



CRT vs CSP in Patients with Reduced EF



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COI Disclosure

Sung Soo Kim

The authors have no financial conflicts of interest
to disclose concerning the presentation





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2 When is CSP needed?

3 Combination (CRT + CSP)





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Why CPP?

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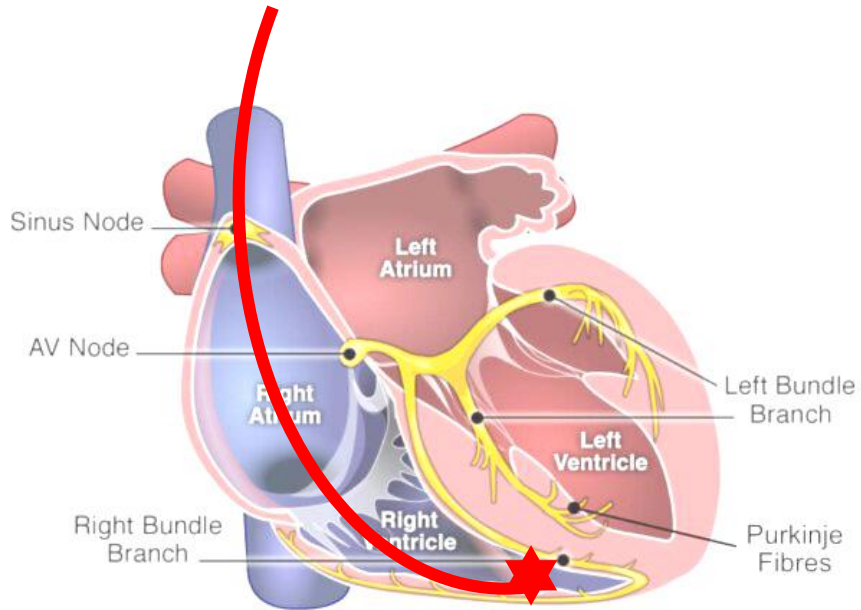
When is CSP needed?

3

Combination (CRT + CSP)

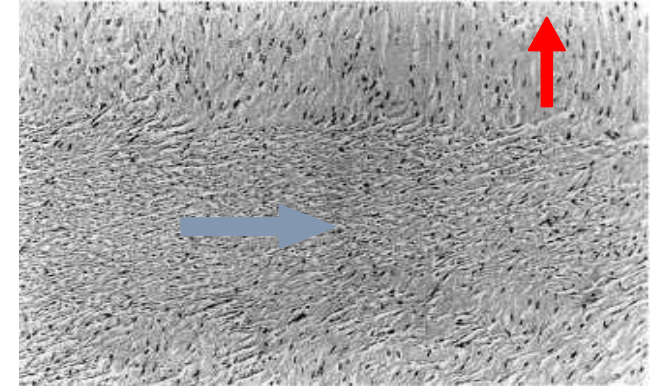


RV apical pacing



❖ Cellular disarray

- Fibrosis (away from pacing lead location)
- Fat deposition
- Calcification
- Mitochondrial abnormalities



Karpawich PP, et al. Am Heart J 1990;119:1077-83

❖ Remodeling

- Modified regional blood flow patterns
- Increased oxygen consumption without increase in blood flow
- Abnormal thickening of LV wall

Right ventricular pacing in permanent pacemaker causes ventricular dyssynchrony because of non physiologic electrical conduction system.

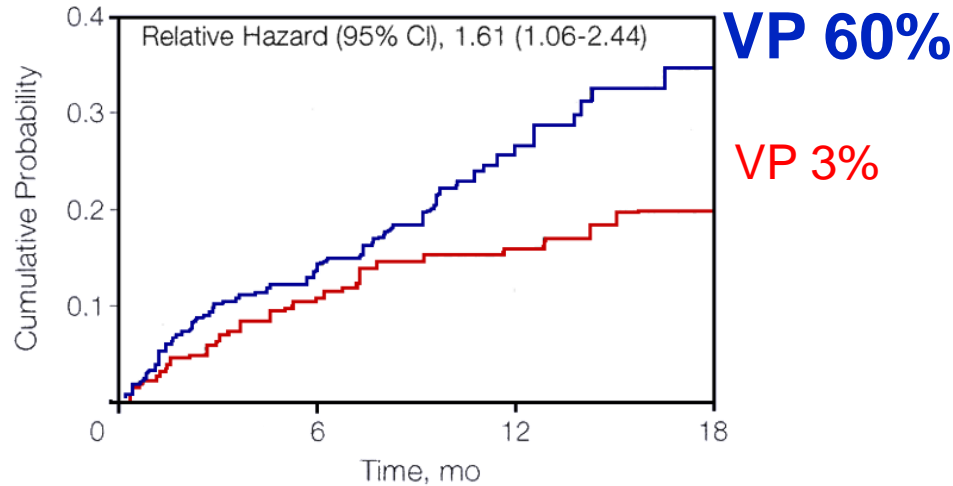
→ All cause mortality , Heart Failure Hospitalization



DAVID Trials (2002)

Dual Chamber and VVI Implantable Defibrillator Trial

Death or First Hospitalization for New or Worsened CHF



No. at Risk	0	6	12	18
DDDR	250	159	76	21
VVI	256	158	90	25

— Dual-Chamber Rate-Responsive Pacing (DDDR)
— Ventricular Backup Pacing (VVI)

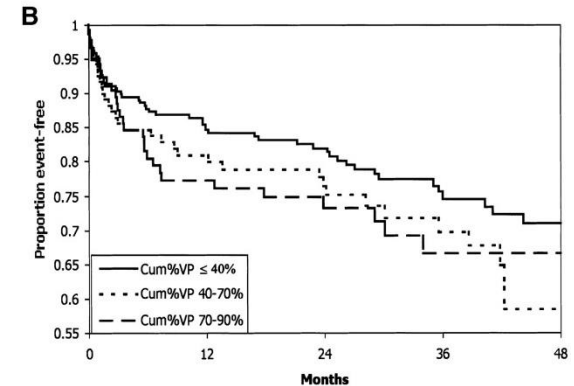
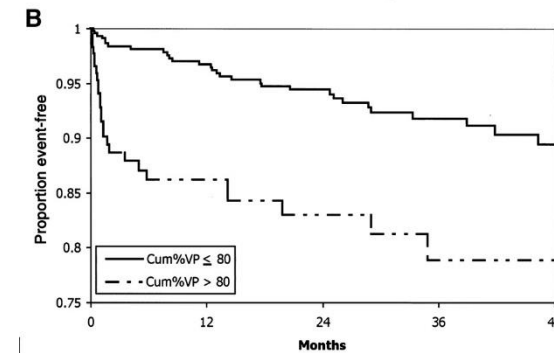
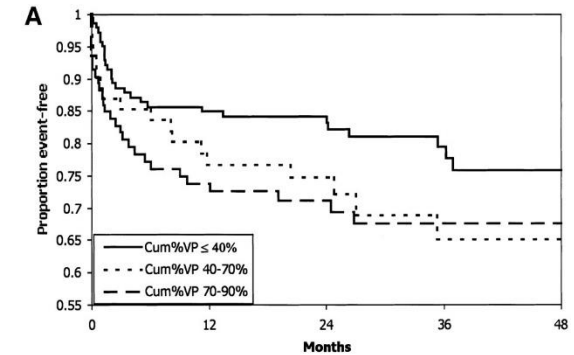
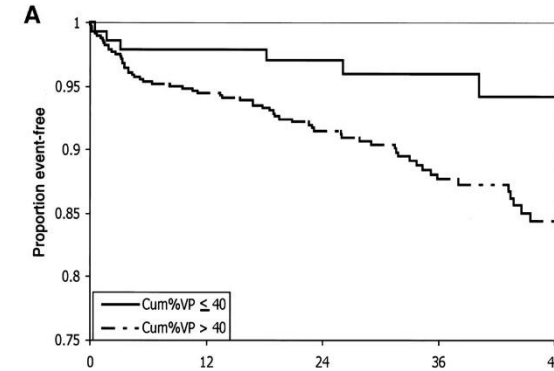
- ✓ ICD indication but No indication for PPM
- ✓ **EF < 40%**
- ✓ DDDR 70 BPM versus VVI 40 BPM

MOST Trials (2002)

MOde Selection Trial

HF Hospitalization

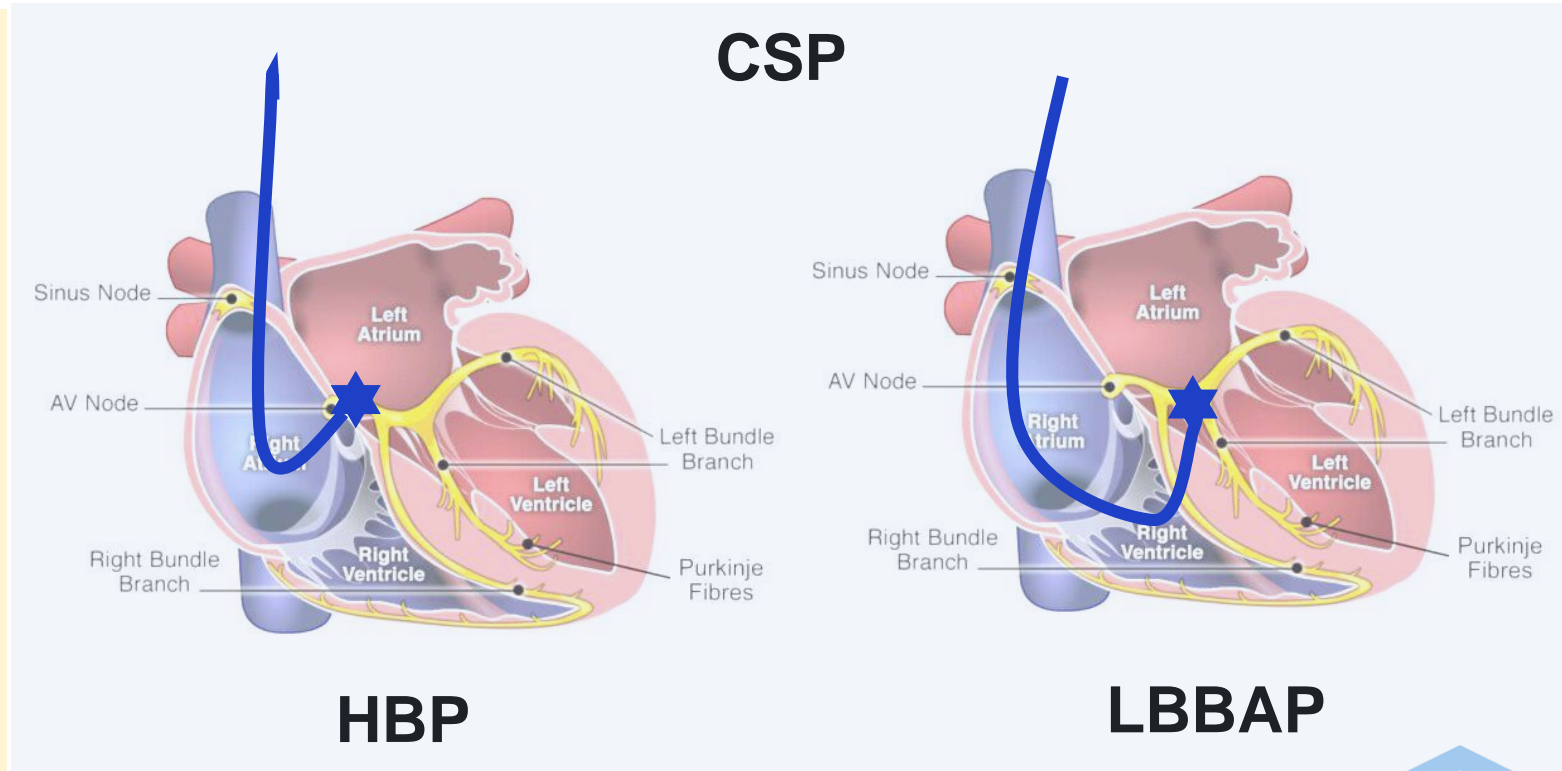
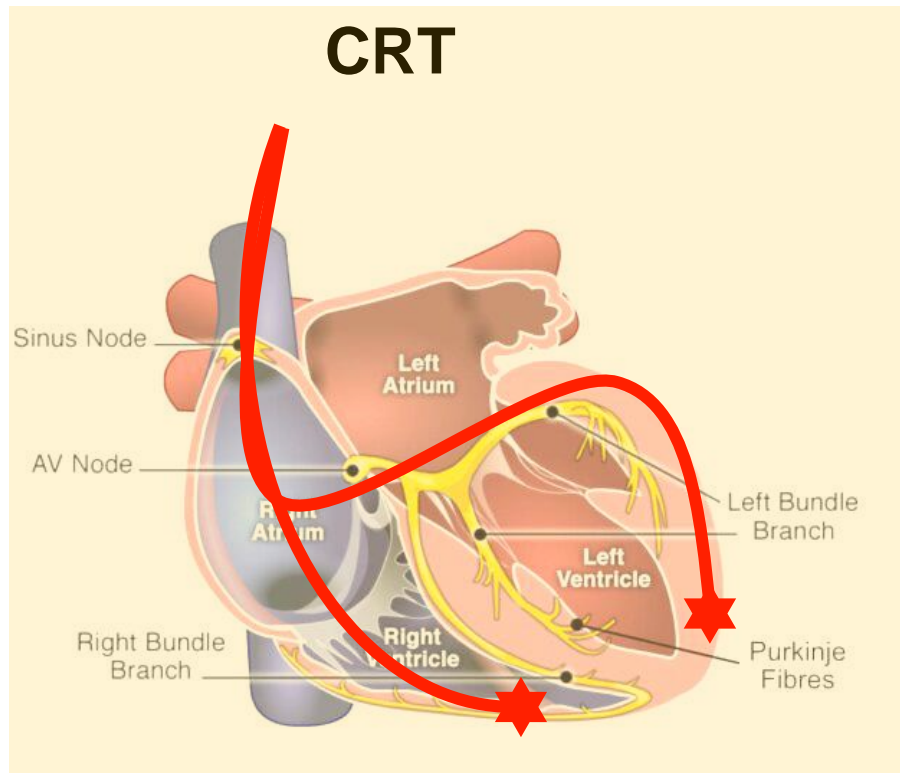
AF



- ✓ DDDR versus VVIR - SN dysfunction
- ✓ **VP > 40%** - HFH, AF ↑

Cardiac physiologic pacing (CPP)

- Cardiac physiologic pacing (CPP) : Restore or Preserve **Ventricular synchrony**.
CRT(Cardiac Resynchronization Therapy) + CSP (Conduction System Pacing)

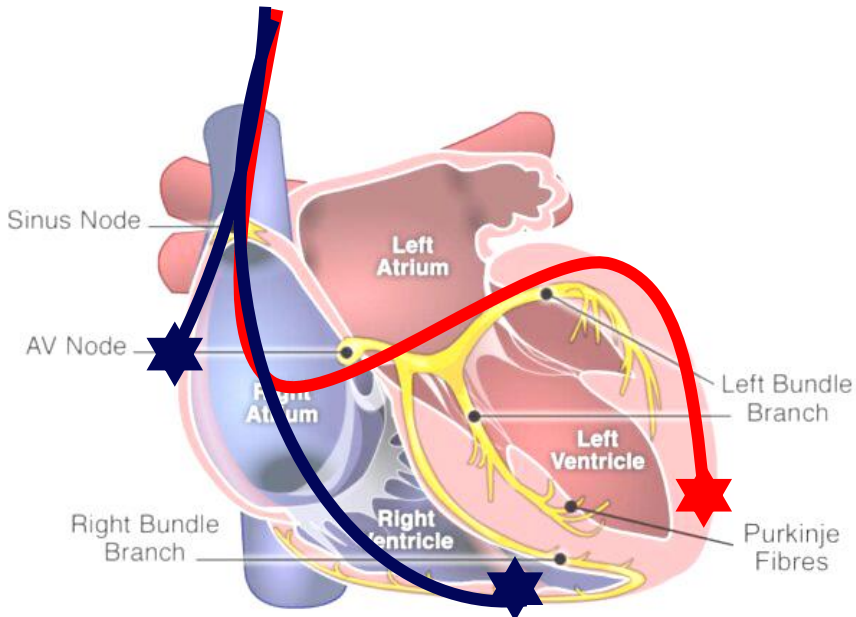


CRT (Cardiac Resynchronization Therapy)

- CRT is recommended for symptomatic patients with **HF** in **LBBB** and with **EF <35%** despite of OMT

COMPANION, CARE HF, MADIT-CRT, RAFT study

CRT is biventricular pacing where **LV lead** is positioned in the **coronary sinus**.



