>e</sup>

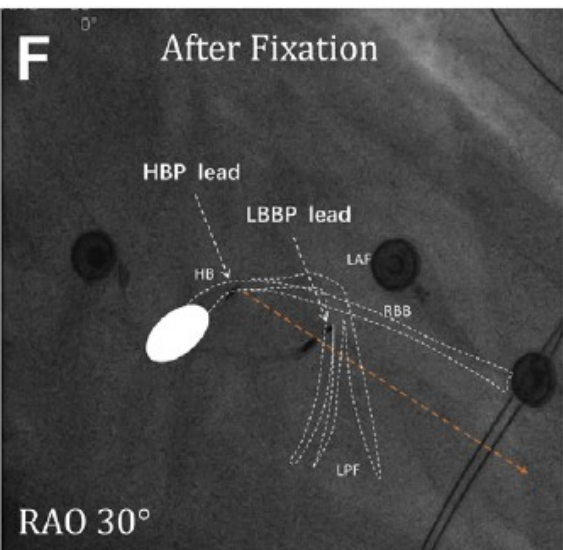
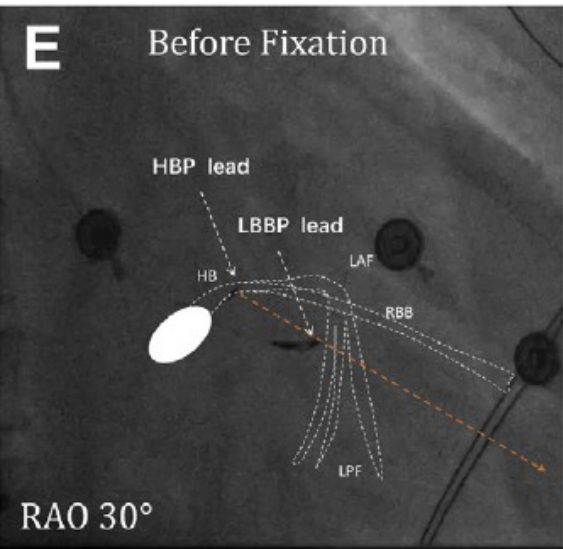


**EF < 35%**  
**BBSx**  
**CRT-Non responders**

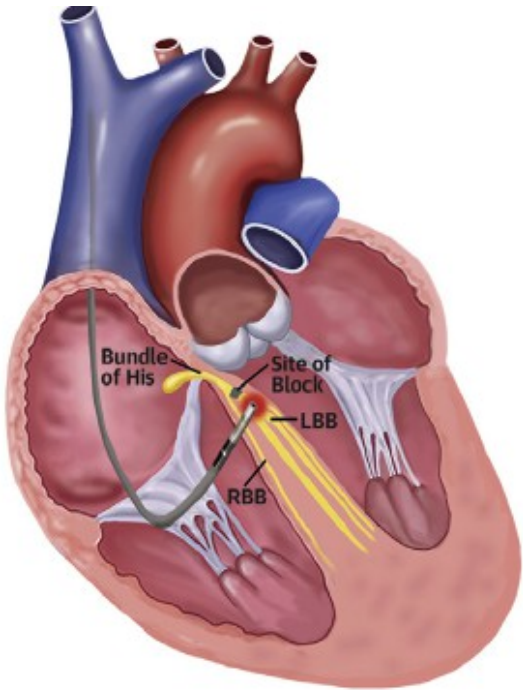
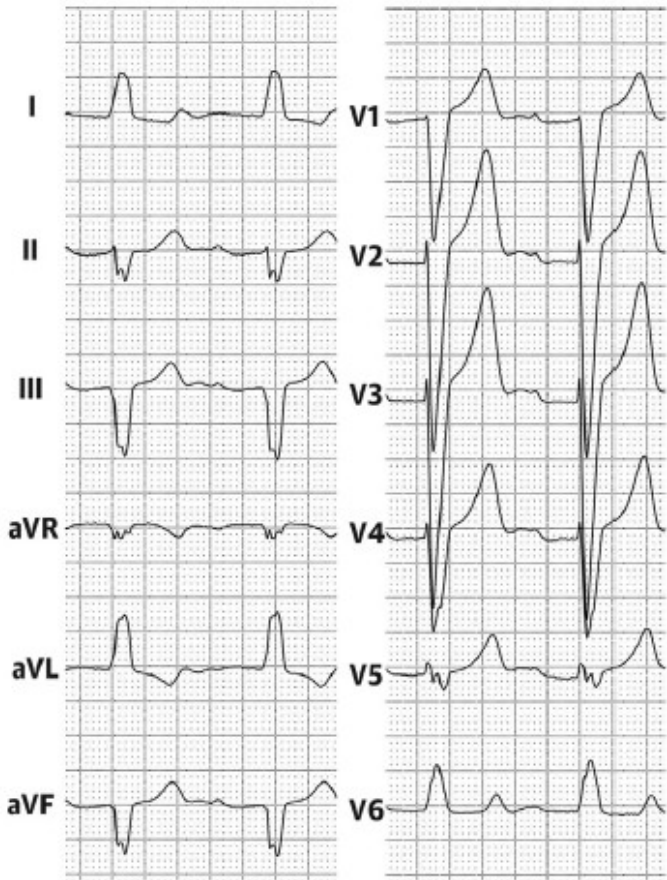


