‘Positief over preventie’

Cardiale resynchronisatie; His/LBB-pacing of toch een conventionele LV-lead?

CNE / NVHVV

17-05-2022

Vokko van Halm

Disclosures

- Vokko van Halm
- Since 2013 Device cardiologist
- Since 2016 head PM/ICD-dept. AUMC, loc. VUmc

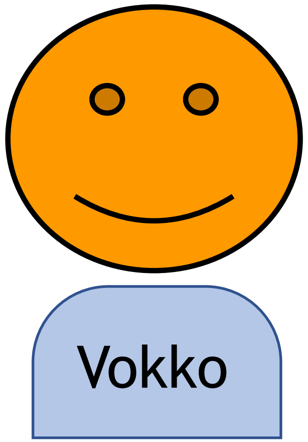
- Speakers fees: Abbott – Biotronik – MicroPort – Medtronic
- Grants: Abbott – Medtronic – Sanofi

“Positief over preventie”

Pacing is goed, het verkleind morbiditeit en verlaagd mortaliteit. Echter blijkt pacing niet voor iedereen altijd goed te zijn.
Mensen met conventionele ***RV-pacing*** hebben jaarlijks maar liefst tussen de ***5 en 10%*** risico om een ***pacing geïnduceerde cardiomyopathie te ontwikkelen (PICM)***.
Van oudsher is de behandeling van PICM ***resynchronisatie*** van de elektrische activatie van het hart middels een ***LV-lead***, cardiale resynchronisatie therapie (CRT).
Echter is gebruik maken van het nog (wel) functionerende deel van het ***eigen geleidingssysteem*** wellicht een nog betere manier van CRT.
Het eigen geleidingssysteem kan opgezocht worden ter plaatse van ***His-bundel of de linker bundeltak*** (His- of LBB-pacing).
Dat maakt dat we nu dus 3 plekken hebben om CRT te bereiken; ***conventionele LV + His + LBB***.
Maar wanneer gebruik je welke positie? Zijn ze alle 3 even succesvol? Wat zijn de lange termijn resultaten?

Tot slot komt de vraag naar voren, met dit ***verhoogde risico op hartfalen*** bij iedereen met een pacemaker zouden we ons dan niet meer moeten focussen op de ***preventie hiervan*** in plaats van achter de feiten aan ons te concentreren op resynchronisatie als het eigenlijk al te laat is?

Bekentenis!



His/LBB -dis believer

His/LBB -believer

2016, hotelbar Wenen avond voor congres

2020, RTL4, 5-uurs show - Hilversum

His/LBB-pacing

- *Waarom?*
- *Wie?*

His/LBB-pacing

- *Waarom?*

- *Wie?*

Waar kunnen we pacen?