ESC 2021 Guidelines

CRT is recommended for symptomatic patients with HF in SR with LVEF $\leq 35\%$, QRS duration ≥ 150 ms, and LBBB QRS morphology despite OMT, in order to improve symptoms and reduce morbidity and mortality.^{37,39,40,254–266,283,284}

I

A

CRT should be considered for symptomatic patients with HF in SR with LVEF $\leq 35\%$, QRS duration 130–149 ms, and LBBB QRS morphology despite OMT, in order to improve symptoms and reduce morbidity and mortality.^{37,39,40,254–266,283,284}

IIa

B

CRT (Cardiac Resynchronization Therapy) – CAVB

EF < 40%, CAVB : BLOCK-HF



Primary Outcome

45.8%

Composite of death, urgent care visit for HF and LV remodeling
HR 0.74 (95% CI 0.60-0.90)

55.6%

Secondary Outcomes

33.5%

Death or urgent care visit
0.73 (95% CI 0.57-0.92)

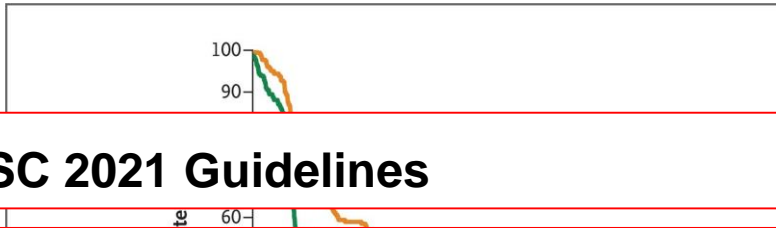
40.6%

22%

Hospitalization for heart failure
0.70 (95% CI 0.52-0.93)

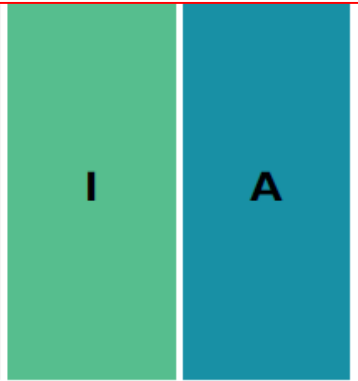
26.3%

Primary Endpoint (Mortality/HF/LVESVI)



ESC 2021 Guidelines

CRT rather than RV pacing is recommended for patients with HFrEF (<40%) regardless of NYHA class who have an indication for ventricular pacing and high-degree AVB in order to reduce morbidity. This includes patients with AF.



183,190,196,268,313,323,357 – 359,361,362

Curtis AB et al. N Engl J Med 2013;368:1585-1593

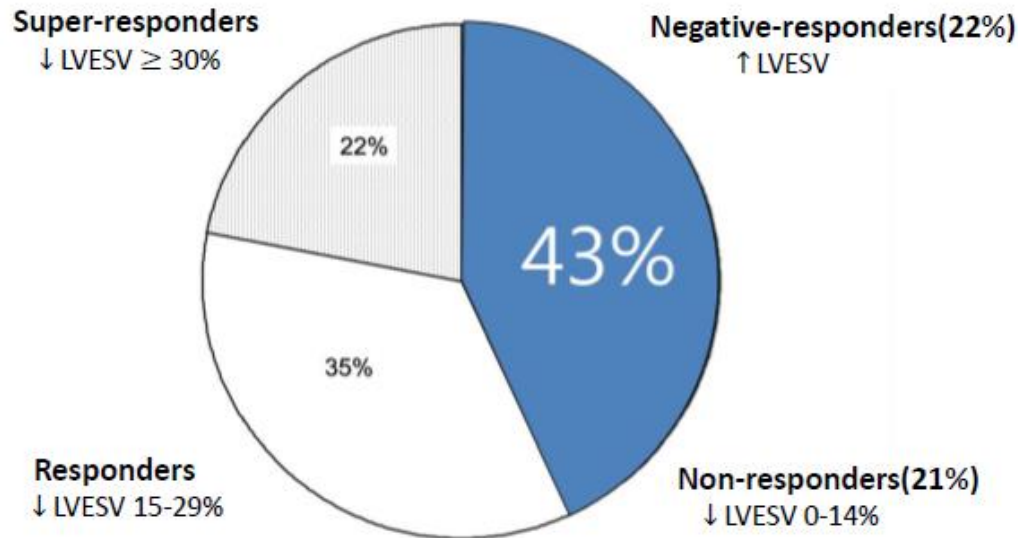
EF > 40%, CAVB : BioPACE

Data on benefit of CRT are conflicting with respect to hospitalization, and **No mortality benefit**

CRT non responder

Extent of LV Reverse Remodeling After 6 months of CRT

- 43% of CRT patients classified as non-responders or negative-responders by LVESV after 6 months(N=302)



Ypendburg et.al JACC 2009;53:483-490

Risk factor

Patient clinical characteristics

Ischemic Cardiomyopathy

Male

QRS duration < 150 ms

RBBB, intraventricular conduction delay

LV end-diastolic volume >240 mL

Ventricular dyssynchrony- Not present

High transmural scar

Right ventricular enlargement, dysfunction

Device-modifiable factors

LV lead position

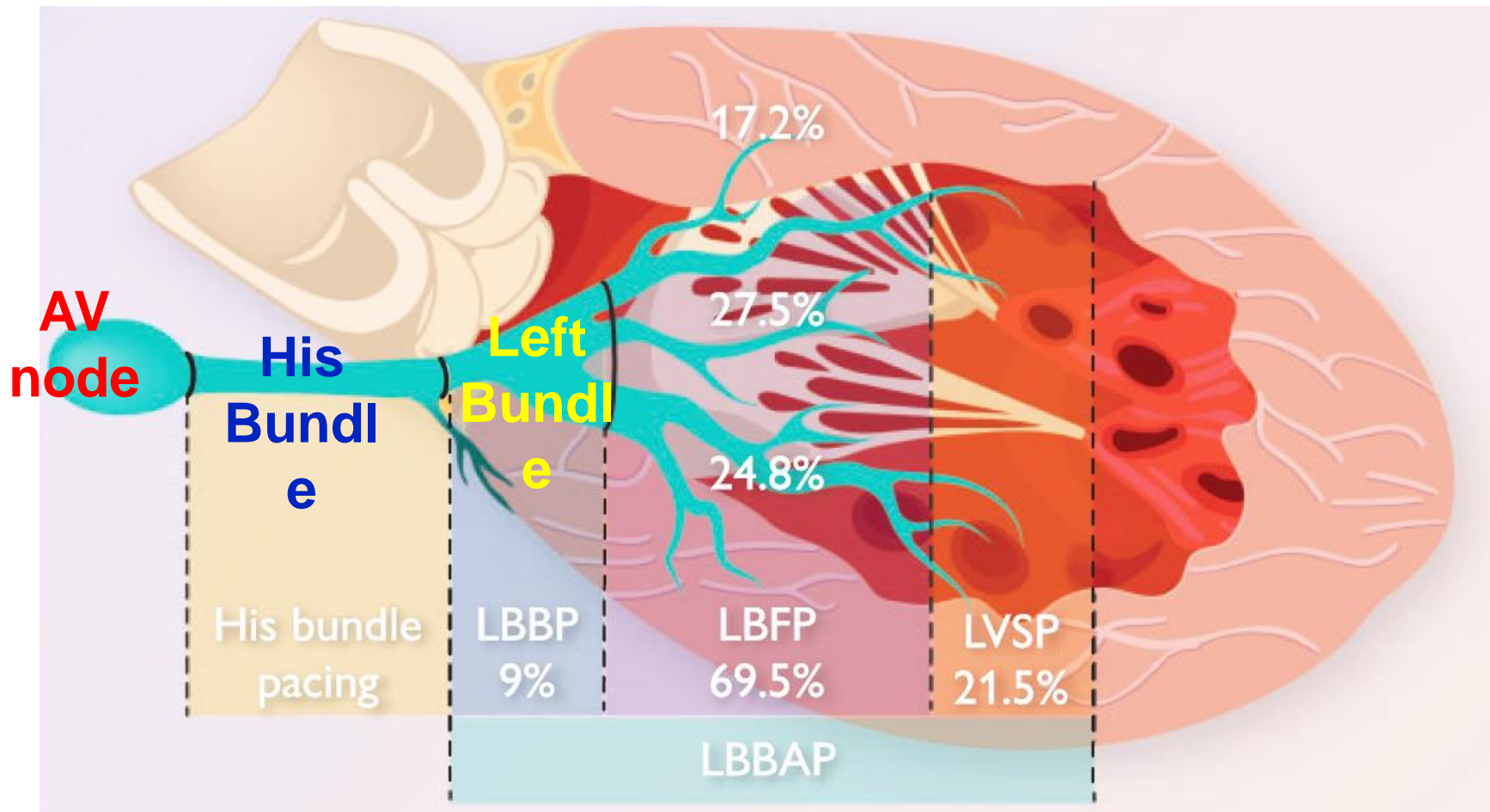
Anterior or inferior septum, apex

BiV pacing < 99%, atrial fibrillation, PVC's

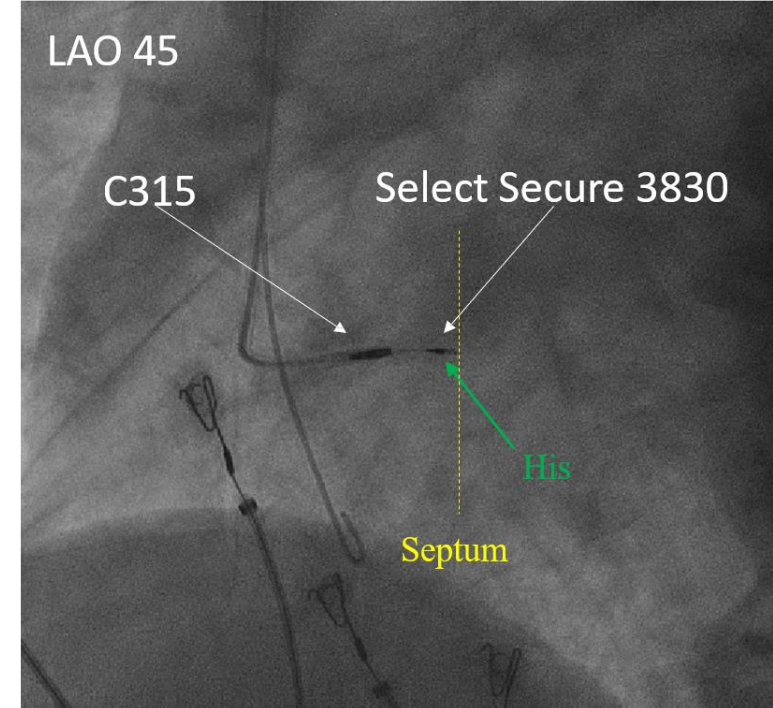
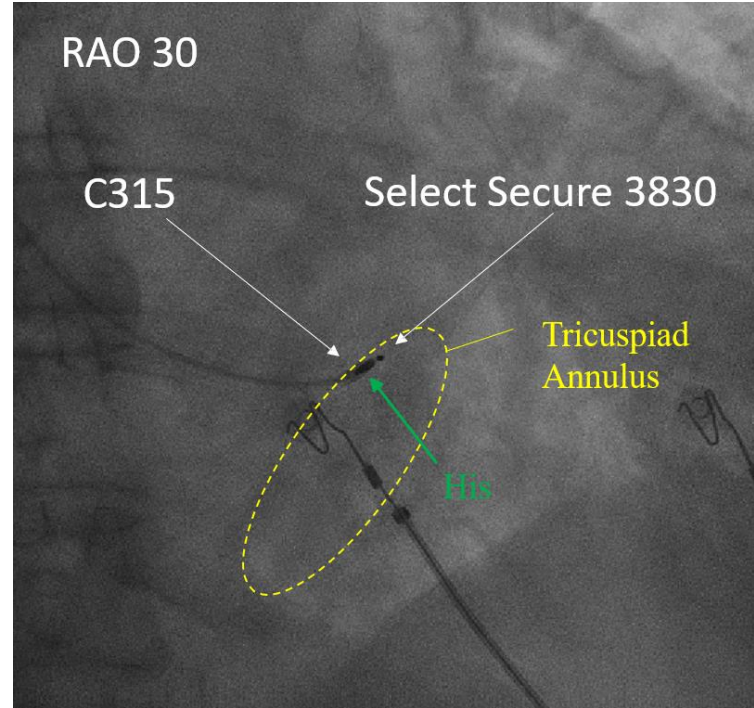
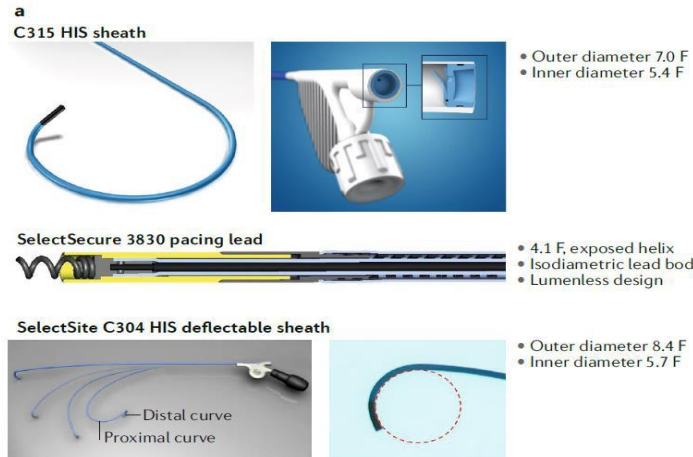
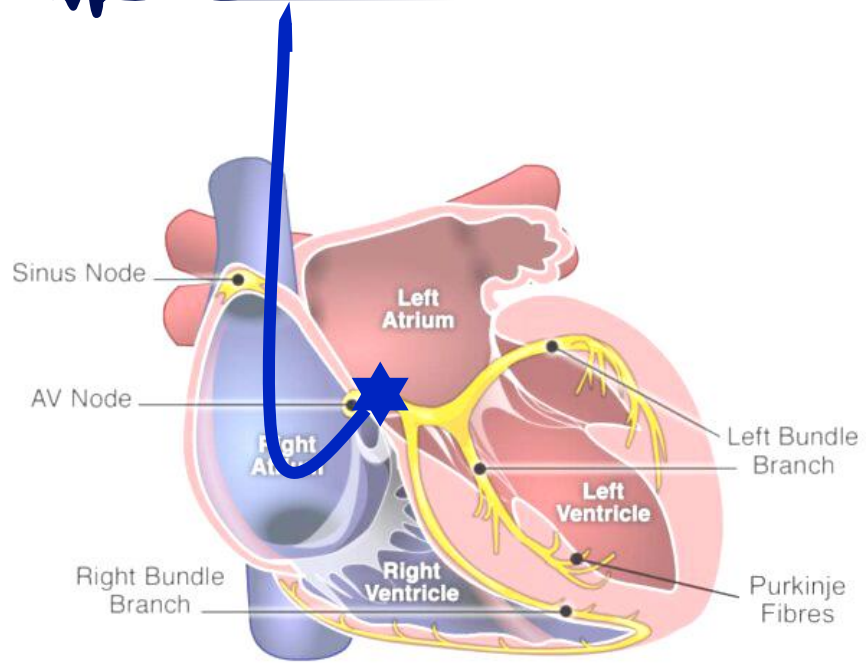
Not optimal AV and VV optimization

Conduction System Pacing, CSP

What treatments should be considered for patients who do not respond to CRT?