# Conduction System Pacing for CRT in LBB Patients: LBB pacing

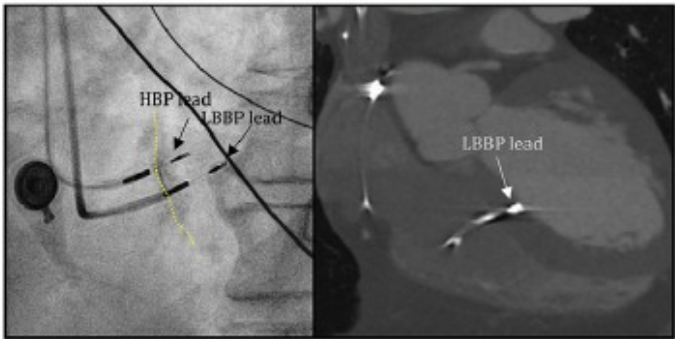
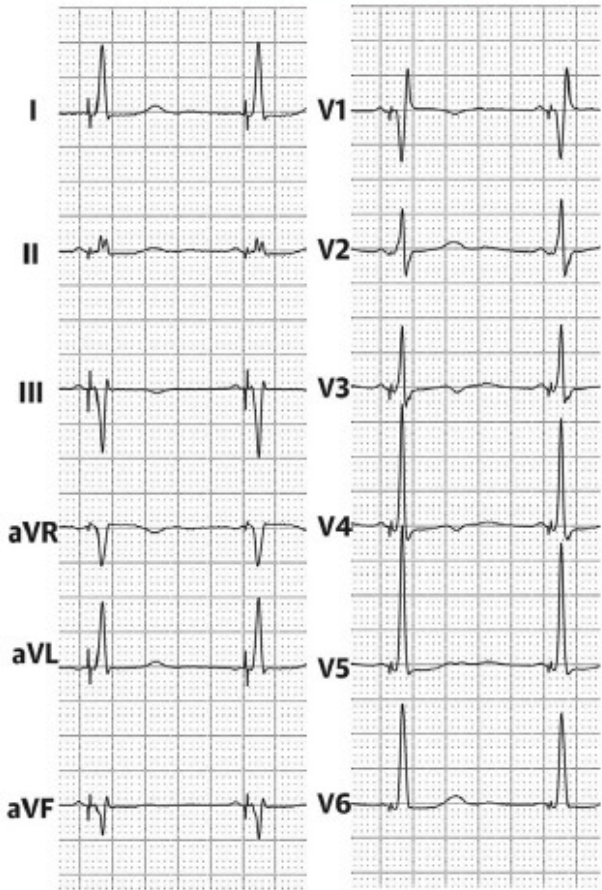
EF < 35%  
BBSx



Intrinsic LBBB  
QRS 165ms



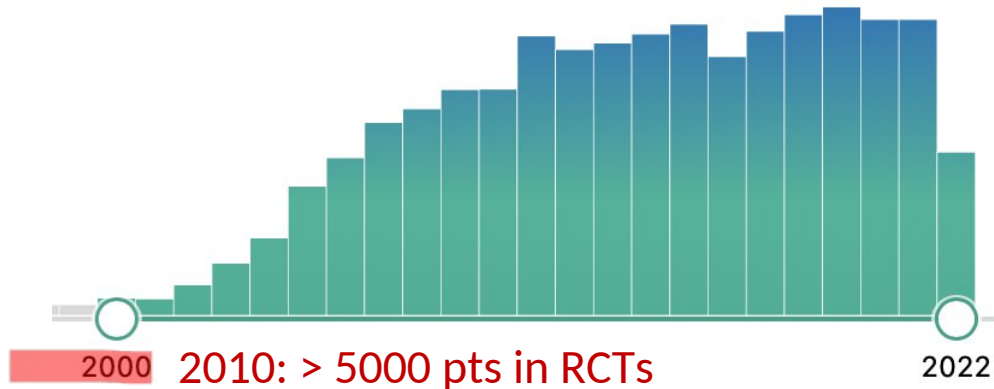
LBBP  
QRS 104ms



Huang, W. et al. J Am Coll Cardiol EP. 2020;6(7):849-58.

# BIV-CRT vs CSP-CRT?

<< < Page 1 of 42 > >>



Query

Results

Search: **(CARDIAC RESYNCHRONIZATION THERAPY[Title/Abstract]) OR (LEFT VENTRICULAR PACING[Title/Abstract])** Filters: from 1999 - 2022 Sort by: Publication Date

8,306

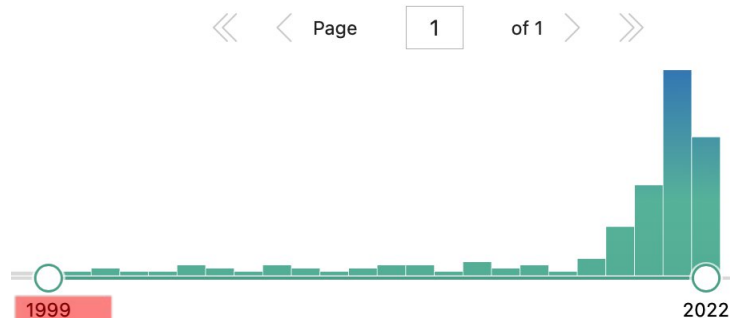
## *Il peso dell'evidenza clinica:*

Query

Results

Search: **(HIS PACING[Title/Abstract]) OR (CONDUCTION SYSTEM PACING[Title/Abstract])** Filters: from 1999 - 2022 Sort by: Publication Date