=> *En kunnen deze sites gebruikt worden voor resynchronisatie?*

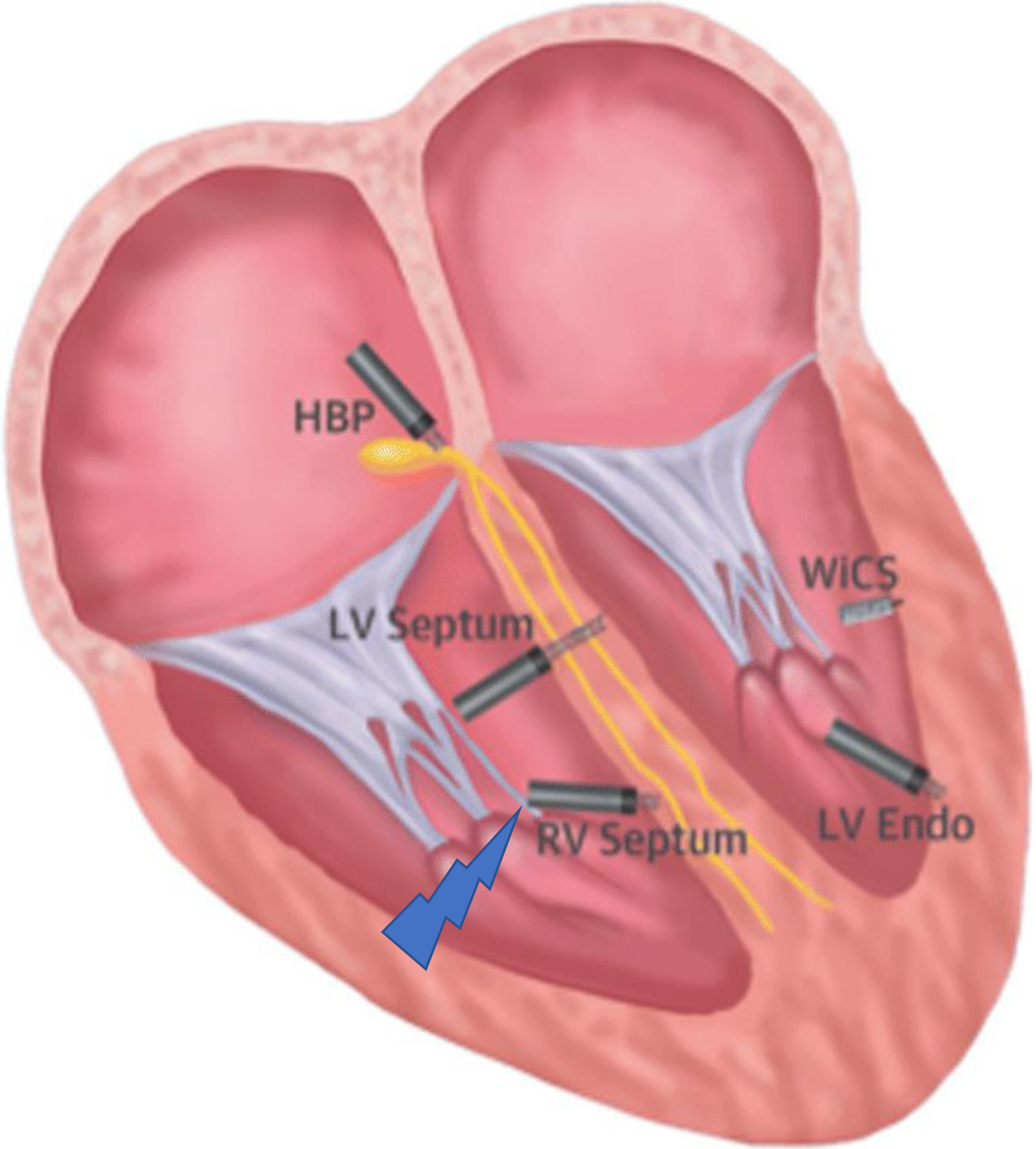
Endocardiaal pacing

Myocardial pacing

- Conventional RV septal
- Experimental LV
- Leadless LV

Conduction pacing

- His bundle
- Left bundle branch



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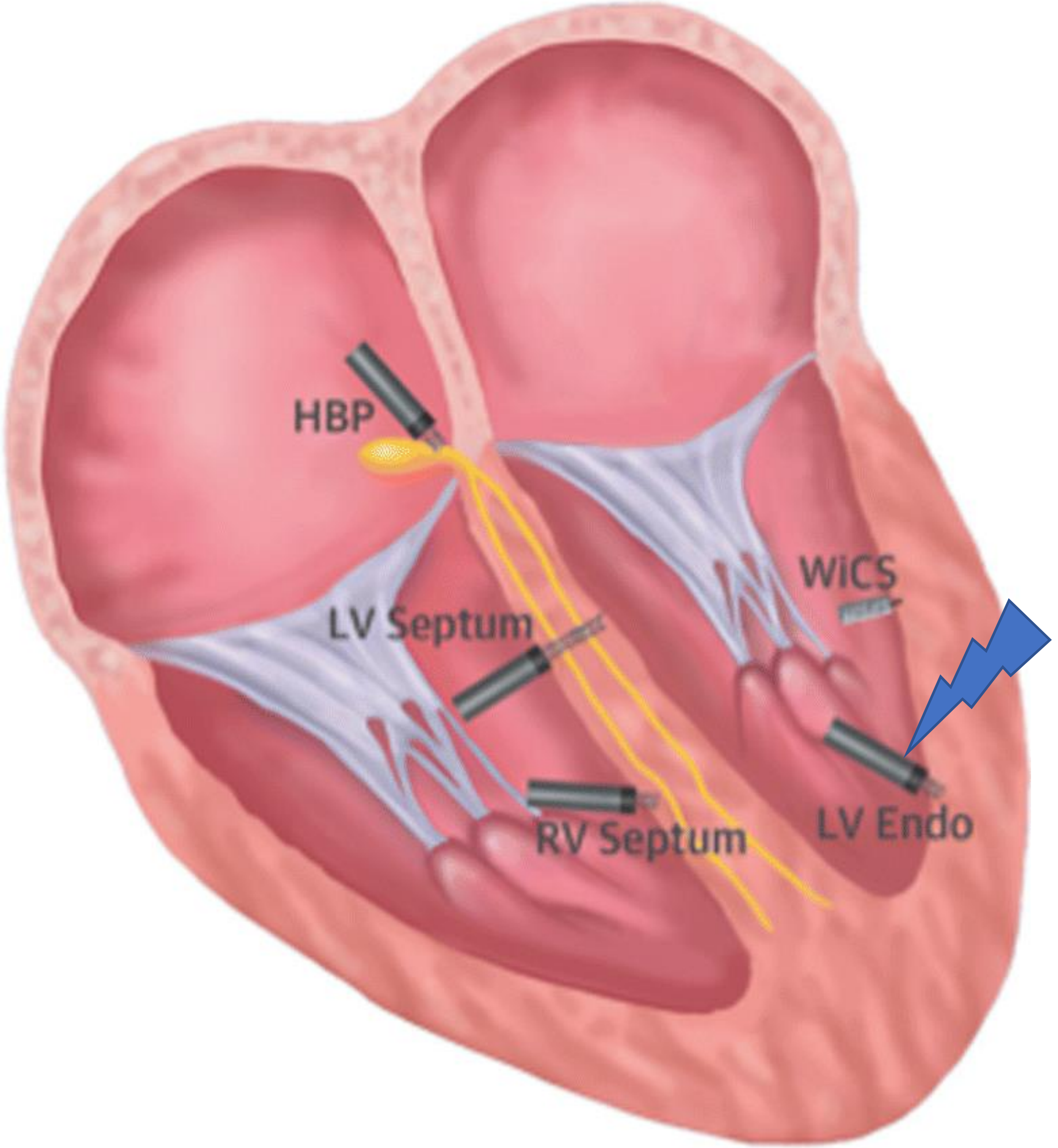