His Bundle Pacing

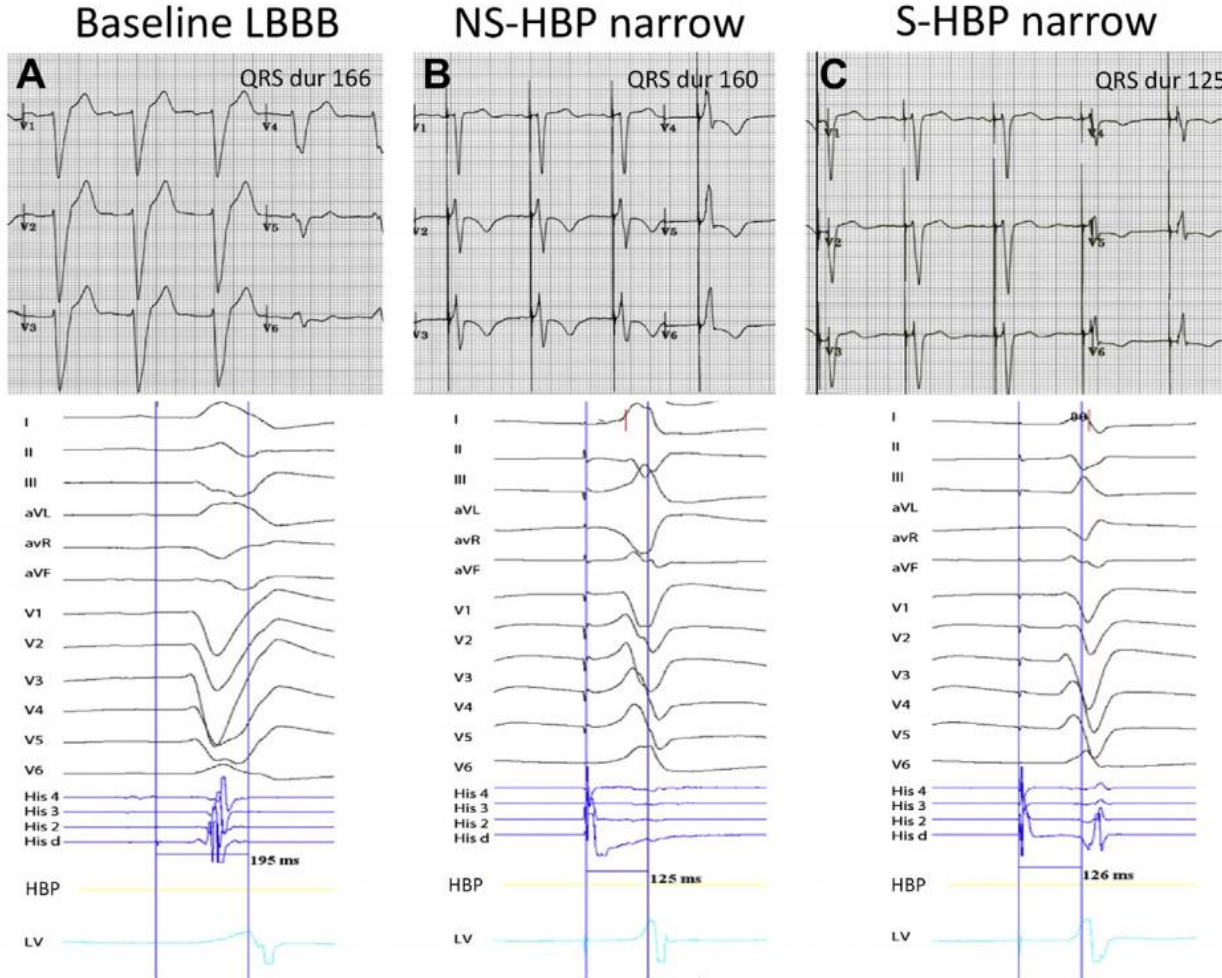


1. Advance / Clockwise Rotation -> Cross tricuspid annulus -> RV
2. Withdraw / Counterclockwise Rotation towards superior margin of septal TA
3. Look for His Potential



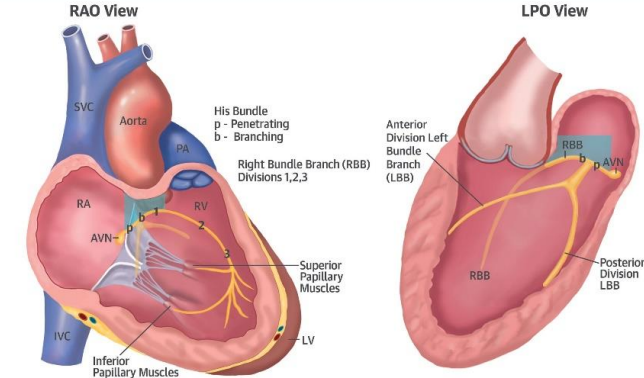
His Bundle Pacing

His bundle pacing can narrow the **QRS duration**, reduce the risk of **death, heart failure hospitalization, upgrade to CRT** when compared with RV pacing.

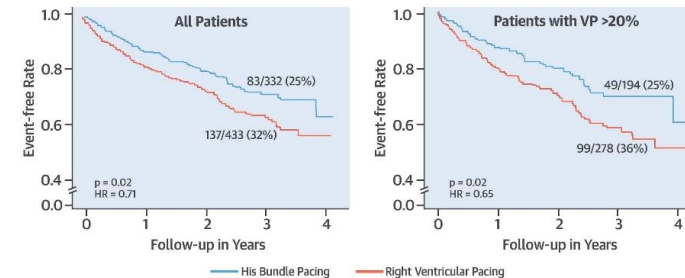


CENTRAL ILLUSTRATION: His Bundle Pacing: Conduction System and Outcomes

A The Conduction System



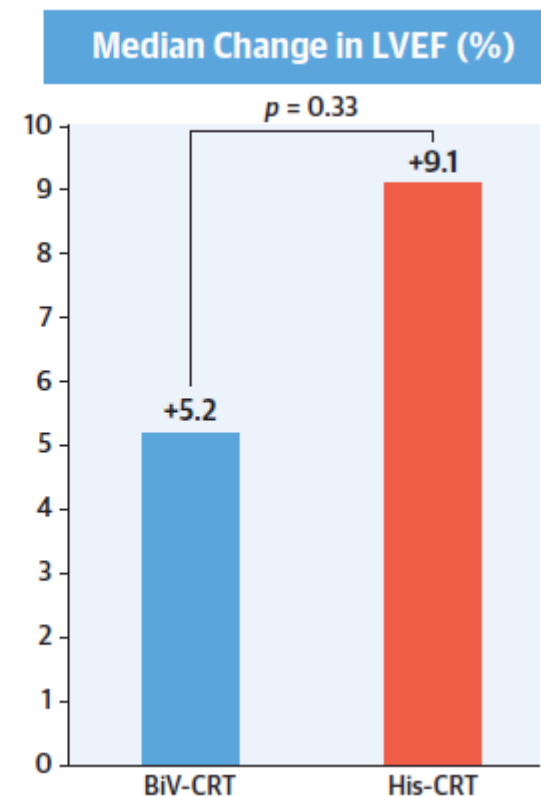
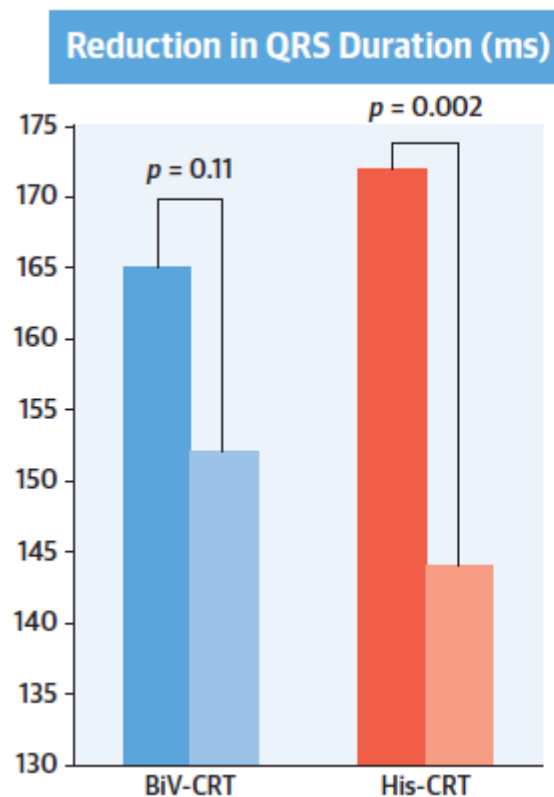
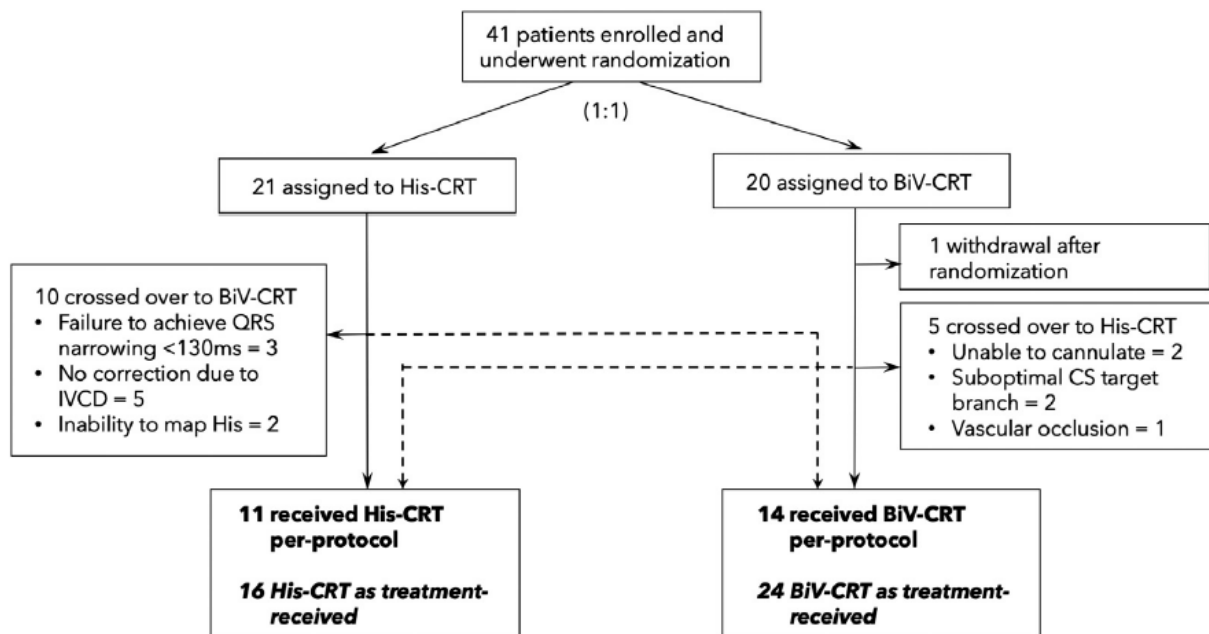
B Combined Endpoint of Death, Heart Failure Hospitalization, or Upgrade to Biventricular Pacing



Vijayaraman, P. et al. J Am Coll Cardiol. 2018;72(8):927-47.