152



Query

Results

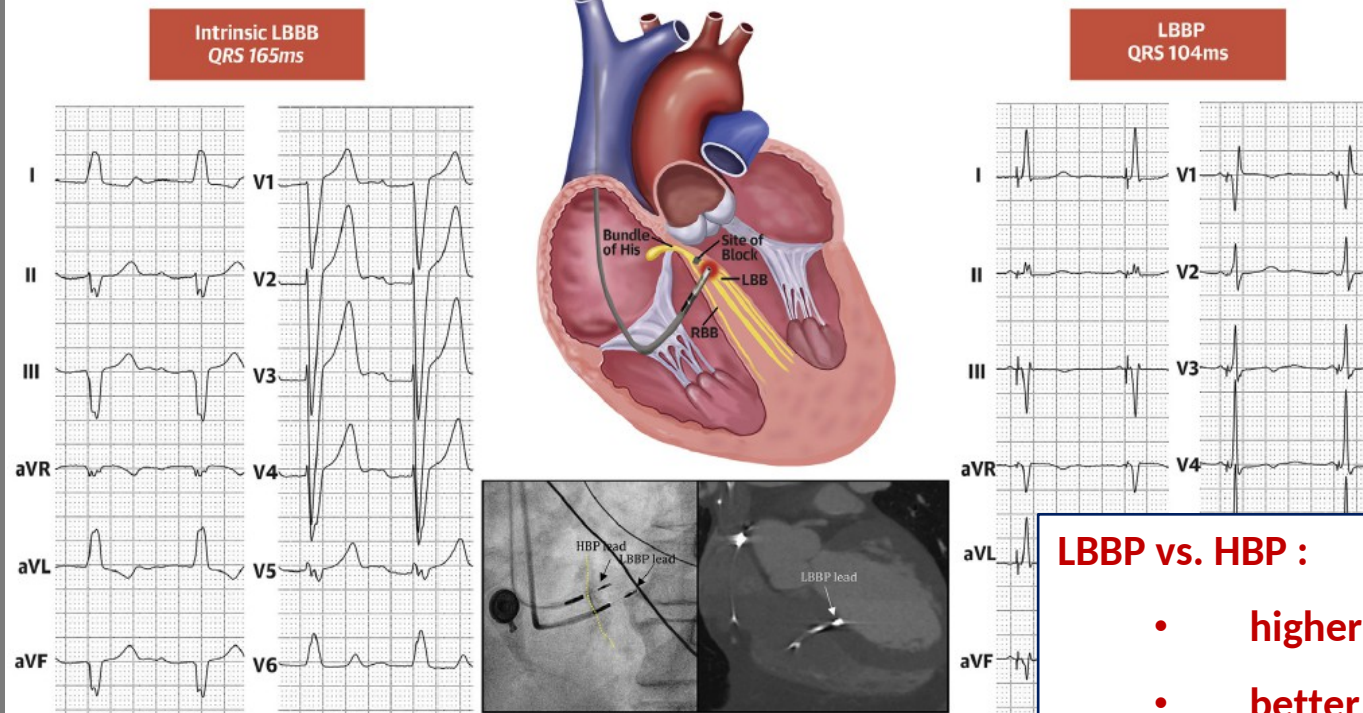
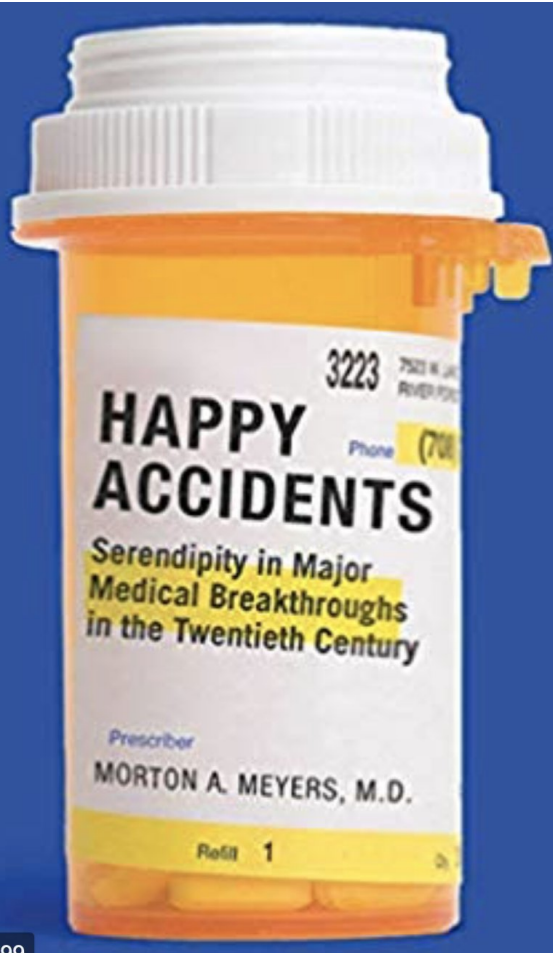
Search: **((CONDUCTION SYSTEM PACING[Title/Abstract]) OR (HIS PACING[Title/Abstract])) AND (CARDIAC RESYNCHRONIZATION THERAPY[Title/Abstract])**