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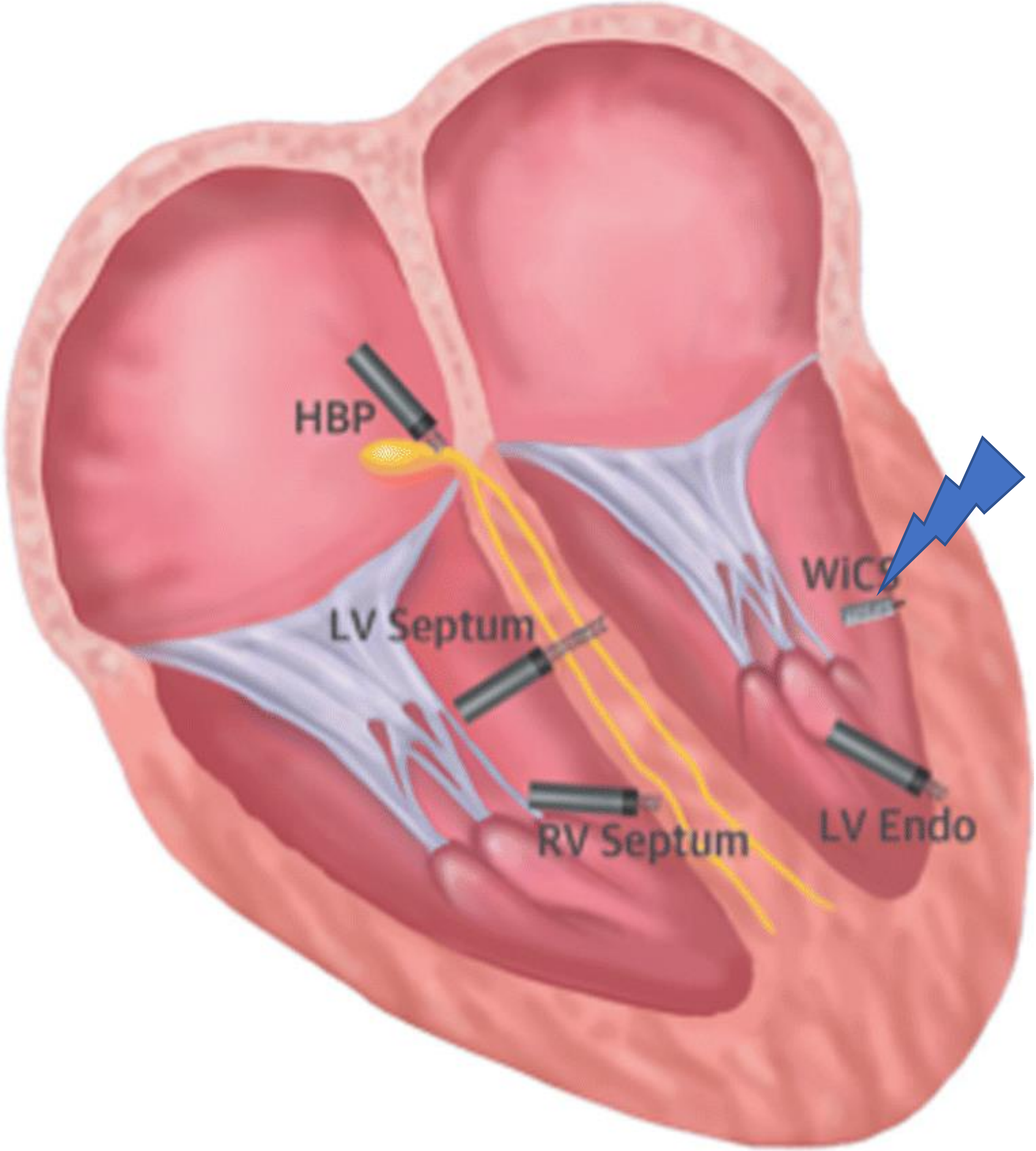

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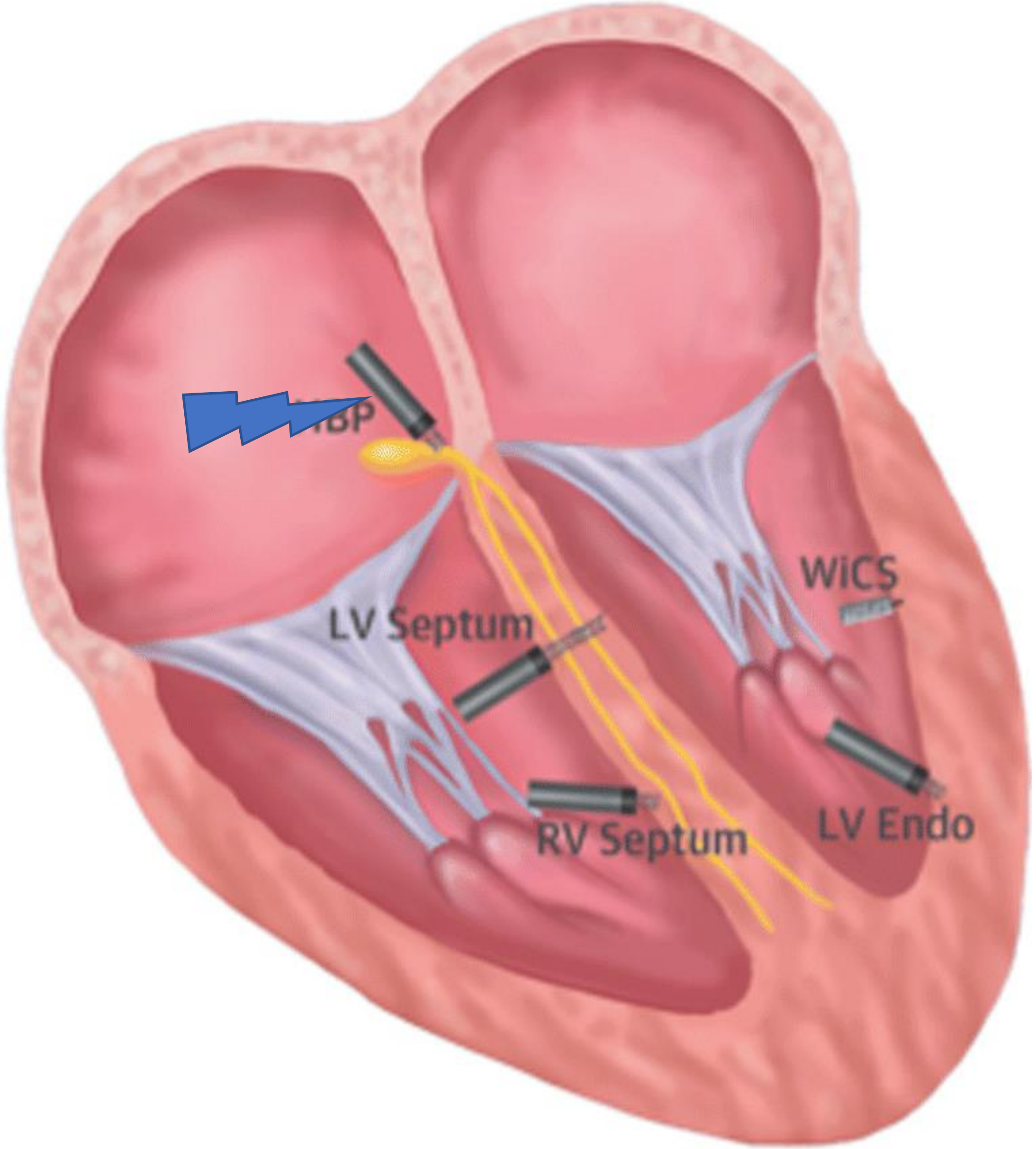