His- SYNC Pilot Trials (CRT vs. HBP)

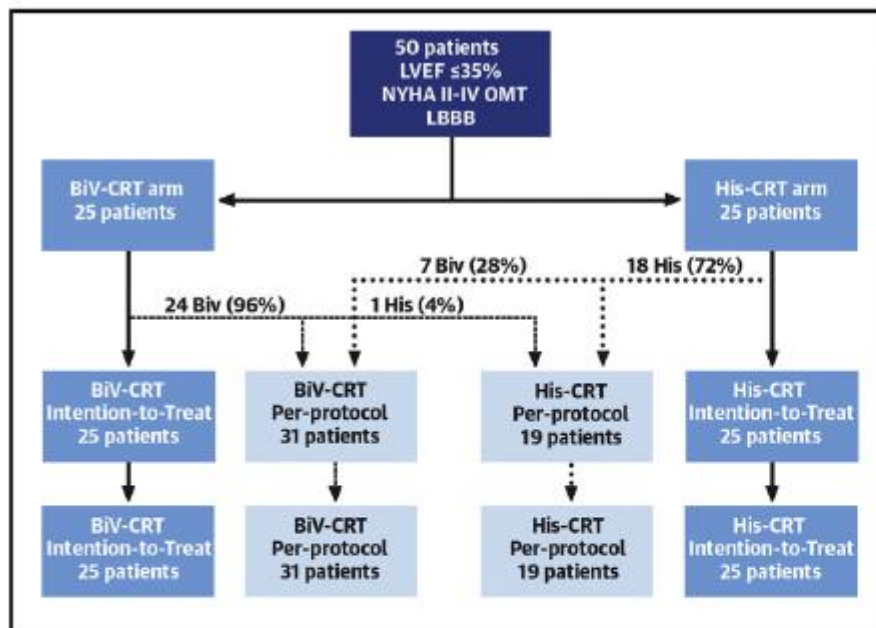
- EF 28%, NYHA II–IV patients with QRS>120 ms



Heart Rhythm 2019;16:1797–1807

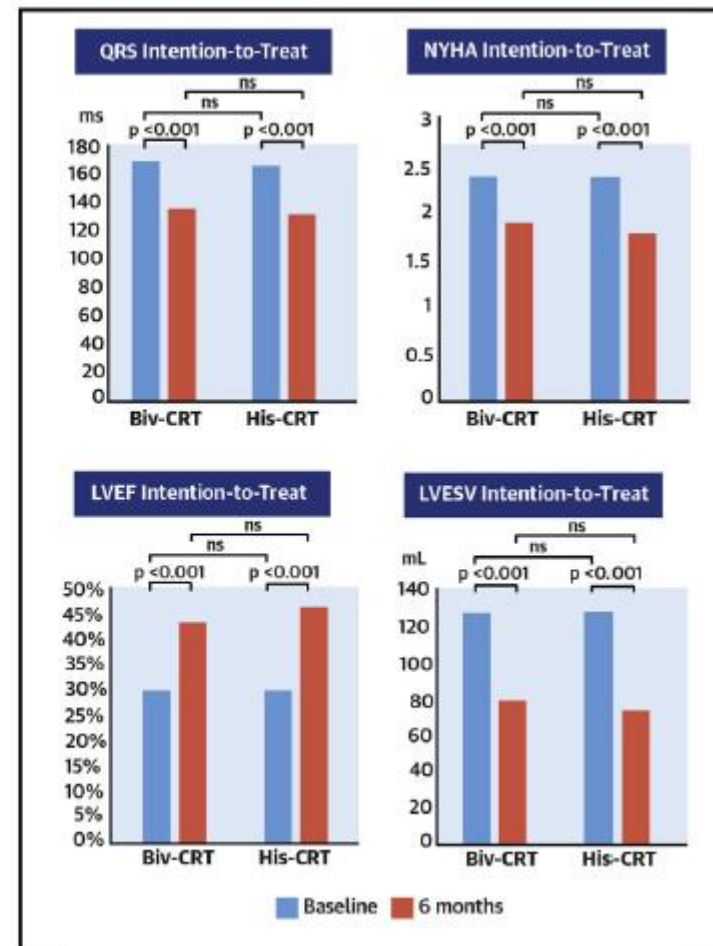
His-Alternative Trials (CRT vs. HBP)

EF <35%, NYHA II–IV, LBBB,
QRS >130-140ms



Pacing Thresholds	Implantation (V at 1 ms dur)	6-month FU (V at 1 ms dur)
LV-leads (n = 31)	1.1 ± 0.7	1.5 ± 0.6*
His-leads (n = 19)	2.2 ± 1.2	2.4 ± 1.6*

* p <0.05 baseline vs. 6-months FU +p <0.05 His-leads vs. LV-leads



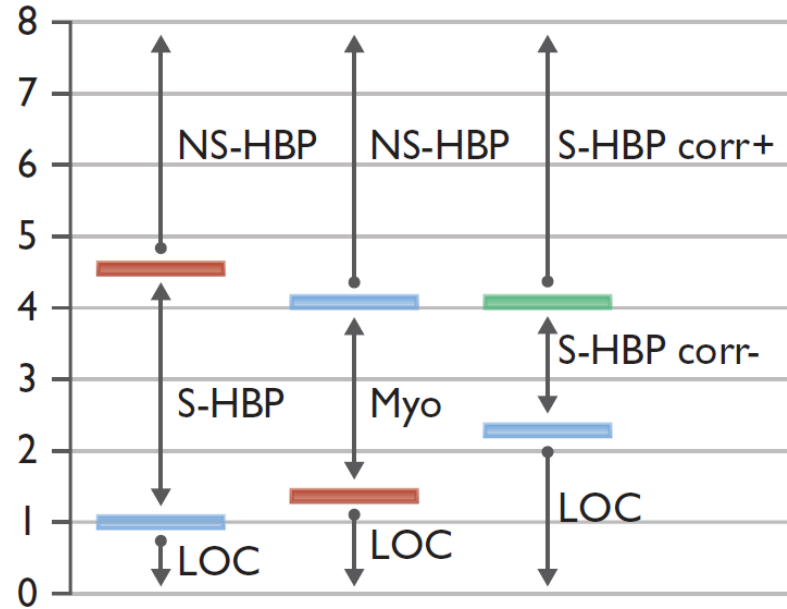
Vinther, M. et al. J Am Coll Cardiol EP. 2021;7(11):1422–1432.

His Bundle Pacing

Limitations

1. **Lead positioning, capture threshold, long term stability -> Backup !!**

Output (V/0.5ms)



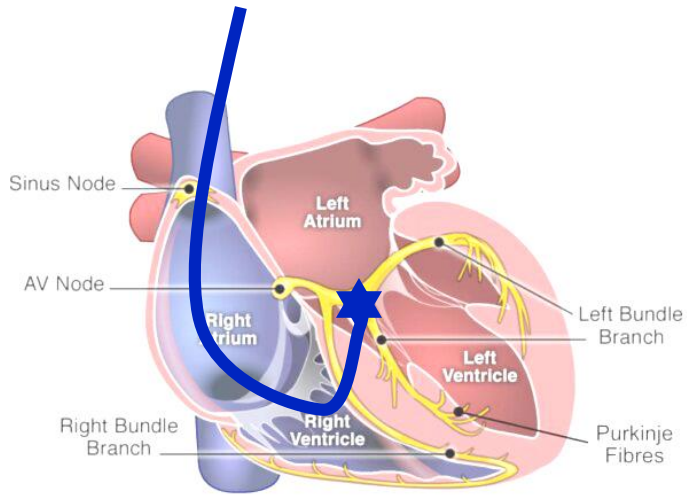
Thresholds

- ▬ His
- ▬ Myocardium
- ▬ Bundle branch

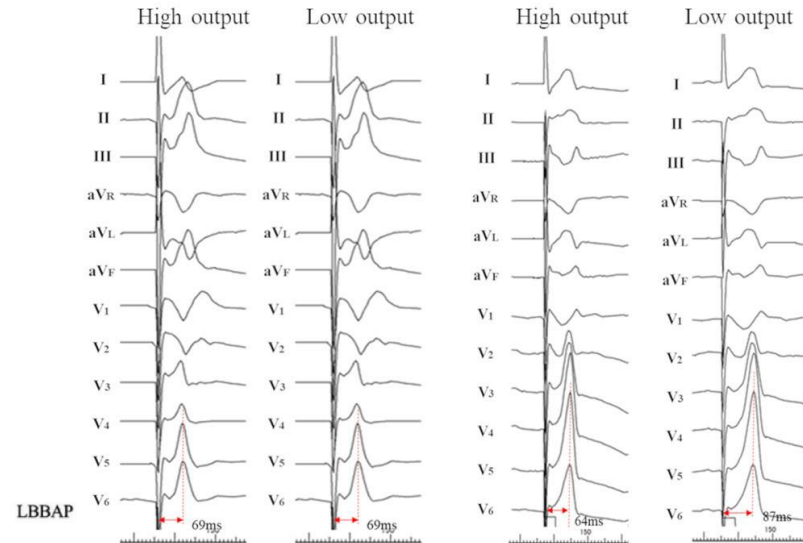
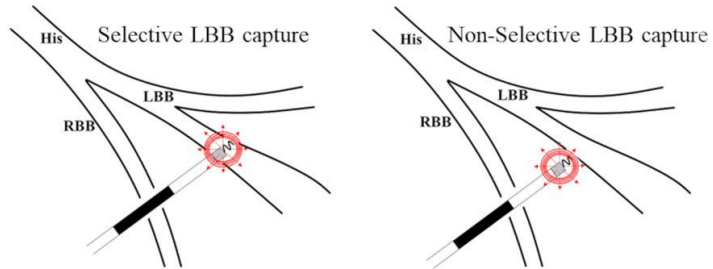
ESC 2021 Guidelines

In CRT candidates in whom coronary sinus lead implantation is unsuccessful, HBP should be considered as a treatment option along with other techniques such as surgical epicardial lead. ^{318,424,440,443}	IIa	B
In patients treated with HBP, implantation of an RV lead used as <u>'backup' for pacing</u> should be considered in specific situations (e.g. pacemaker dependency, high-grade AVB, infranodal block, high pacing threshold, planned AVJ ablation) or for sensing in the case of issues with detection (e.g. risk of ventricular undersensing or oversensing of atrial/His potentials). ^{423,426,444}	IIa	C
HBP with a <u>ventricular backup lead</u> may be considered in patients in whom a 'pace-and-ablate' strategy for rapidly conducted supraventricular arrhythmia is indicated, particularly when the intrinsic QRS is narrow. ^{197,199,200,318}	IIb	C

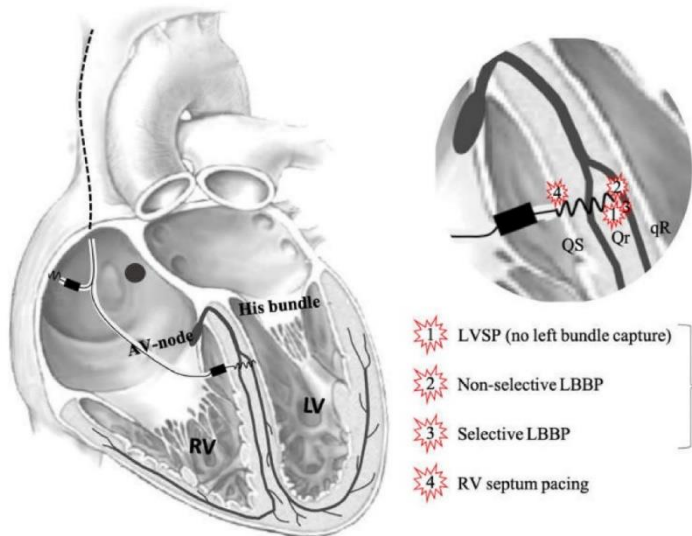
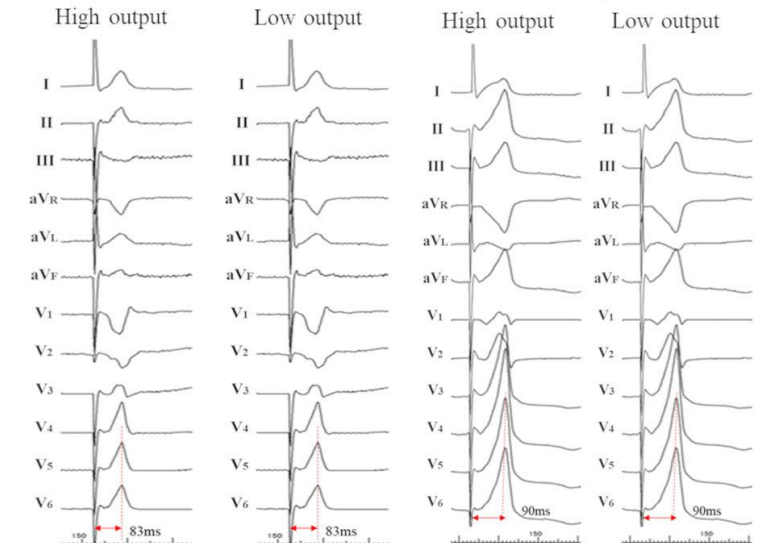
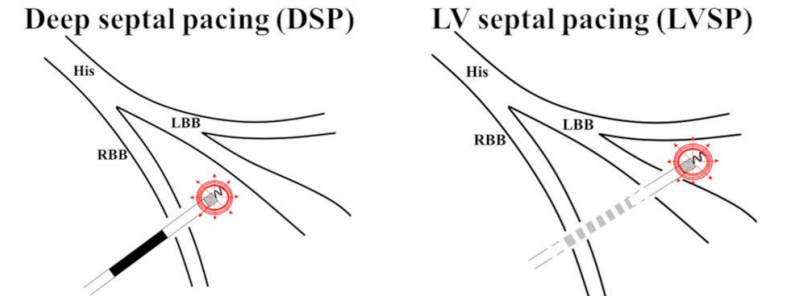
LBBAP, Left bundle branch area pacing



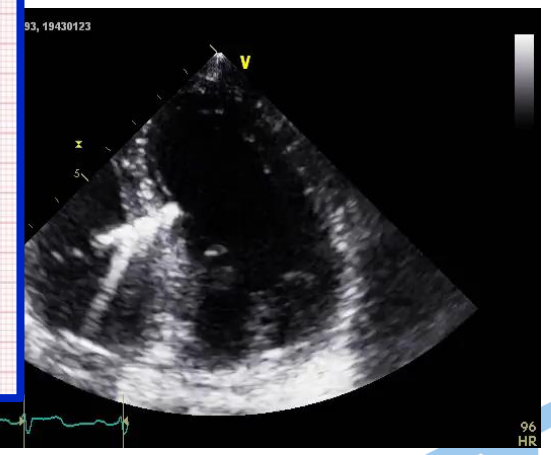
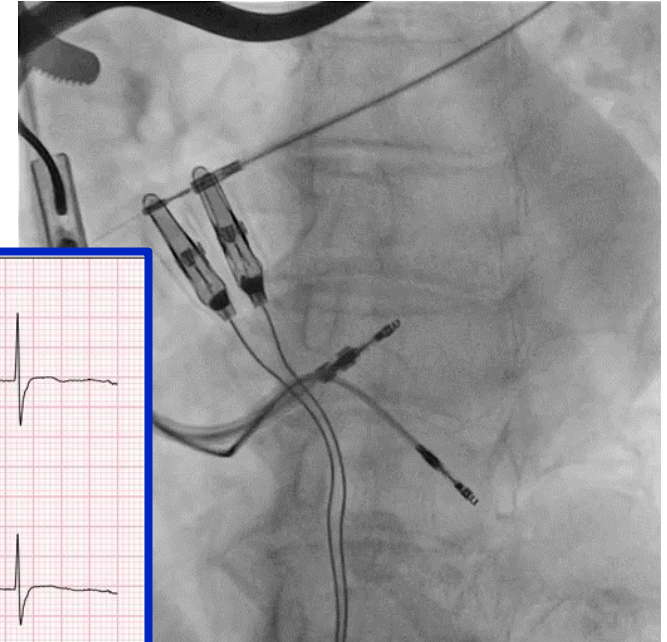
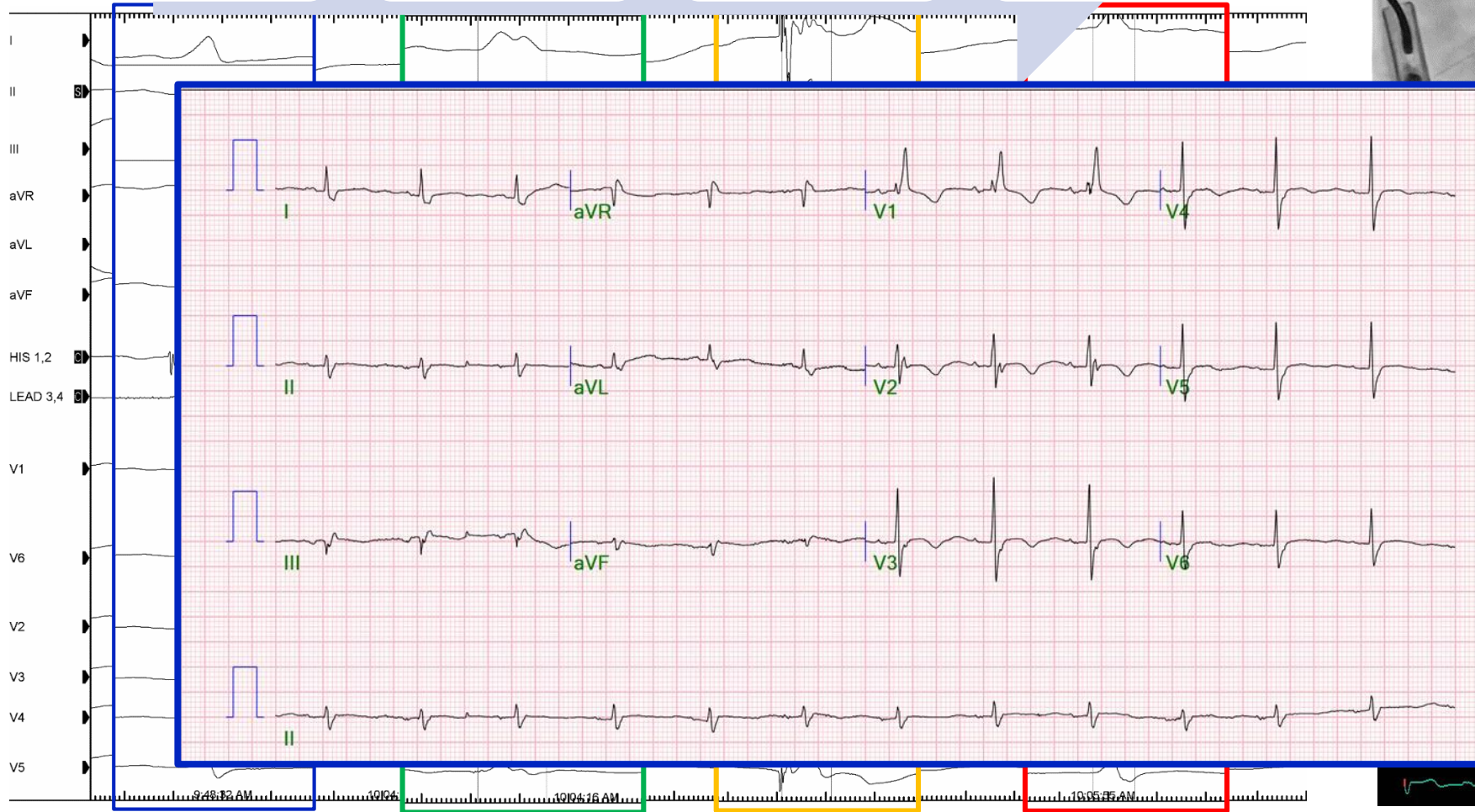
Left bundle branch pacing (LBBP)