42



# Serendipity-based Medicine

## From HBP to LBB Pacing

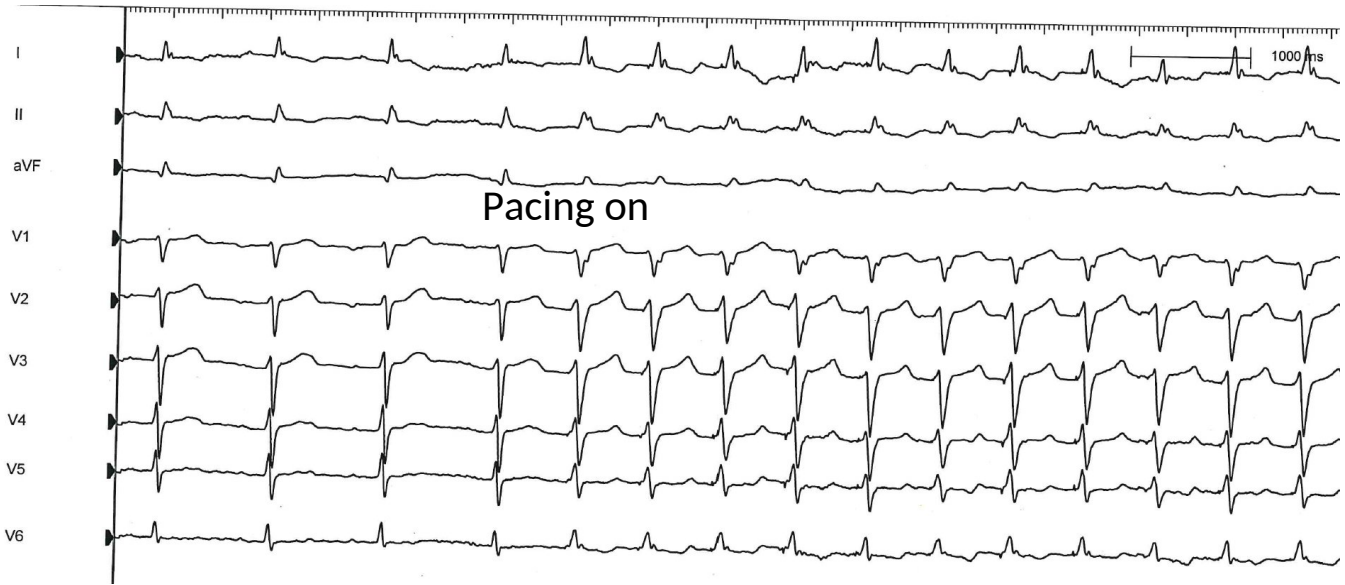
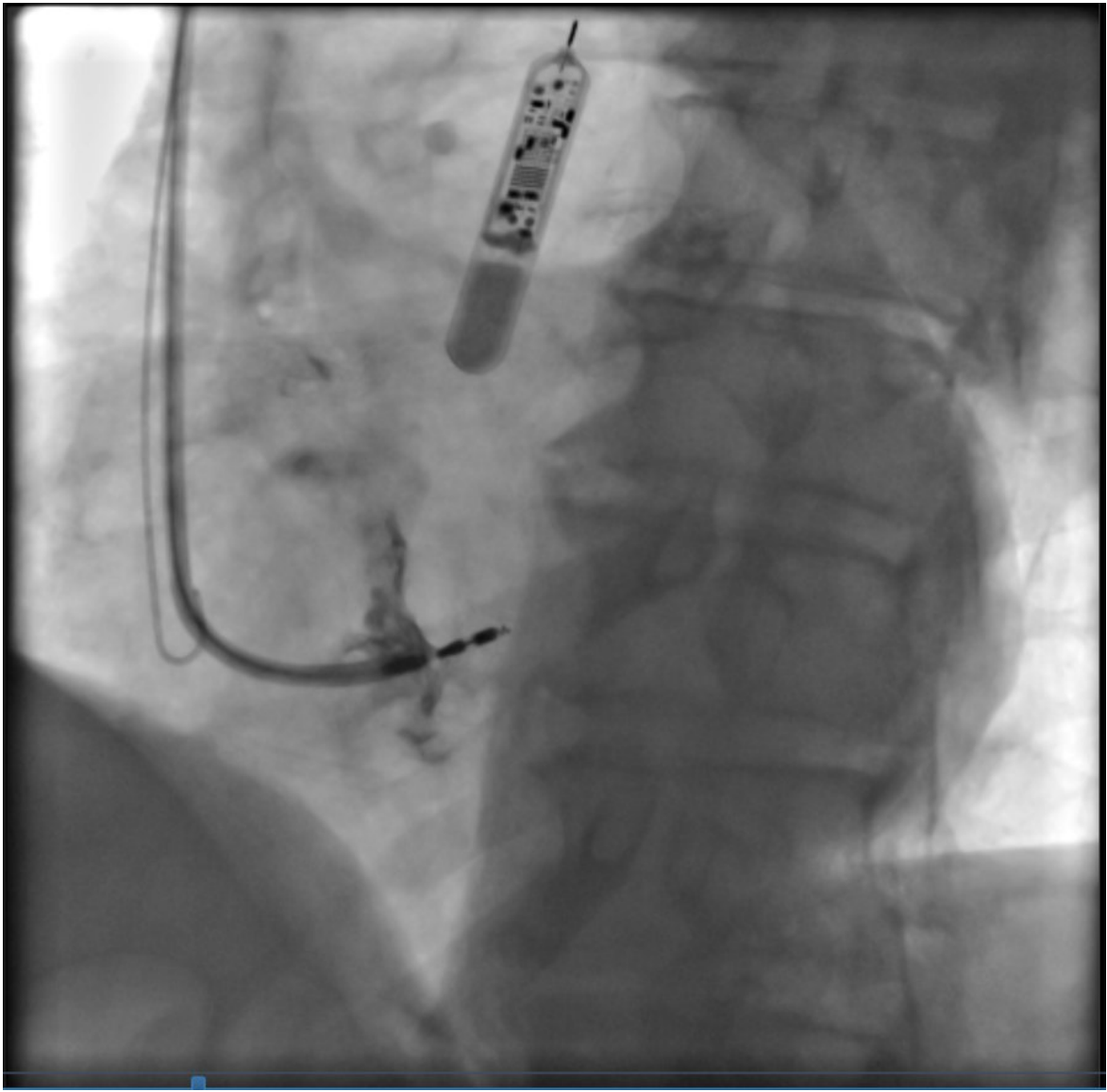