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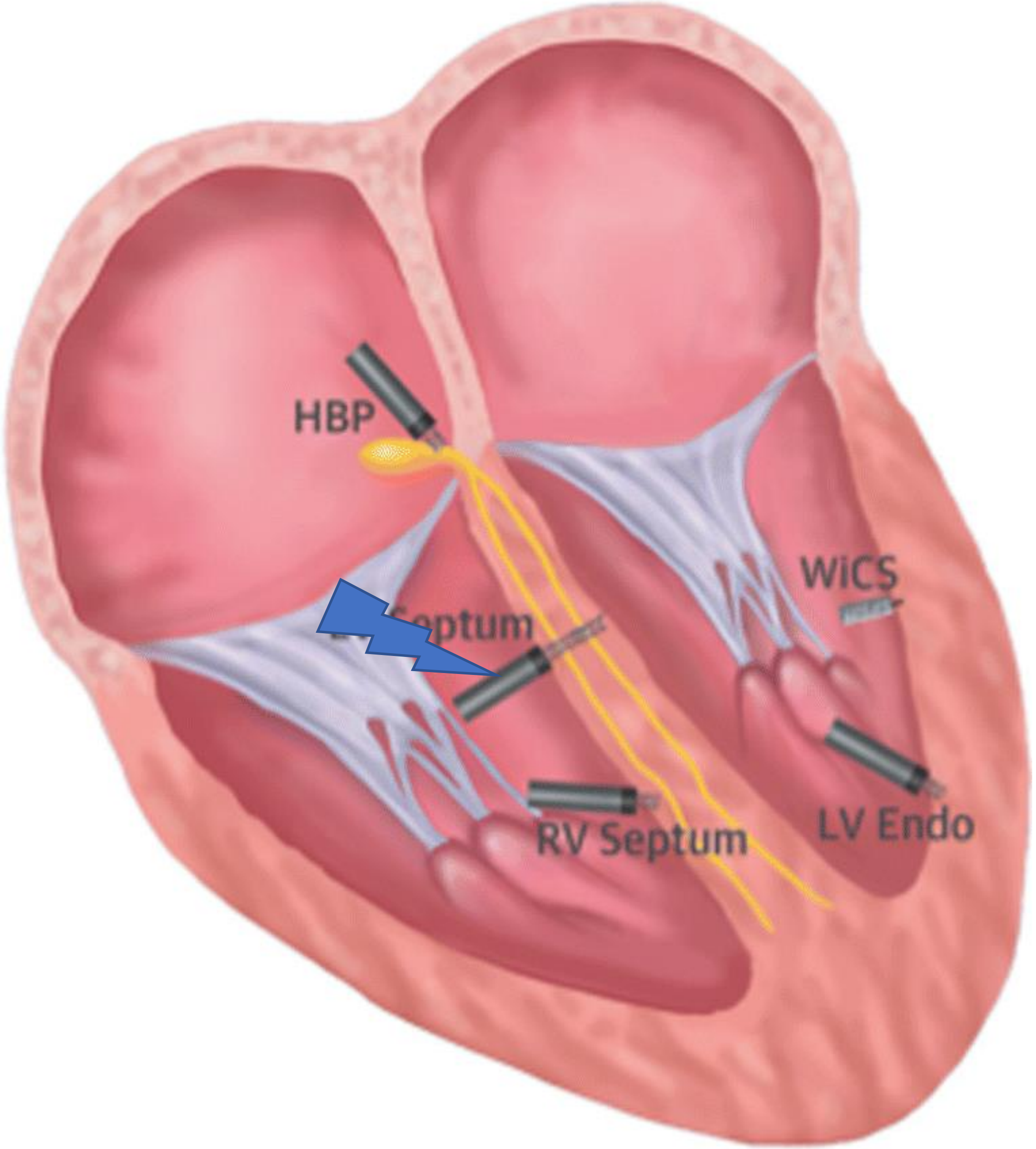


Waarom welke pacingsite?