Non-LBBP



Left Bundle Branch Pacing

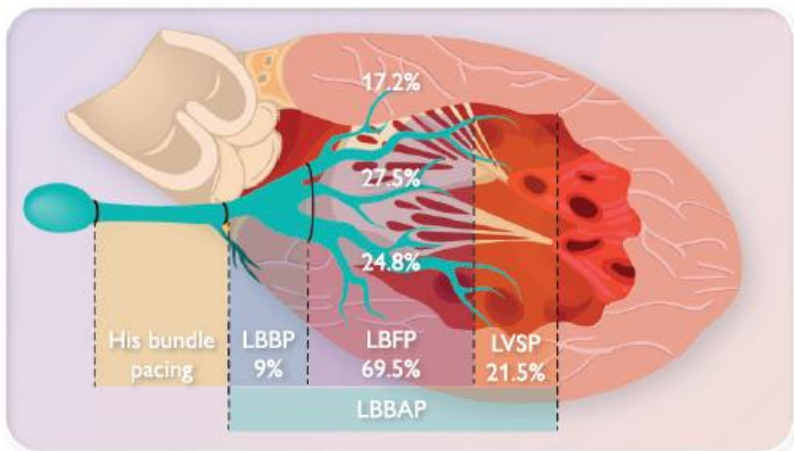


LBBAP, LBB area pacing

Melos study is a prospective, multicenter, registry based observational study in Europe
Efficacy and Safety of LBBAP

MELOS — MULTICENTER EUROPEAN LEFT BUNDLE BRANCH AREA PACING OUTCOMES STUDY

Prospective, multicenter, registry-based observational study 2533 Participants 14 European centres



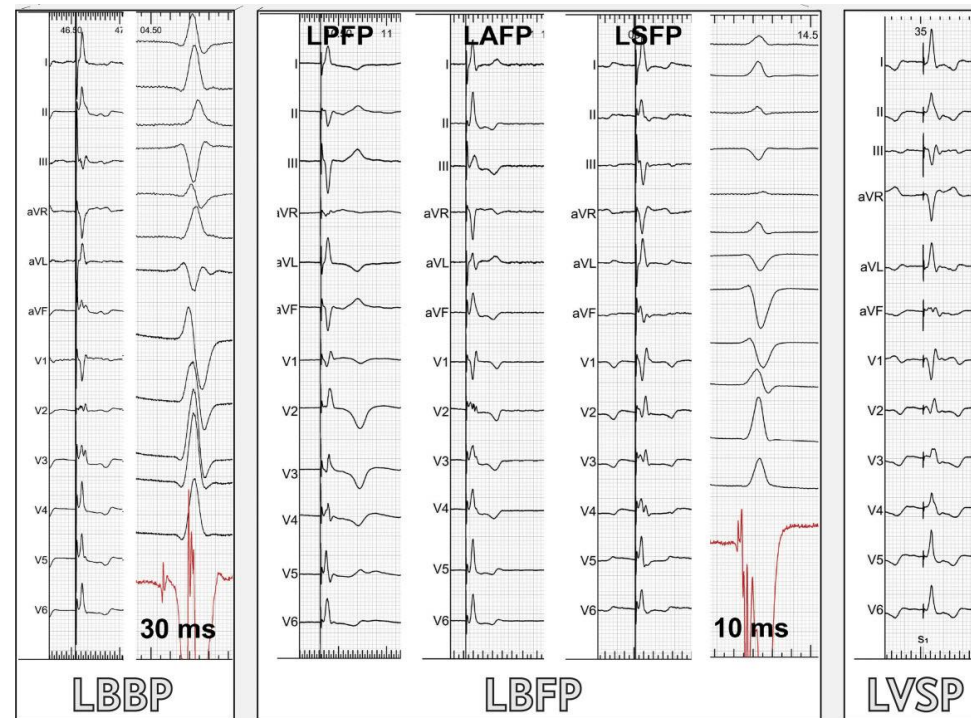
Independent predictors of LBBAP lead implantation failure

Heart failure indication OR 1.49, 95% CI 1.01–2.21
 Baseline QRS duration, per 10 ms OR 1.08, 95% CI 1.03–1.14
 LVEDD, per 10 mm increase OR 1.53, 95% CI 1.26–1.86

LBBAP implantation success
 Bradycardia indication success 92.4%
 Heart failure indication success 82.2%

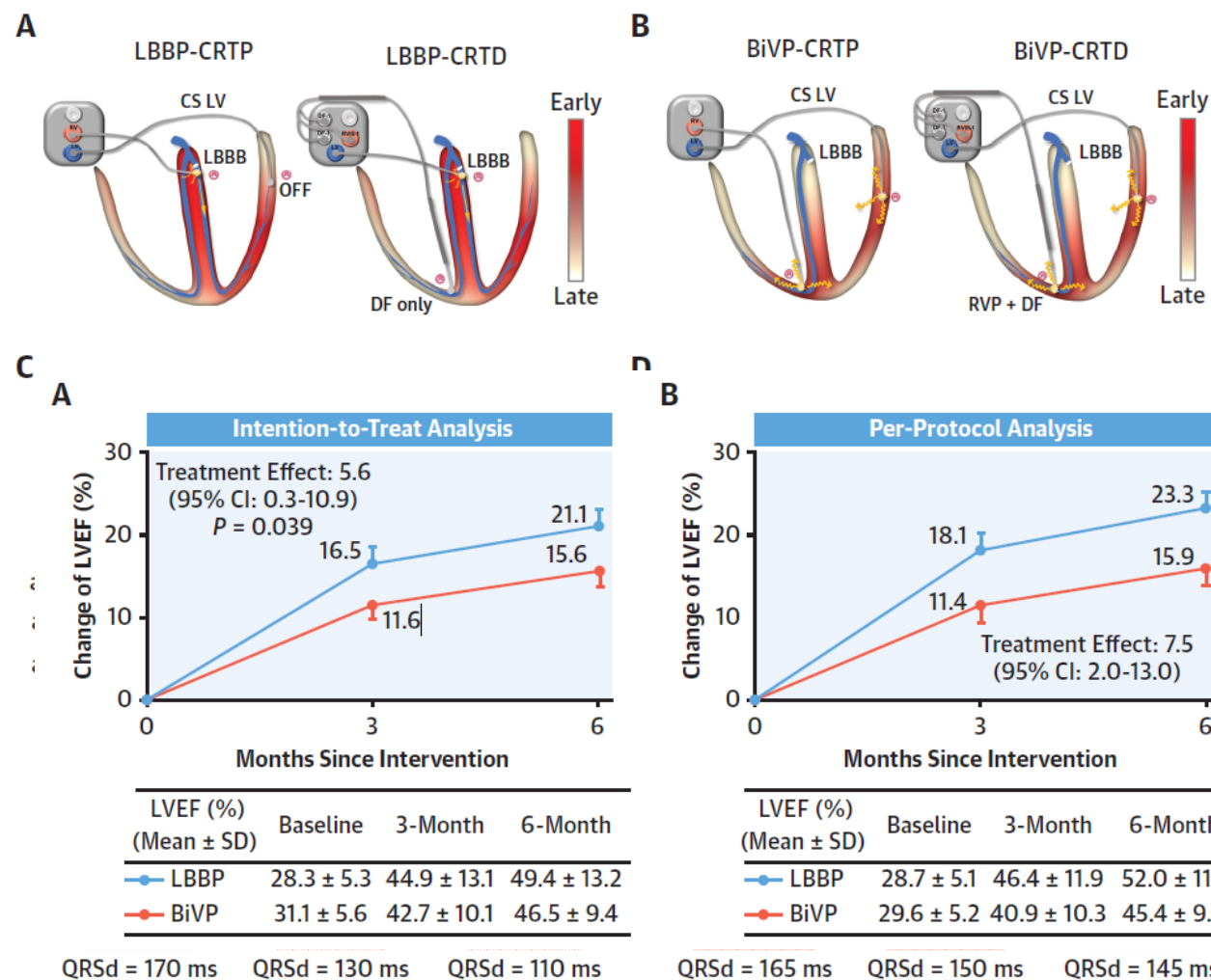
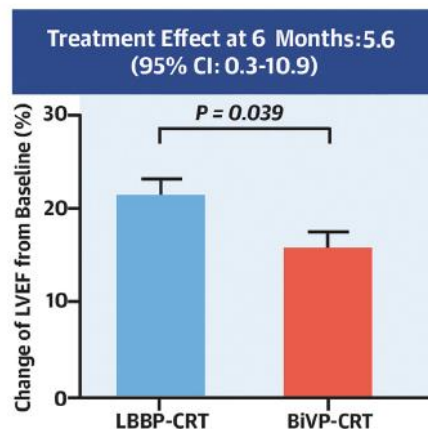
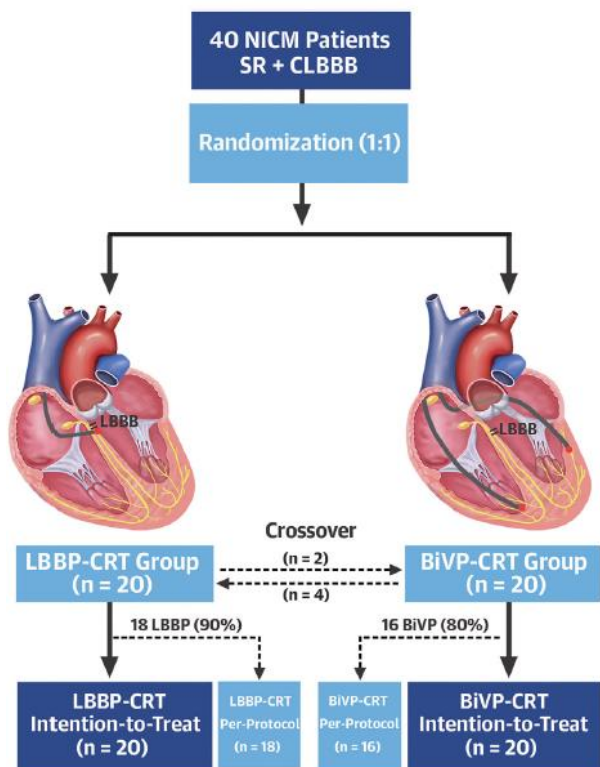
LBBAP lead complications 8.3%

- Acute perforation to LV 3.7%
- Lead dislodgement 1.5%
- Acute chest pain 1.0%
- Capture threshold rise 0.7%
- Acute coronary syndrome 0.4%
- Trapped/damaged helix 0.4%
- Delayed perforation to LV 0.1%
- Other 0.7%



LBBP-RESYNC (CRT vs. LBBP)

EF <35%, NYHA II-IV, LBBB, QRS >130-140ms



Wang Y, et al. J Am Coll Cardiol. 2022;80(13):1205-1216.