Huang, W. et al. J Am Coll Cardiol EP. 2020;6(7):849-58.

### LBBP vs. HBP :

- higher implantation success rates
- better pacing parameters

*"Chance favours the prepared mind." L. Pasteur*



# Comparative effects of left bundle branch area pacing, His bundle pacing, biventricular pacing in patients requiring cardiac resynchronization therapy: A network meta-analysis

Juan Hua MD | Chenxi Wang MD | Qiling Kong MD | Yichu Zhang MD |

**Feb. 2022**

**TABLE 1** Characteristics of included studies

Authors	Year	Regions	Study design	Total patients	Study patients	Interventions	Follow-up (months)
Guo et al. <sup>21</sup>	2020	China	Non-RCT	42	LBBB morphology (Strauss's criteria), with LVEF ≤ 35%, NYHA Classes II–IV	BVP versus LBBAP	6
Li et al. <sup>23</sup>	2020	China	Non-RCT	81	LBBB and LVEF ≤ 35%	BVP versus LBBAP	6
Upadhyay et al. <sup>33</sup>	2019	Chicago	RCT	41	NYHA II–IV patients with QRS > 120 ms	BVP versus HBP	12.2
Wang et al. <sup>34</sup>	2020	China	Non-RCT	40	SR, CLBBB with QRSd > 140 ms (M) and > 130 ms (F), LVEF ≤ 35%, and NYHA classes II–IV	BVP versus LBBAP	6
Wu et al. <sup>35</sup>	2020	China	Non-RCT	135	LVEF ≤ 40% and typical LBBB	BVP versus HBP versus LBBAP	12
Vinther et al. <sup>36</sup>	2021	Denmark	RCT	50	Symptomatic HF, LVEF ≤ 35% and LBBB	BVP versus HBP	6

**HYS-SYNC**

**HIS-Alternative**

**Results:** Six articles involving 389 patients remained for the final meta-analysis. The mean follow-up of these studies was  $8.03 \pm 3.15$  months. LBBAP resulted in a

**RCTs: < 100 pts**

**Conclusion:** The NMA first found that LBBAP and HBP resulted in a greater LVEF improvement and a narrower QRS duration compared with BVP. Additionally, LBBAP resulted in similar clinical outcomes but with lower pacing thresholds, and may therefore offer advantages than does HBP for CRT.