RV-pacing ‘the standard’

- Pacemakertherapie verlaagt morbiditeit/mortaliteit t.g.v. brady-aritmieën
- Echter deel patiënten pacing-geïnduceerde afname LV/RV functie (=PICM)
- Definitie: ≥ 5 - 10% daling in LVEF of HF of LVEF ≤ 40%
- Tot 20% in 3,3 jaar in de literatuur

RV-pacing 'the standard'

Merchant et al. Card electrophysiol clin 2018

Table 1
Predictors of pacing induced cardiomyopathy

Study	Inclusion Criteria	Patients, n	Definition of PICM	Average Follow-up, Years	Patients with PICM, n (%)	Independent Risk Factors
Khurshid et al,[3] 2014 (single center); Khurshid et al,[21] 2016	RV single of dual chamber PPM; frequent (≥20%) RV pacing; repeat echocardiogram performed ≥1 y post-PPM implantation	257	≥10% decrease in LVEF < resulting in LVEF <50%	3.3	50 (19.5%)	Male gender (HR 2.15; 95% CI: 1.7–3.94, *P* = .01) Wider native QRS duration (HR 1.03 per 1 ms increase; 95% CI: 1.01–1.05, *P*<.001) Paced QRS ≥150 ms was 95% sensitive for development of PICM
Kiehl et al,[5] 2016 (single center)	RV single of dual chamber PPM; complete heart block; LVEF >50%	823	Post-PPM LVEF ≤40% or need for CRT upgrade	4.3	101 (12.3%)	Baseline LV dysfunction (HR 1.047 per 1% decrease; 95% CI: 1.002–1.087, *P* = .02) % RV pacing (HR 1.011 per 1% RV pacing; 95% CI: 1.002–1.020, *P* = .21) ≥20% RV pacing (HR: 6.76; 95% CI: 2.08–22.0, *P* = .002)
Lee at al,[4] 2016 (single center)	RV single of dual-chamber PPM; sinus node dysfunction or atrioventricular block; LVEF >40%	234	LVEF decrease >5% with symptoms of HF without other etiology for HF	15.6	48 (20.5%)	Old age (HR 1.62; 95% CI: 1.22–2.16, *P* = .001) Longer-paced QRS duration (HR 1.54; 95% CI: 1.15–2.05, *P* = .003) Higher myocardial scar score (HR: 1.23; 95% CI 1.03–1.49, *P* = .037) Higher percentage RV pacing (HR 1.31; 95% CI: 1.01–1.49, *P* = .010)
Kim et al,[22] 2018 (3 centers)	RV single of dual-chamber PPM: complete heart block; echocardiogram before and after PPM implantation	130	≥10% decrease in LVEF < resulting in LVEF <50%	4.5	21 (16.1%)	Paced QRS duration (HR 1.05; 95% CI: 1.02–1.09, *P* = .001)