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Combination (CRT + CSP)

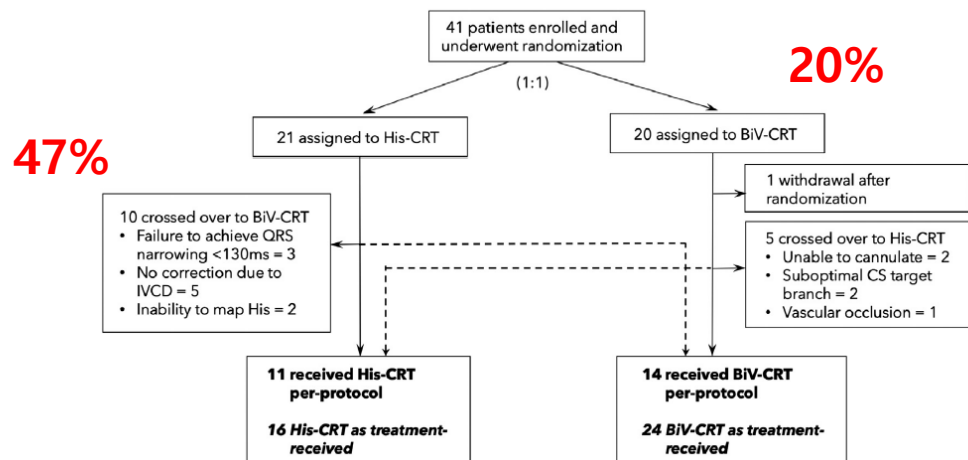


1. Implant Failure

Implant failure : HBP 40% CRT 20% LBBAP 10%

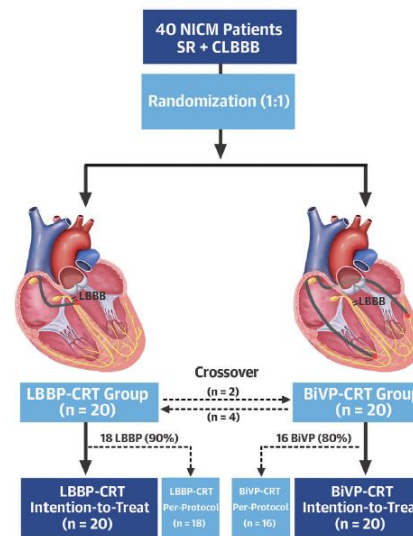
Recommendations	COR	LOE
In patients undergoing CRT with BiV pacing implantation via the CS, <u>crossover to CSP with HBP or LBBAP</u> is reasonable <u>when the CS LV lead placement is unsuccessful or suboptimal</u> .	Ila	C-LD
In patients undergoing CRT with BiV pacing implantation via the CS, <u>crossover to surgical epicardial CRT</u> with BiV pacing might be reasonable when the initial approach is unsuccessful or suboptimal.	Ilb	C-LD

His-SYNC Pilot Trials



Crossover - 36% (HBP 47%, CRT 20%)

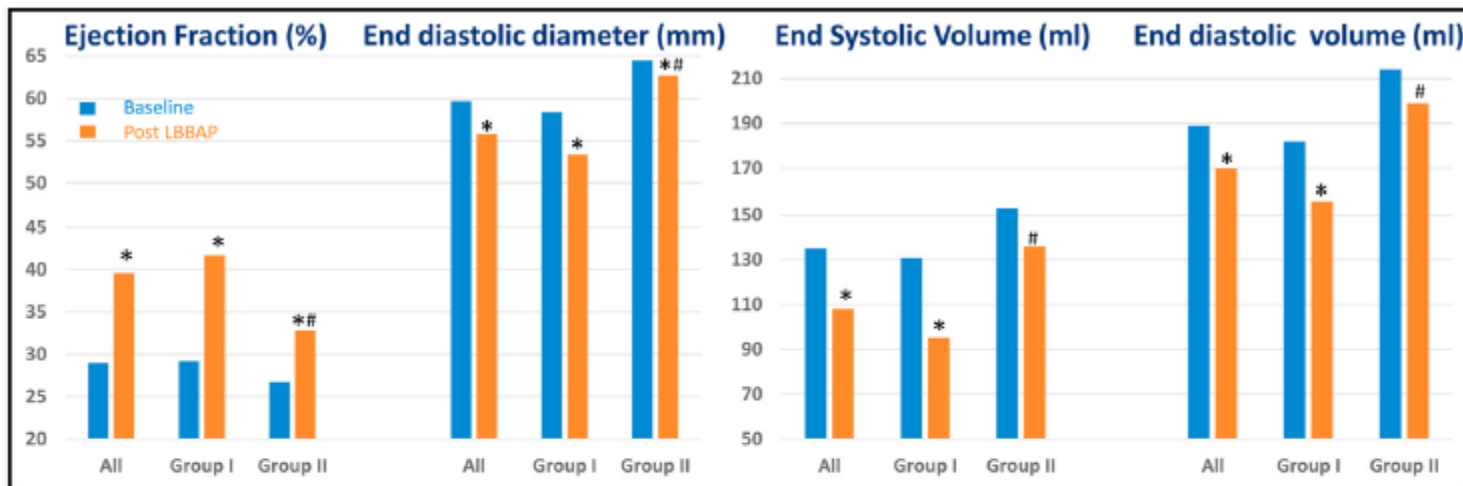
LBBB RESYNC Trials



Crossover - 15% LBBAP 10%, CRT 20%

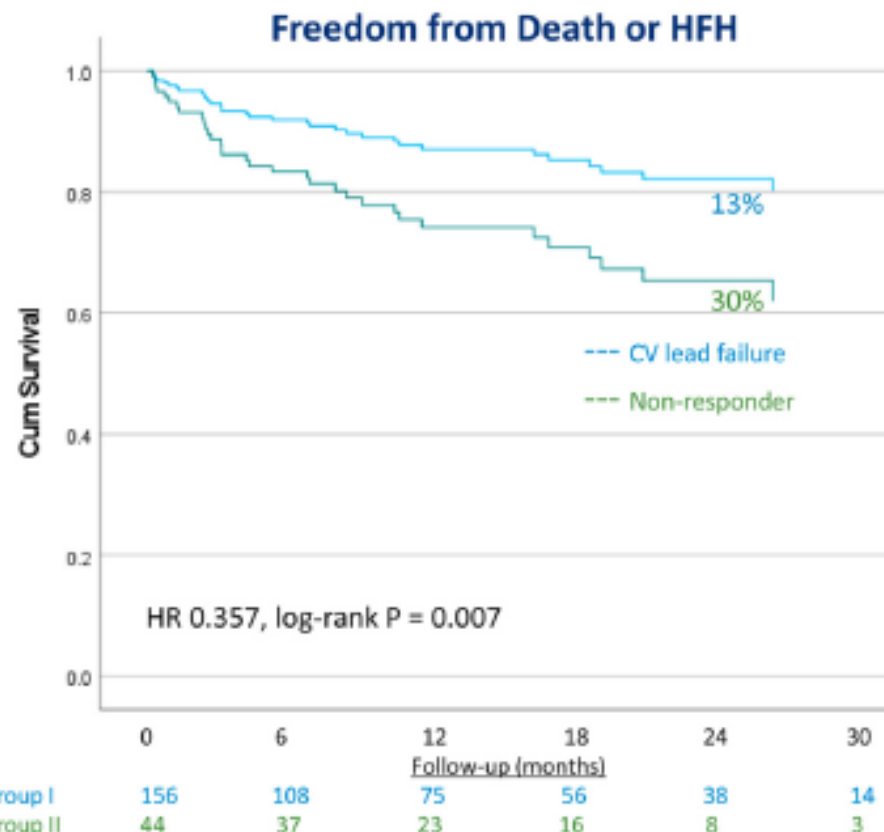
2. CRT Non responder

Rescue Left Bundle Branch Area Pacing



	ALL (n=150)			Group I: FAILED CV LEAD (n=114)			Group II: NON-RESPONDER (n=36)		
	Baseline	LBBAP	p-value	Baseline	LBBAP	p-value	Baseline	LBBAP/LOT	p-value
Echocardiographic response: (n=150)									
LVEF (%)	29±9.7	39.6±12	<0.001	29.2±9.3	41.7±11.9	<0.001	26.7±8	32.8±9.6 [†]	<0.001
LVEDD (mm)	59.7±10	55.8±10	<0.001	58.4±10	53.4±9.2	<0.001	64.5±9.7	62.7±10.2 [#]	0.024
LVESV (ml) (n=122)	135±71	108±69	<0.001	131±72	95±60	<0.001	153±78	136±80 [#]	0.70
LVEDV (ml) (n=127)	189±79	170±86	<0.01	182±77	156±77	<0.001	214±98	199±92 [#]	0.59

Values are mean ± SD or n (%). CV-coronary venous; LBBAP-left bundle branch area pacing; LOT- LBBAP optimized; LVEDD-left ventricular end-diastolic diameter; LVEDV-left ventricular end-diastolic volume; LVEF-left ventricular ejection fraction; LVESV-left ventricular end-systolic volume; NYHA-New York heart association. *p<0.01 compared to baseline; # p<0.01 compared to Group I.



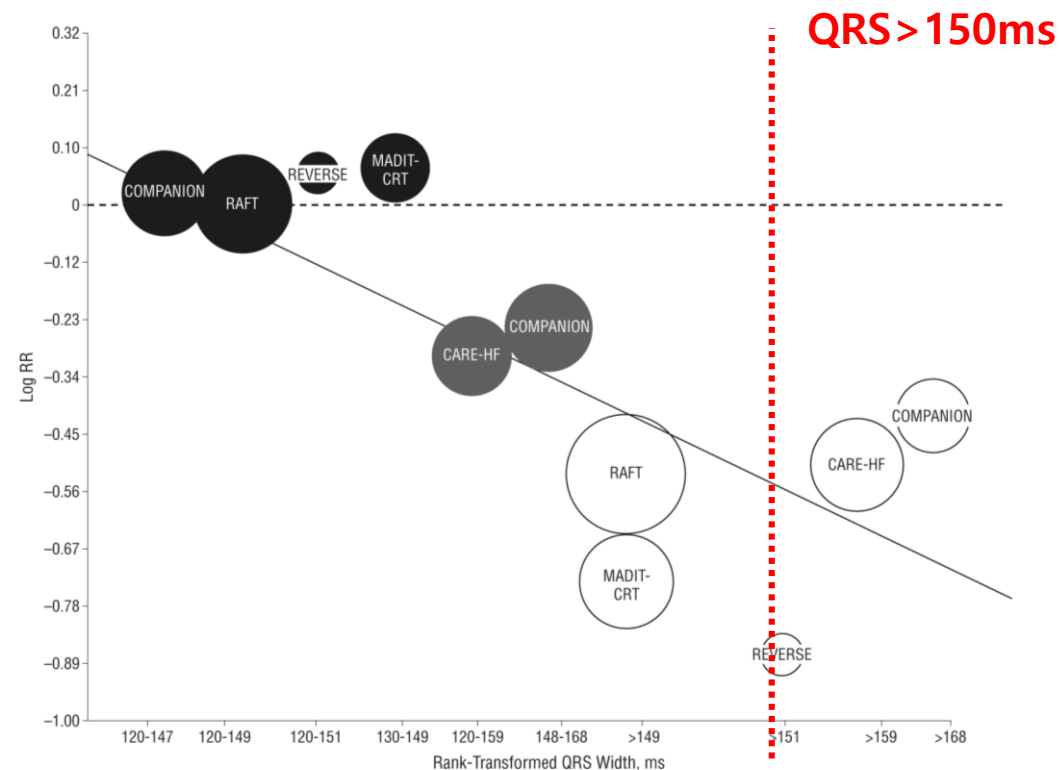
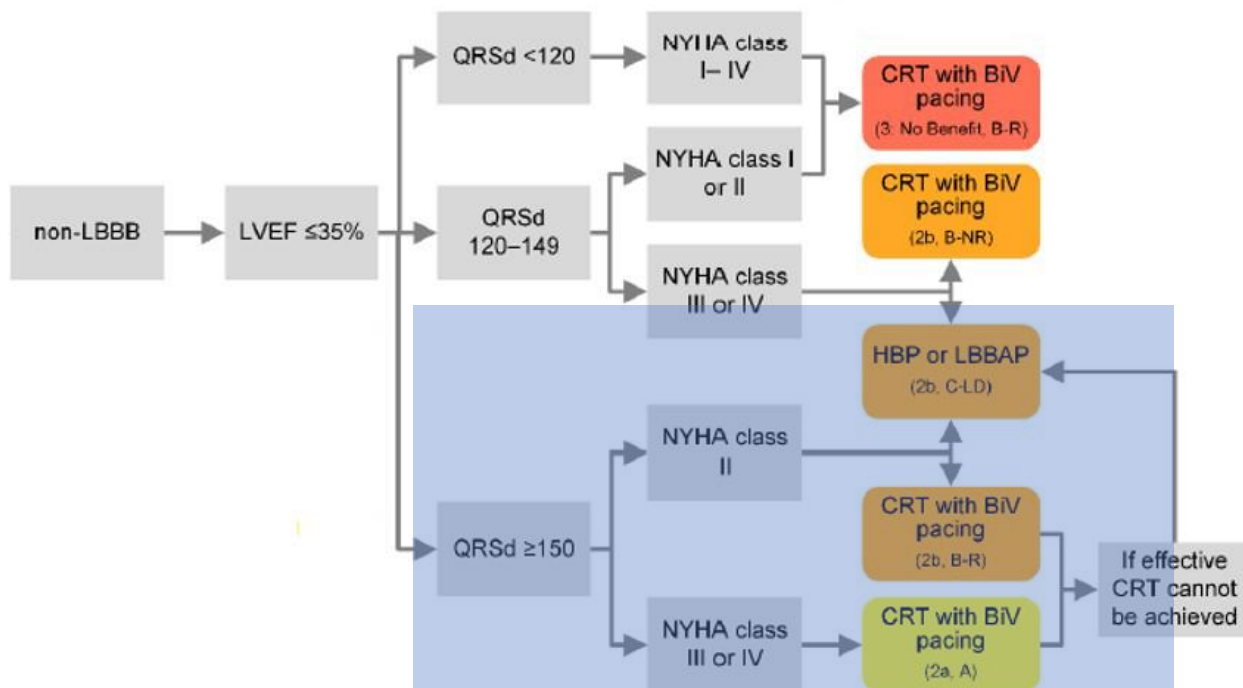
In patients who **did not respond to CRT**, LBBAP has shown the reduction in EF, end diastolic volume, diameter, which leading to decrease the death or HFH.

Vijayaraman P et al. Rescue left bundle branch area pacing in coronary venous lead failure or nonresponse to biventricular pacing: results from International LBBAP Collaborative Study Group. *Heart Rhythm* 2022;19:1272–1280.

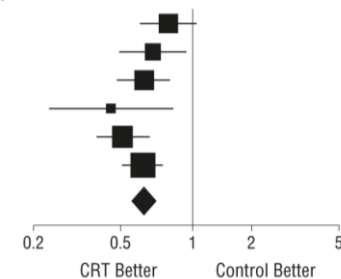
3. Non LBBB

Non-LBBB – QRS duration > 150ms : **CRT Class IIa**

Evidence of CSP – only small retrospective

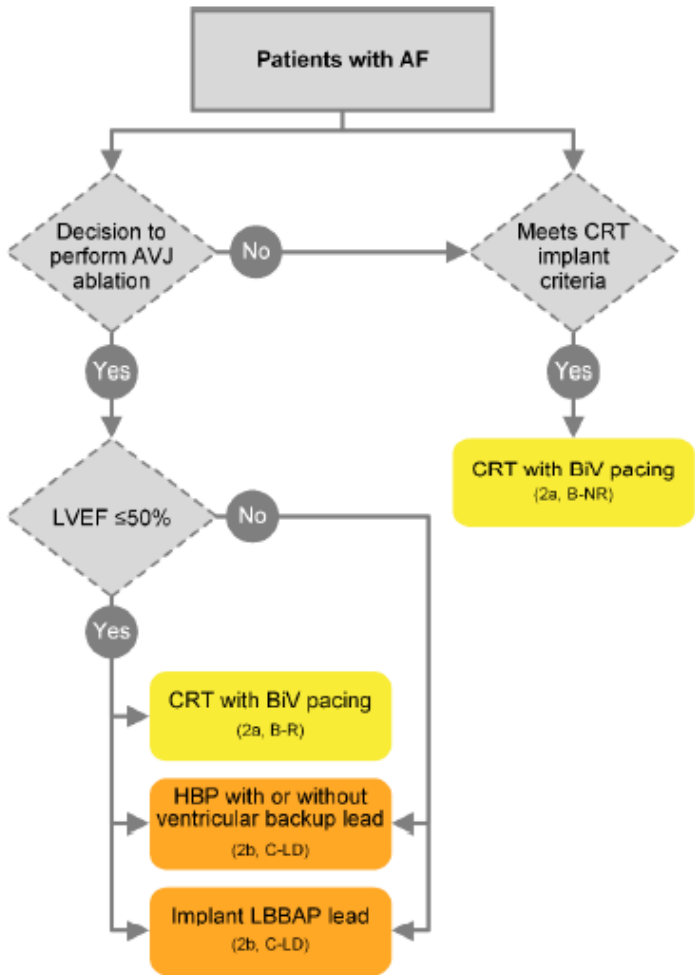


	RR (95% CI)	z Value	P Value
COMPANION (QRS, 148-168 ms, n=314)	0.78 (0.59-1.04)	-1.70	.09
COMPANION (QRS, >168 ms, n=287)	0.66 (0.47-0.93)	-2.35	.02
CARE-HF (QRS, >159 ms, n=505)	0.60 (0.46-0.79)	-3.70	<.001
REVERSE (QRS, >151 ms, n=307)	0.42 (0.22-0.81)	-2.61	.009
MADIT-CRT (QRS, >149 ms, n=1175)	0.48 (0.37-0.63)	-5.41	<.001
RAFT (QRS, >149 ms, n=1036)	0.59 (0.48-0.73)	-4.93	<.001
Meta-analysis	0.60 (0.53-0.67)	-8.67	<.001



In patients with **non LBBB and QRS duration of 150ms**, CRT is indicated as a **class II** recommendation based on evidence from studies such as Companion, Care HF. If effective CRT cannot be achieved, CSP can be attempted as an alternative option.