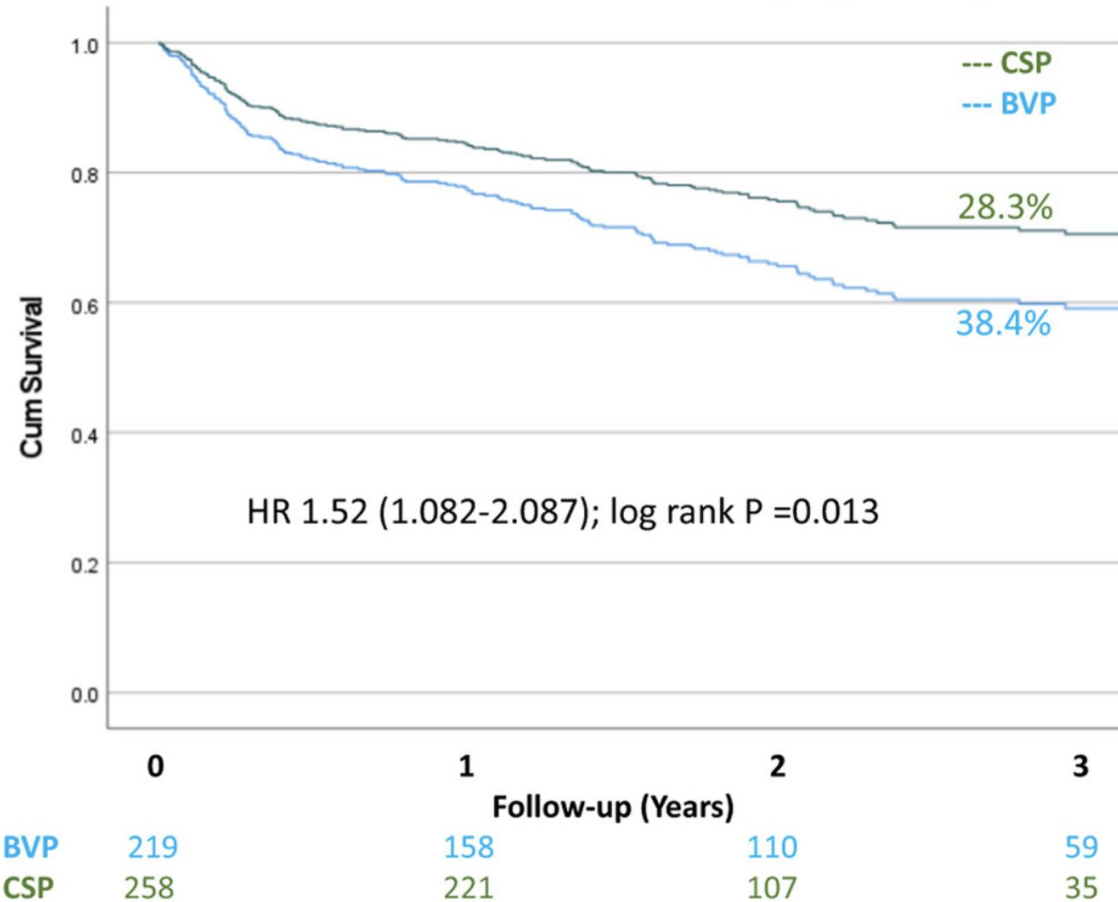
# Clinical outcomes of conduction system pacing compared to biventricular pacing in patients requiring cardiac resynchronization therapy

Pugazhendhi Vijayaraman, MD, FHRS • Dipen Zalavadia, MD • Abdul Haseeb, MD • ...  
Richard G. Trohman, BS, MBA, MD, FHRS • Faiz A. Subzposh, MD • Parikshit S. Sharma, MD, MPH, FHRS  
[Show all authors](#)

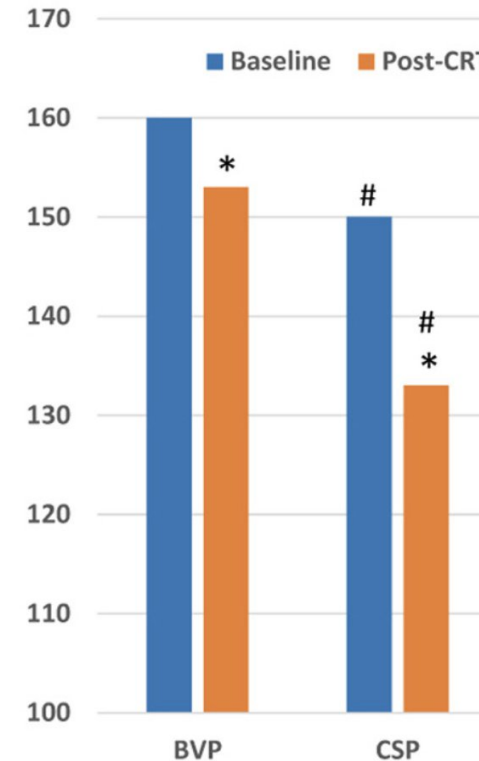
Published: April 29, 2022 • DOI: <https://doi.org/10.1016/j.hrthm.2022.04.023>

- 477 patients (BVP 219; CSP 258 [HBP 87, LBBAP 171])
- At 2 major health care systems

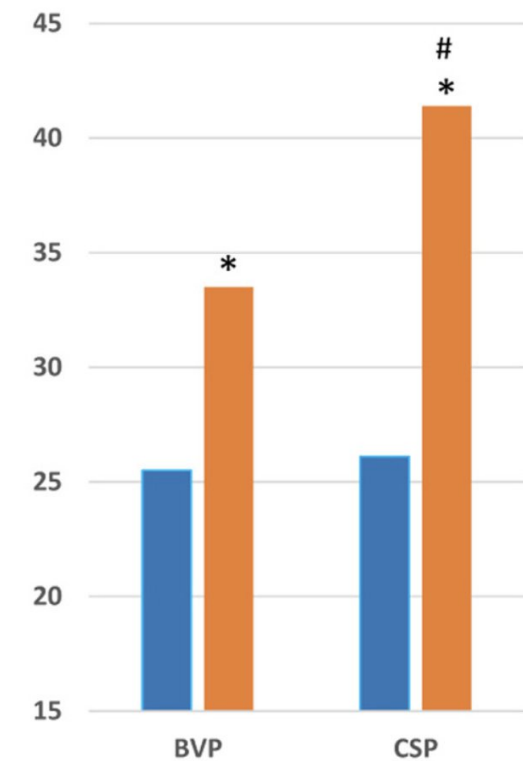
## Freedom from Death or HFH (All, N=477)