PICM

Merchant et al. Card electrophysiol clin 2018

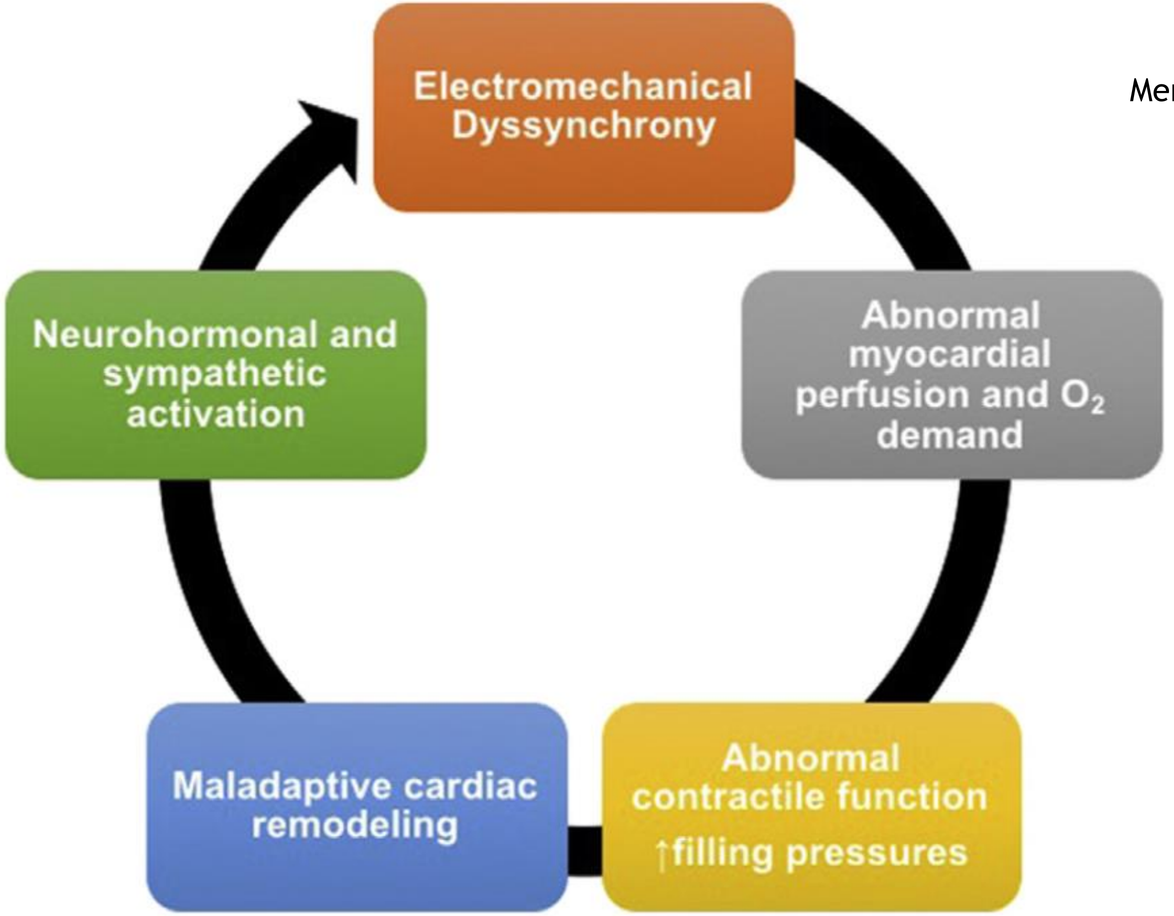
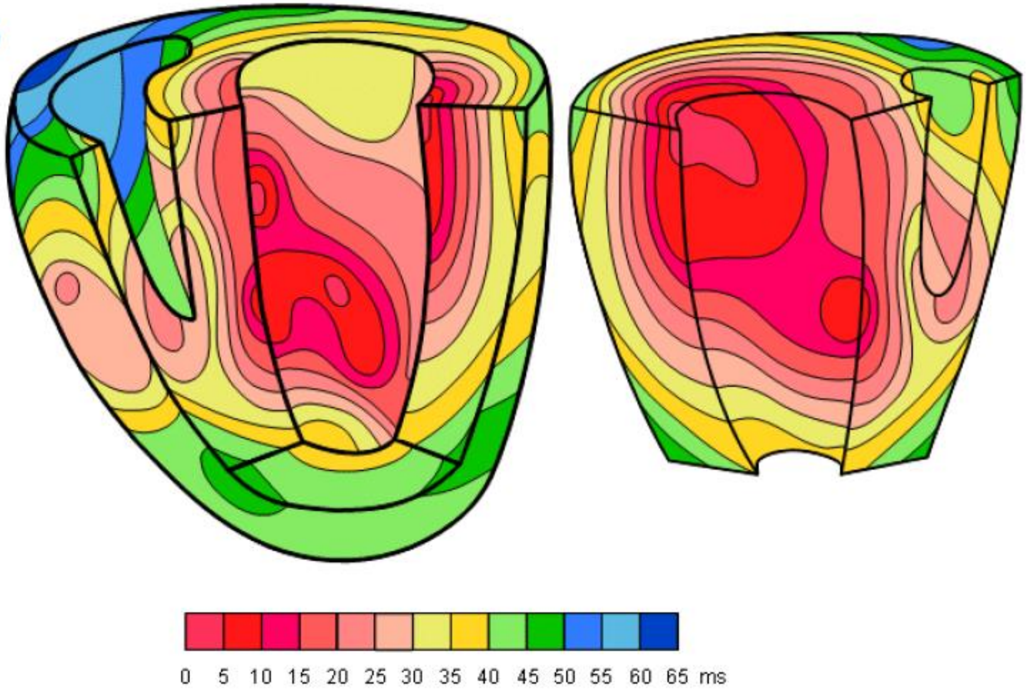


Fig. 1. Mechanisms for development of pacing-induced cardiomyopathy.

Normale activatie LV

- Electrical impulse generated in the sinus node exits the fast conducting Purkinje system at sites surface of the septum