4. AF, AVJ ablation, EF < 50%

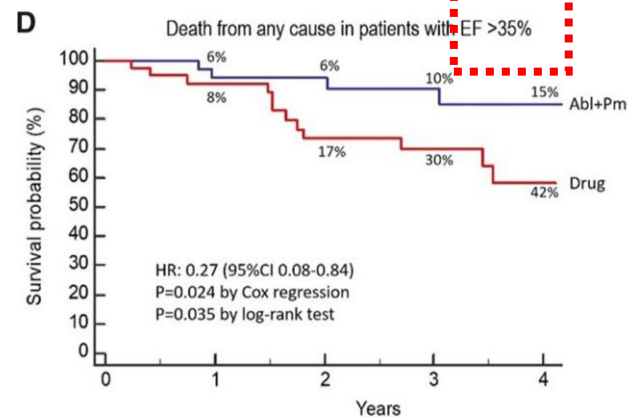
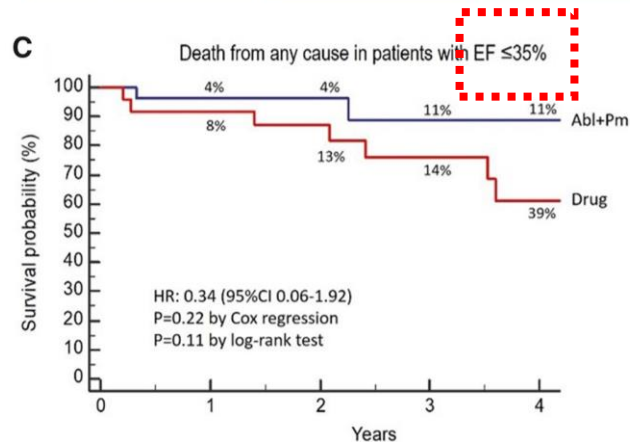
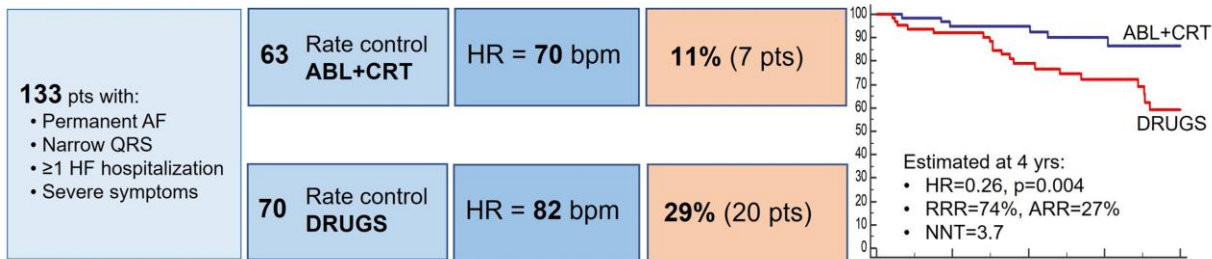
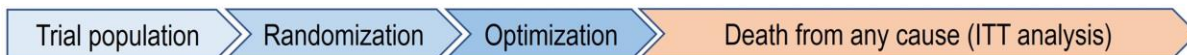


In patients with AF and reduced EF, AV node ablation and CRT is indicated when HF, rate uncontrolled.

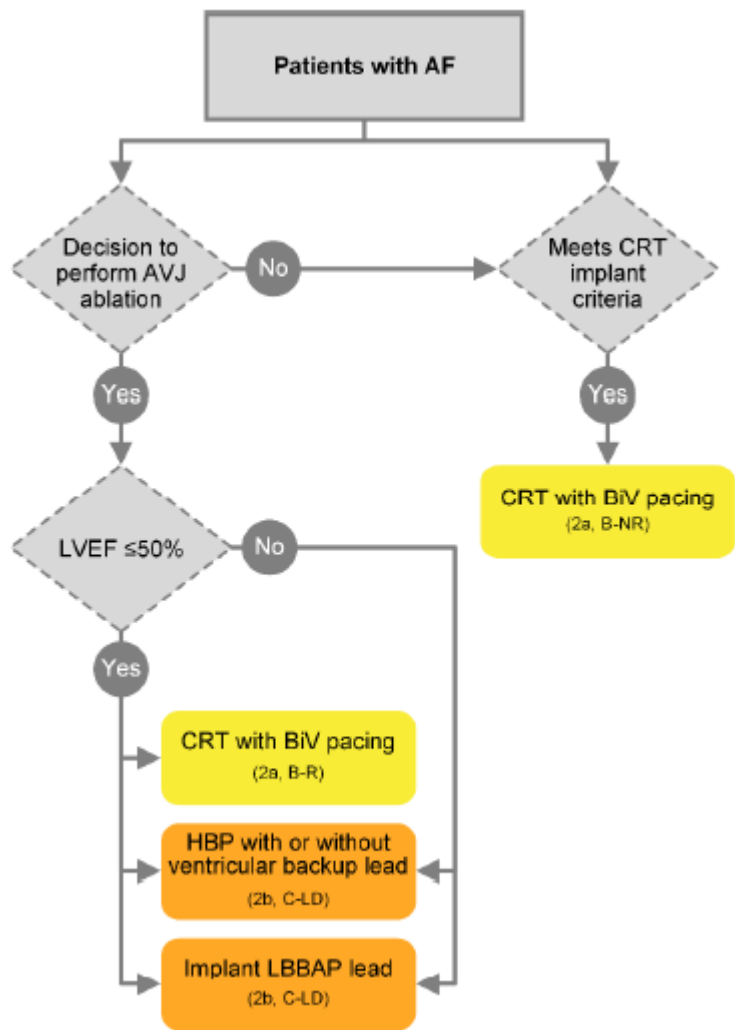
APAF-CRT trials

AF > 2 years, EF 41%, HR 101 bpm

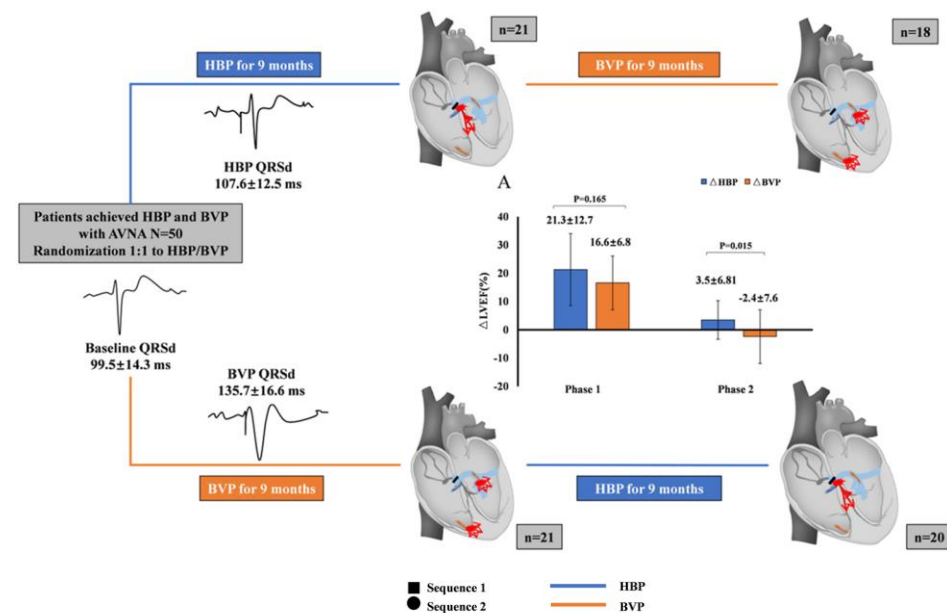
AV junction ablation and cardiac resynchronization for patients with permanent atrial fibrillation and narrow QRS: The APAF-CRT Mortality Trial. *Brignole M et al.*



4. AF, AVJ ablation, EF < 50%

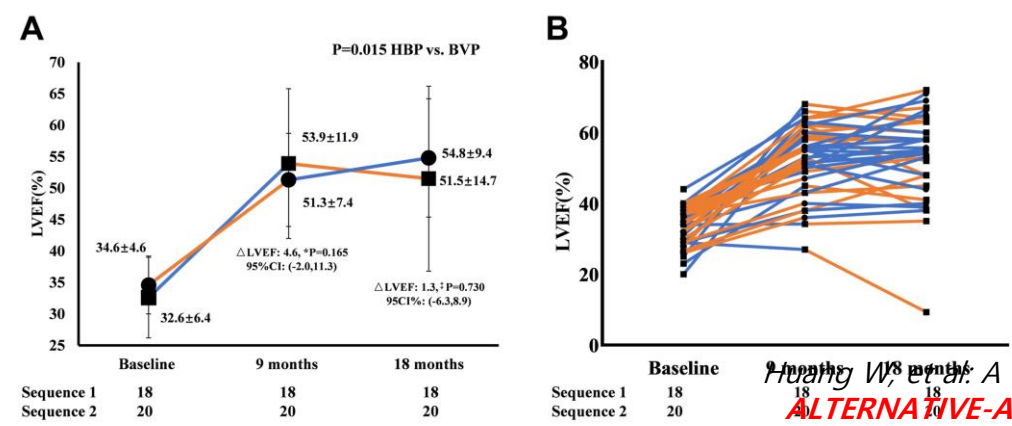


Alternative AF trials HBP vs BVP AVN ablation, AF, EF < 50%



AVJ + HBP	AVJ + LBBAP
Challenging	Relatively easy
Majority required back-up pacing lead (58%)	Not required
Longer procedure/ fluoroscopy time	Shorter procedure/ fluoroscopy time
Risk of acute rise in HBP thresholds (14%)	No risk of acute rise in thresholds
Significant proportion with chronic thresholds ≥2.5V (48%)	None had chronic thresholds ≥2.5V
Chronic HBP lead deactivation/extraction in 17%	None had LBBAP lead deactivation/extraction

CSP with either HBP or LBBAP preserves or restores LV systolic function in patients with refractory AF post AVJ ablation despite 100% ventricular pacing burden.



Huang W, et al. A multicenter, randomized, crossover study-The ALTERNATIVE-AF trial. Heart Rhythm 2022, 19(12):1948-1955.

5. HFmrEF (EF 36-50%)

QRS > 150ms : CRT, CSP class IIb



Evidence: Small single center studies

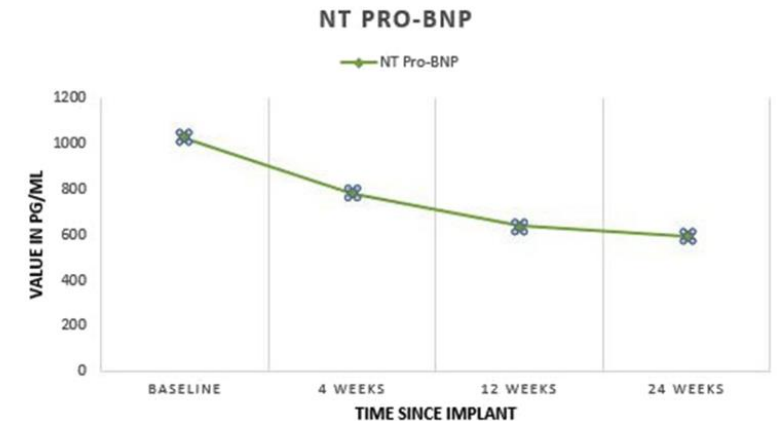
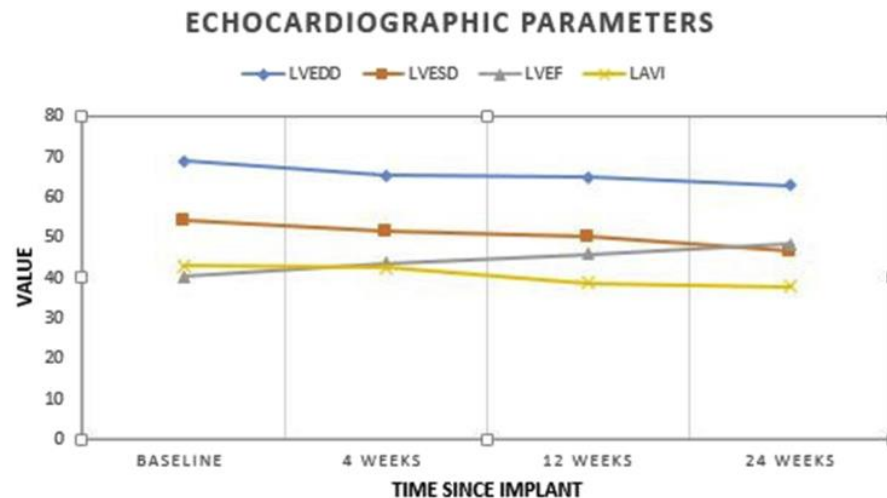
India, Single center

23 CRT-P patients

EF 36-45%

Prospective

2 years clinical follow up





Contents

1

Why CPP?

2

When is CSP needed?