## QRS duration



## Ejection Fraction



CRT-BIV procedural duration **154±32**



# BIV-CRT vs CSP-CRT?

***Il peso dell'evidenza  
clinica:***



**CSP-CRT**



**BIV-CRT**

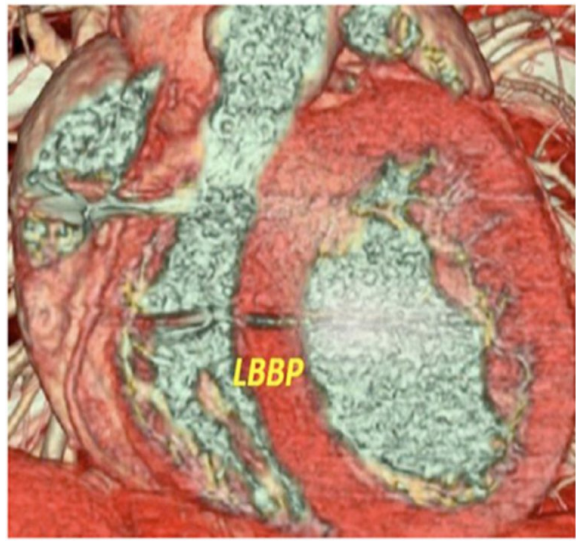
# Rescue left bundle branch area pacing in coronary venous lead failure or nonresponse to biventricular pacing: Results from International LBBAP Collaborative Study Group

Pugazhendhi Vijayaraman, MD, FHRS • Bengt Herweg, MD, FHRS • Atul Verma, MD, FHRS • Parikshit S. Sharma, MD, MPH, FHRS • Syeda Atiqa Batul, MBBS, MD • Shunmuga Sundaram Ponnusamy, MBBS, MD, CEPS-A • Robert D. Schaller, DO, FHRS • Oscar Cano, MD, PhD • Manuel Molina-Lerma, MD • Karol Curila, MD • Wim Huybrechts, MD • David R. Wilson, MD • Leonard M. Rademakers, MD, PhD • Praveen Sreekumar, MBBS, MD • Gaurav Upadhyay, MD • Kevin Vernooy, MD, PhD • Faiz A. Subzposh, MD • Weijian Huang, MD, FHRS • Marek Jastrzebski, MD, FRCR

Published: April 30, 2022

## RESCUE LBBAP (N=200)

Group I – Lead Failure (N = 156)  
Group II – Non-responder (N = 44)

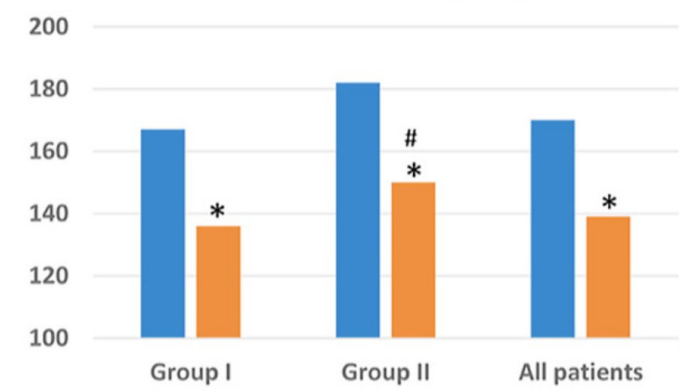


■ Baseline  
■ Post CRT

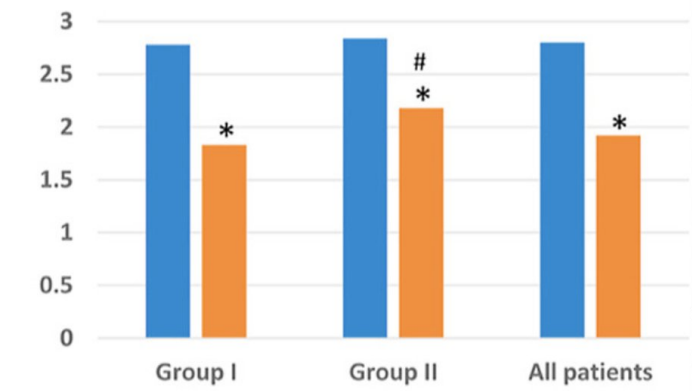
\*P<0.001 compared to baseline  
# P<0.01 compared to Group I

- 16 international centers
- 200 patients (CV lead failures 156; nonresponders 44)
- Procedural duration was 119.5 ± 59.6 minutes, and fluoroscopy duration was 25.7 ± 18.5 minutes
- . The risk of death or HFH was lower in those with CV lead failure than in nonresponders (hazard ratio 0.357; 95% confidence interval 0.168–0.756; P = .007)