- Hypothesis: pacing near these exit function close to normal

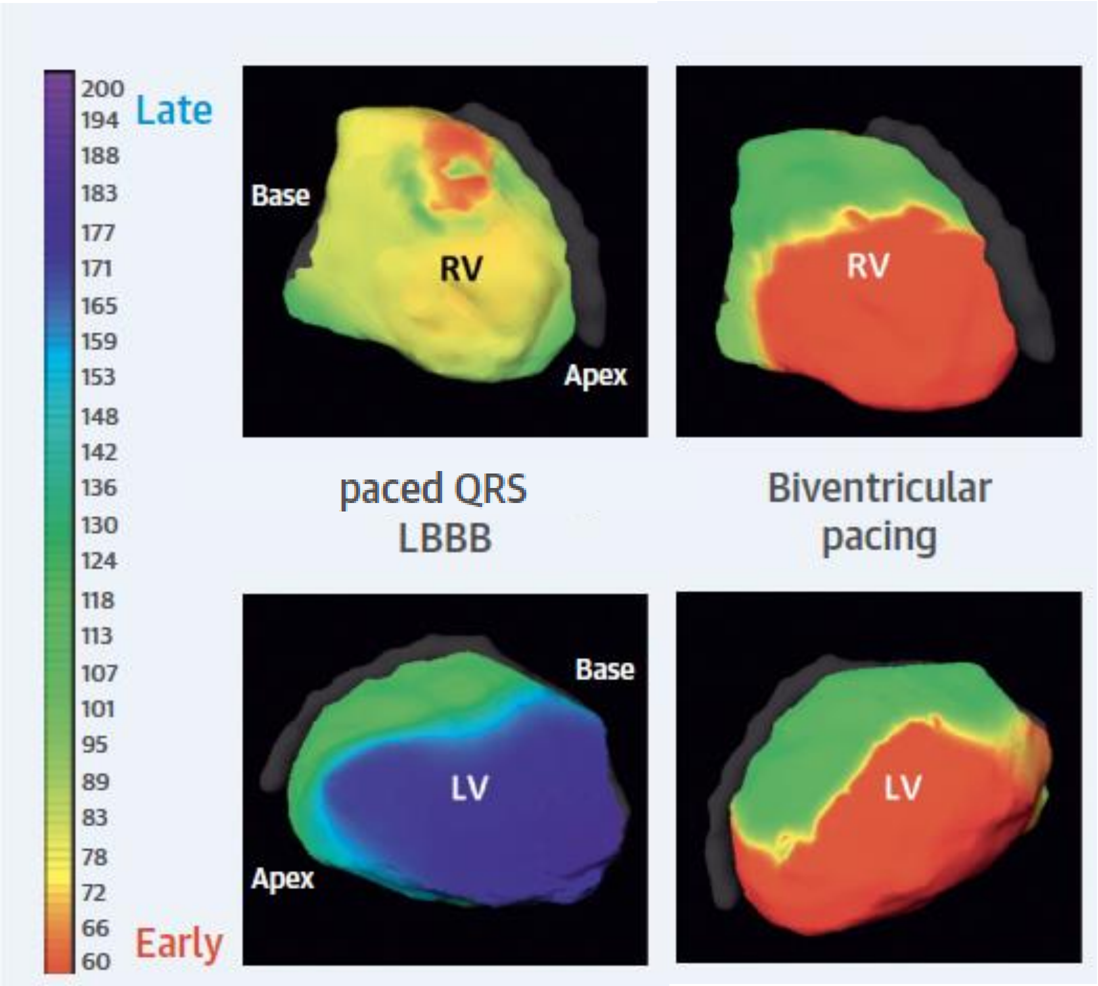


Durrer et al. Circ 1970
Myerburg et al. Circ Res. 1972

CRT lost PICM op

- oudsher middels LV-lead

- Echter:



CRT lost PICM op

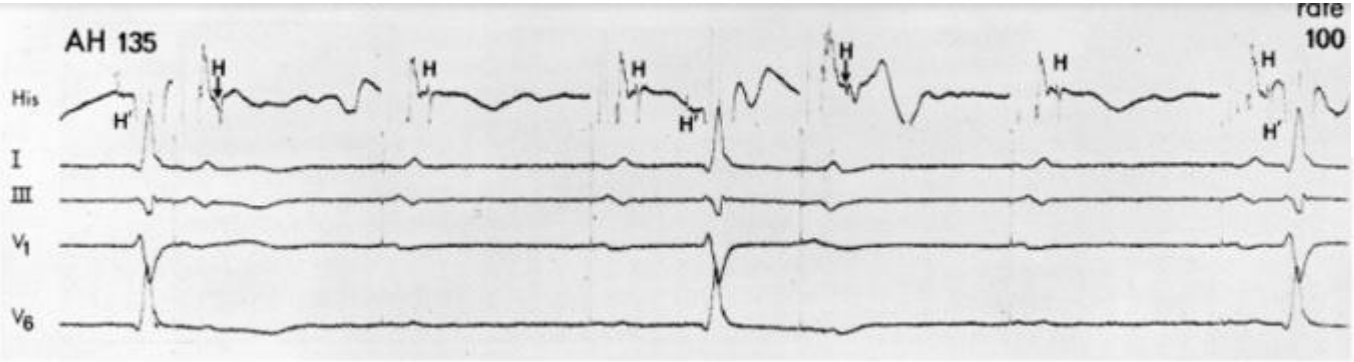
CRT - Biventricular Pacing

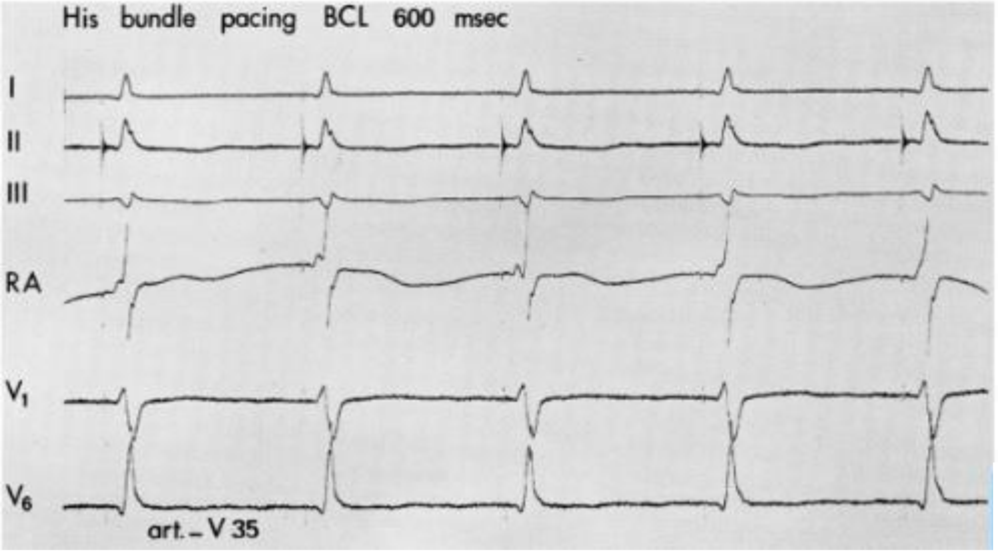
- ..delivers imperfect ventricular resynchronisation.
- ..does not return left ventricular activation times to those seen in intrinsically narrow QRS.

- Rates of nonresponse to CRT remain high: 30 - 40%.
- Rates of implant failure for CRT range between 5 - 9%.

Is een pacingsite die zo veel mogelijk gebruik maakt van ‘normale’, eigen geleidingssysteem niet beter?

His pacing anno 1972





Circulation, Volume XLV, March 1972

Conduction Disturbances Located within the His Bundle

By Reinier M. Schuilenburg, M.D., and Dirk Durrer, M.D.