3

Combination (CRT + CSP)



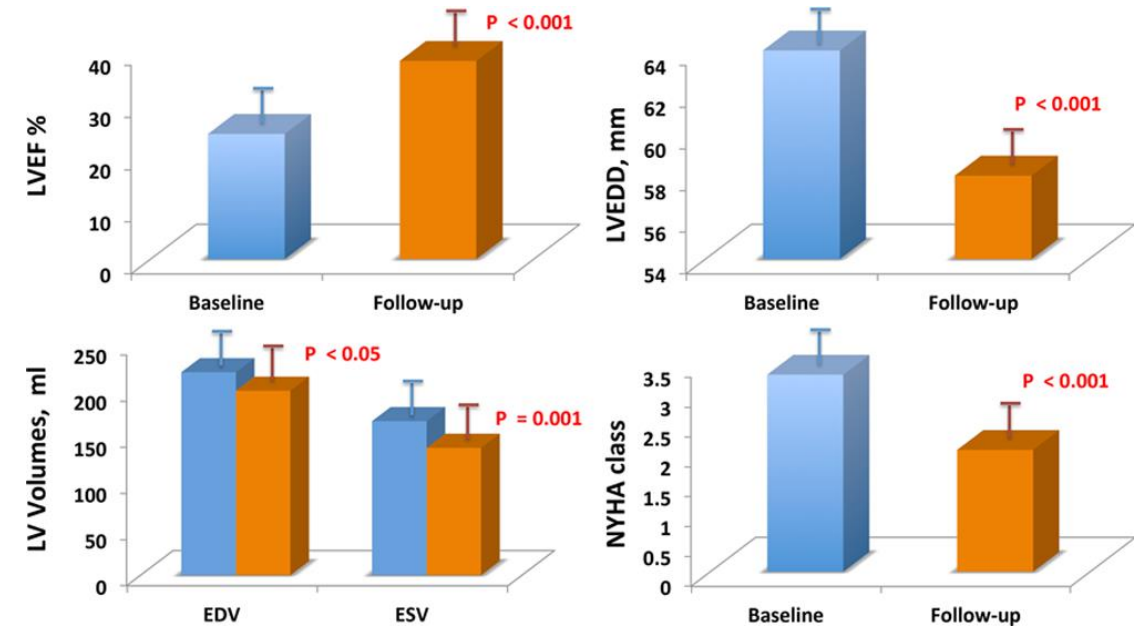
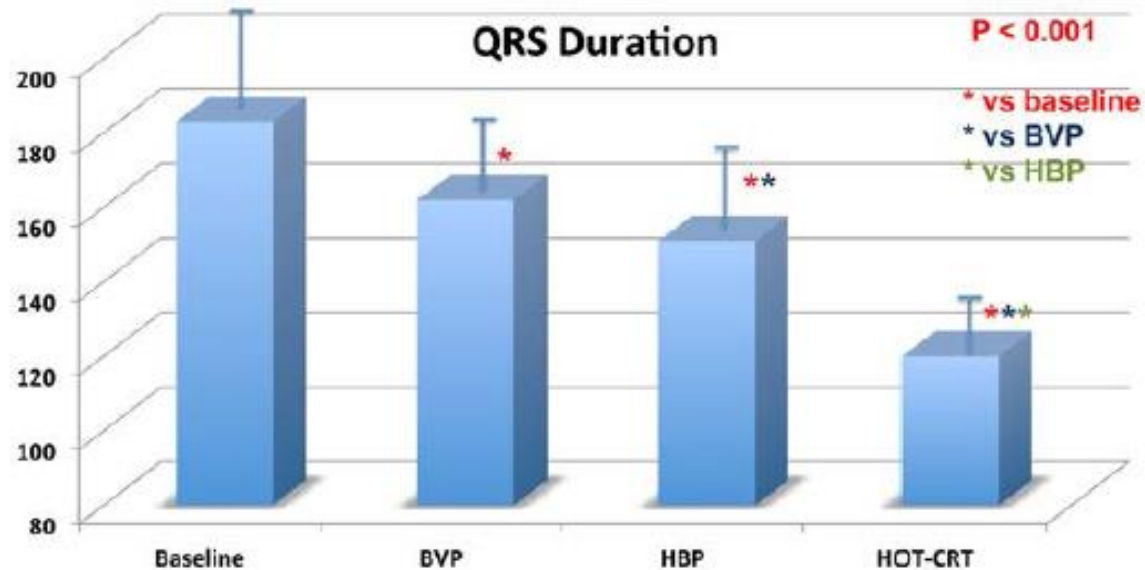
HBP + BVP (HOT-CRT, His Optimized CRT)

HOT CRT trials demonstrated that HBP with LV lead implantation resulted in reduction in QRS duration, improvement of EF, LV diameter and symptom relief.

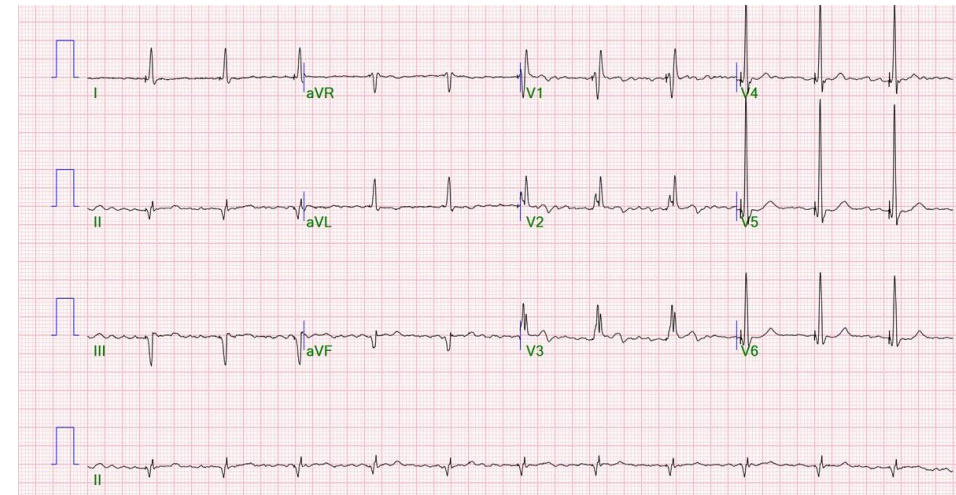
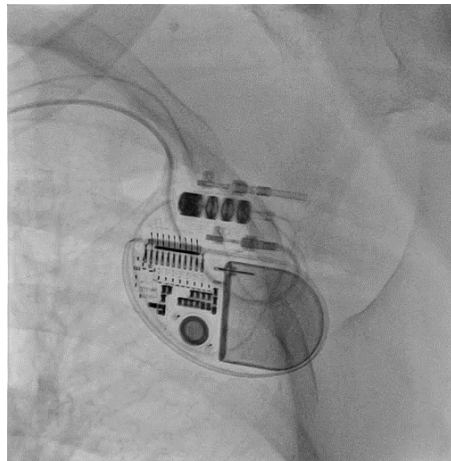
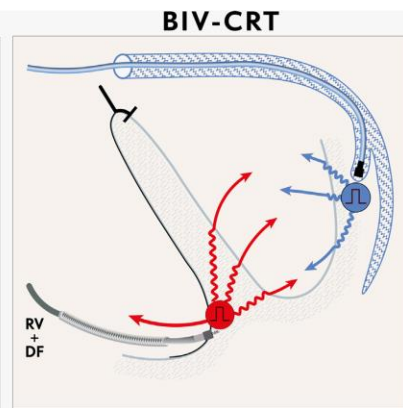
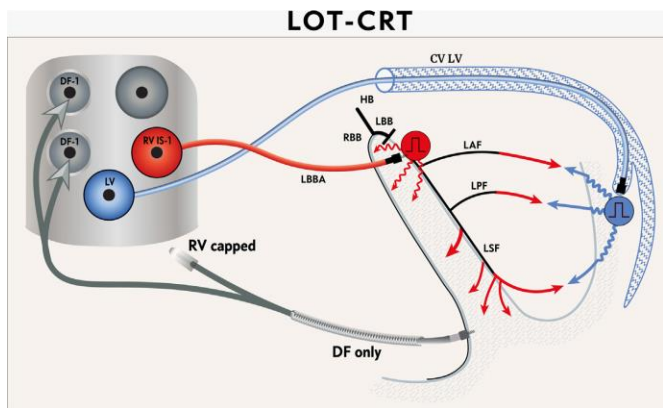
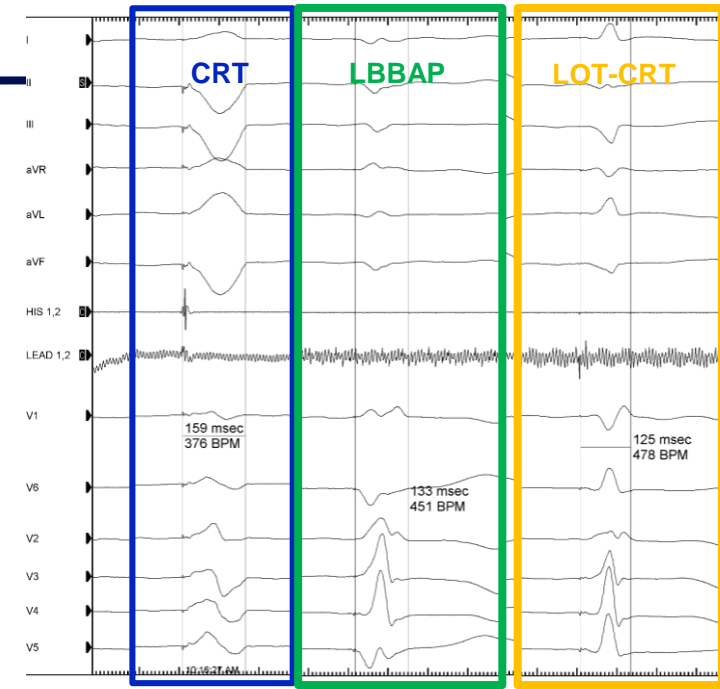
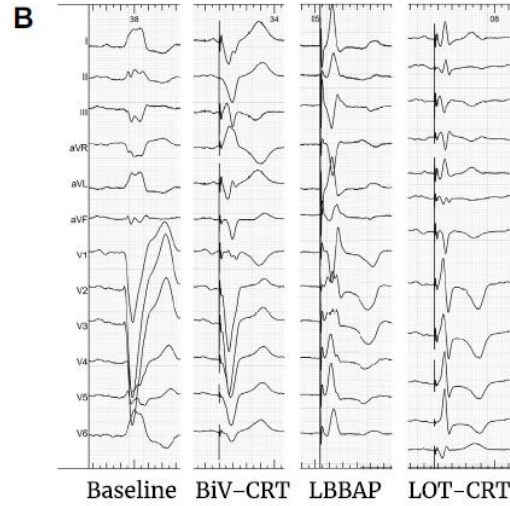
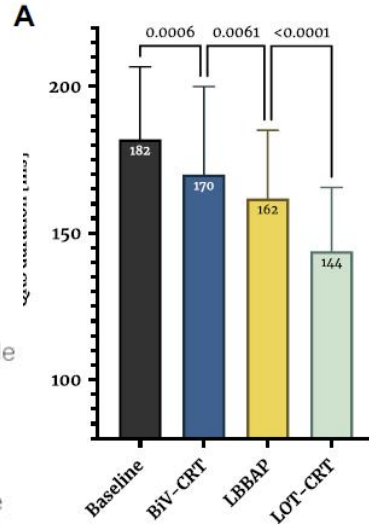
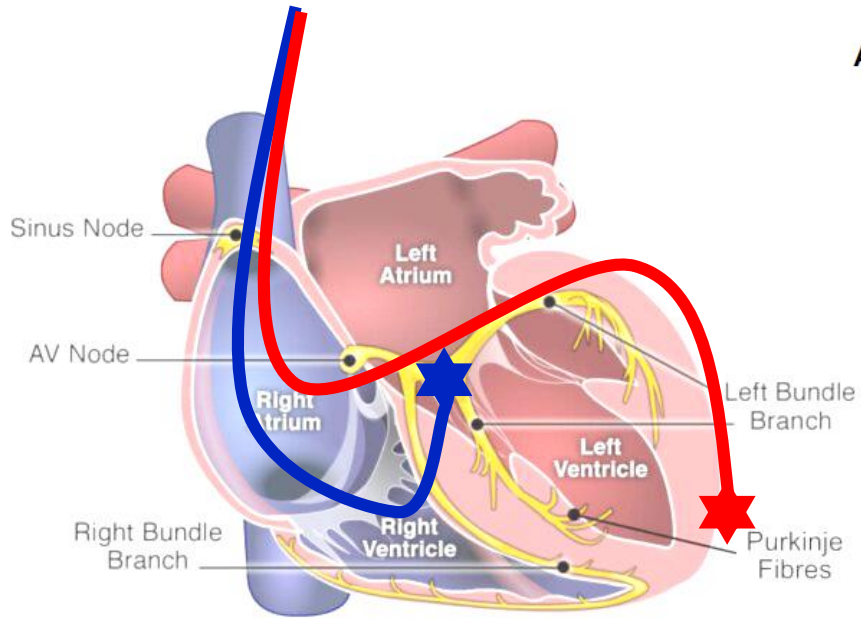
27 Patients LBBB/IVCD, QRSd > 140ms
NYHA class III-IV, LVEF < 35%



Success rate : 25/27 patients (93%)



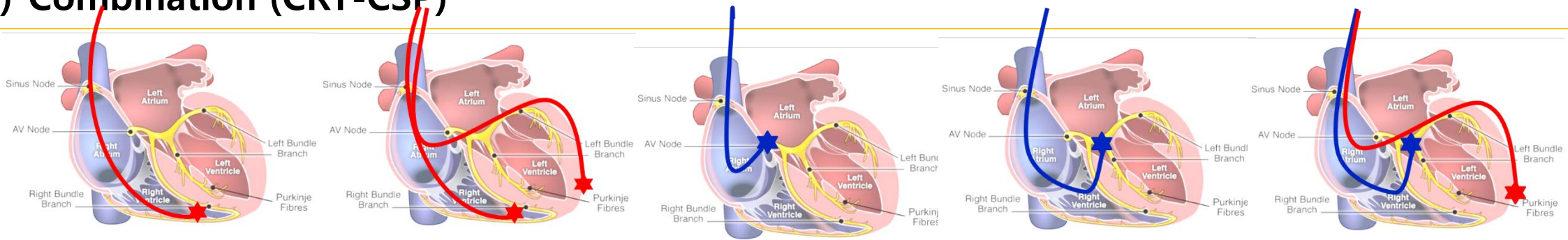
LBBAP + BVP (LOT-aCRT)



Jastrzebski M, Moskal P, Huybrechts W, et al. Left bundle branch-optimized cardiac resynchronization therapy (LOT-CRT): results from an International LBBAP Collaborative Study Group. *Heart Rhythm* 2022; 19:13–21.

Summary

- 1) **LBBB** EF <35%, QRS >120-150 - **Class I CRT** (If fail, **Class IIa CSP**)
- 2) **Non – LBBB** EF <35%, QRS >150 **Class IIa CRT** **Class IIb CSP**
- 3) **Implant Failure, Non Responder** **Class IIa CSP**
- 4) **AF** **Class IIa CRT** **Class IIb CSP**
- 5) **HFmrEF (EF 35-50%) (LBBB>150ms)** **Class IIb CRT, CSP**
- 6) **Combination (CRT-CSP)**



Myocardial Pacing

RVP

BVP

Conduction System Pacing

HBP

LBBAP

HOT CRT

LOT CRT

DANKSCHEEN
 SPASSIBO SHACHALHUYA NUHUN SHACHALHUYA CHALTU YAQHANYELAY YUSPAGARATAM HUI
GRACIAS TASHAKKUR ATU SUKSAMA EKHMET HATUR G LI
 ARIGATO SHUKURIA MERASTAWHY GAEJTHO LAH **THANK**
 SHUKURIA GOZAIMASHITA EFCHARISTO AGUYJE FAKAAUE KOMAPSUMNIDA MAAKE GRAZIE MEHRBANI PALDIES **YOU**
 JUSPAXAR BIANKA MERASTAWHY GAEJTHO LAH **YOU** MAMETA
 BOLZIN MERCI MINMONCHAR