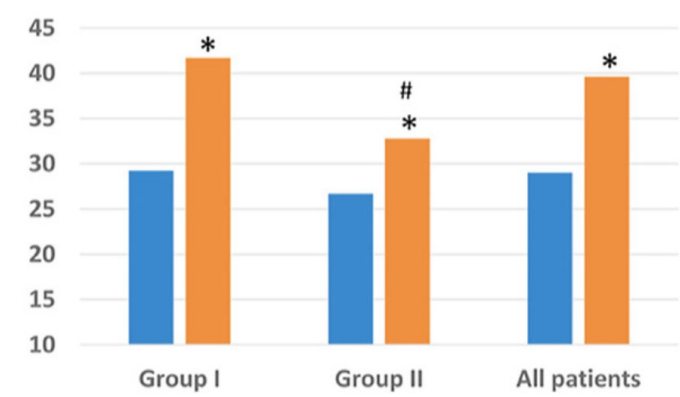
### QRS duration (ms)



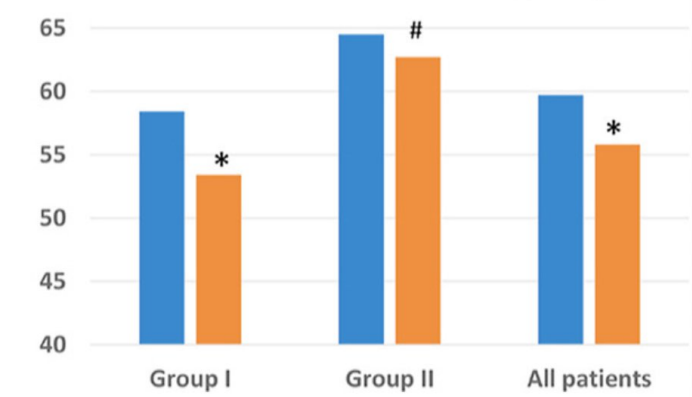
### NYHA Class



### Ejection Fraction (%)



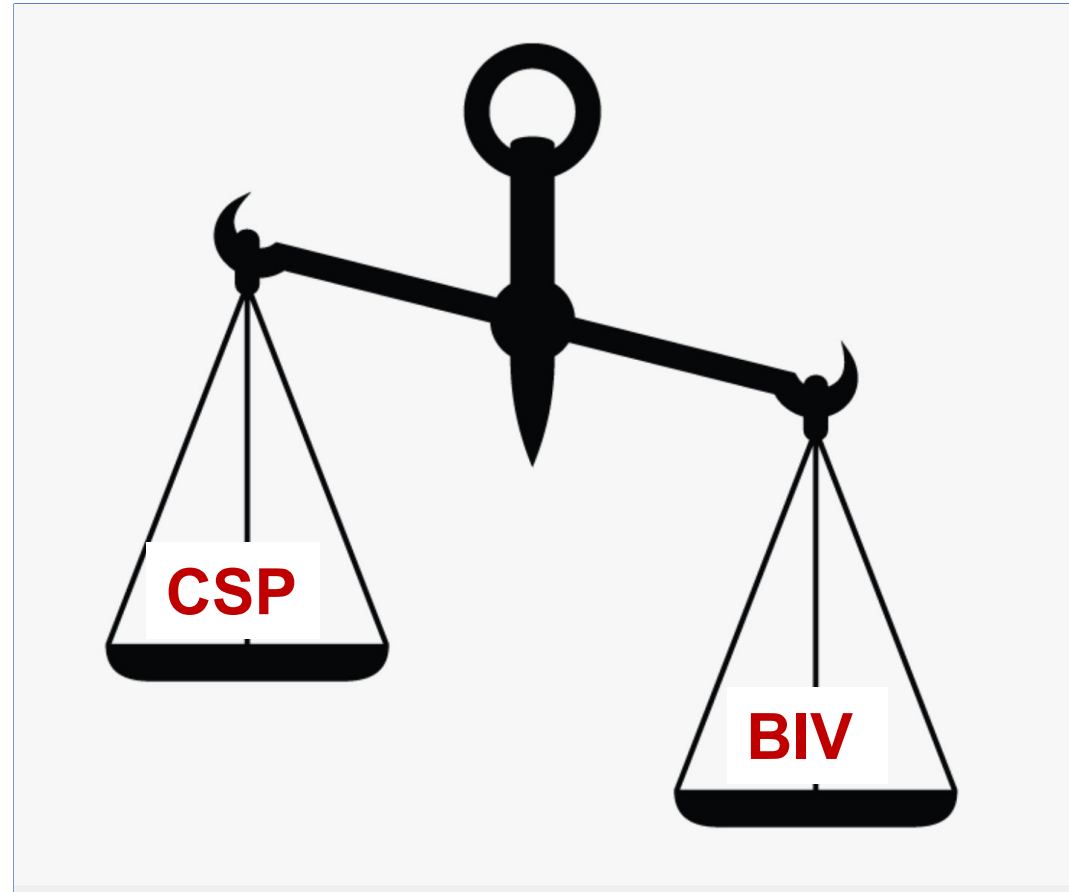
### End Diastolic Diameter (mm)



# BIV-CRT vs CSP-CRT (1° step)

## • Pros BIV-CRT:

1. Clinical evidence implant data
2. Specific devices and software for optimization
3. No backup leads....
4. Higher Familiarity



## • Cons BIV-CRT:

1. The beauty of the EKG (HBP)

*No differences in complication rates..*