From the University Department of Cardiology and Clinical Physiology, Wilhelmina Gasthuis, Amsterdam, The Netherlands.

Address for reprints: R. M. Schuilenburg, M.D., Department of Cardiology, Wilhelmina Gasthuis, Eerste Helmersstraat 104, Amsterdam, The Netherlands.

Received August 3, 1971; revision accepted for publication October 28, 1971.

His-CRT vs. BiV-CRT

His Resynchronization Versus Biventricular Pacing in Patients With Heart Failure and Left Bundle Branch Block

Acute crossover comparison between His pacing and conventional BiV CRT:

- NYHA 2-4, LBBB, LVEF<35% referred for CRT
- Non-invasive epicardial electrical mapping (LVAT)
- Invasive beat by-beat blood pressure

Upadhyay et al. Circ. 2019
Upadhyay et al. JACC. 2019

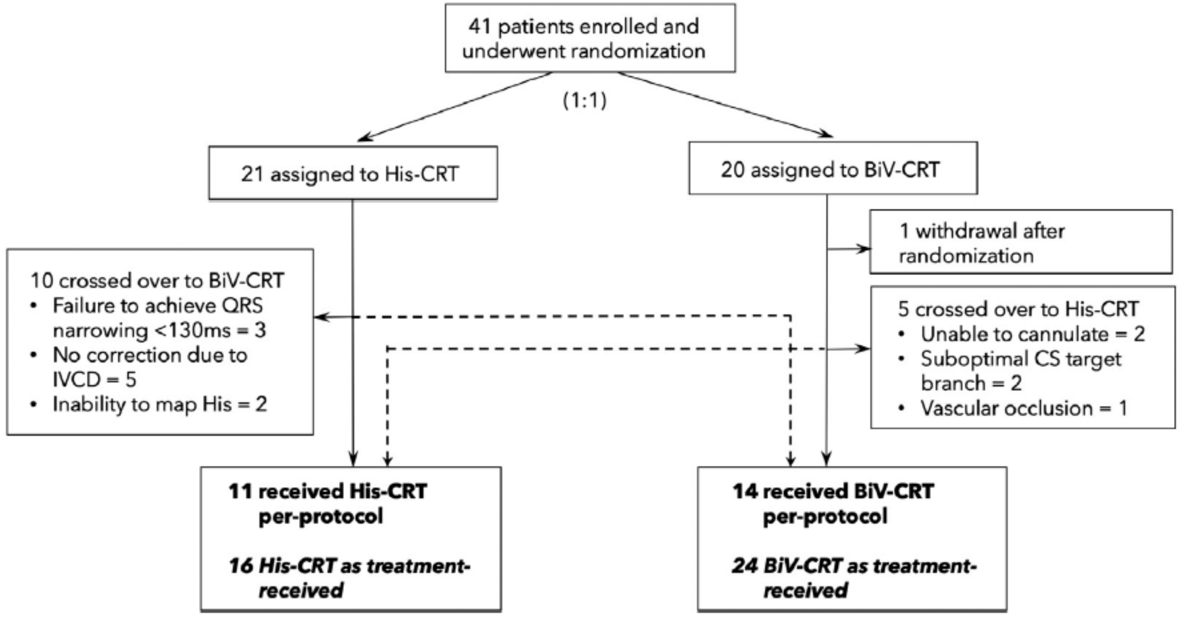
TABLE 1 Baseline Characteristics

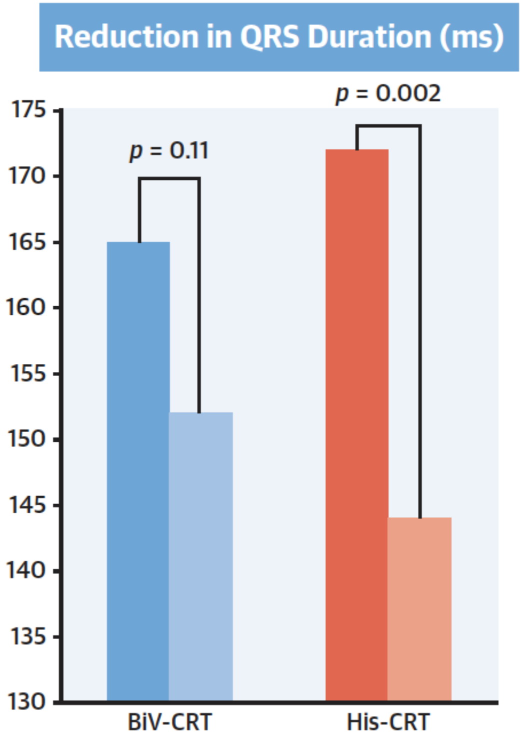
Age, yrs	67 ± 10 (48-89)
Male	9 (53)
Ejection fraction, %	26 ± 7 (14-40)
NYHA functional class	2.2 ± 0.7 (1-4)
I	1 (6)
II	12 (71)
III	3 (18)
IV	1 (6)
Previous MI	6 (38)
ACE inhibitor/ARB	17 (100)
Beta-blocker	14 (82)
MRA	11 (65)
Sacubitril	2 (12)
QRS duration, ms	
Atrial pacing (AAI)	178 ± 30 (136-272)
His bundle pacing	139 ± 29 (106-200)
Biventricular pacing	158 ± 21 (109-195)
PR interval, ms	180 ± 24 (130-244)
Selective His bundle capture	2 (12)
Subclavian access His bundle pacing	13 (76)
LV lead in lateral branch of CS	17 (100)
Quadripolar LV lead	16 (94)
Invasive BP measurement	11 (65)

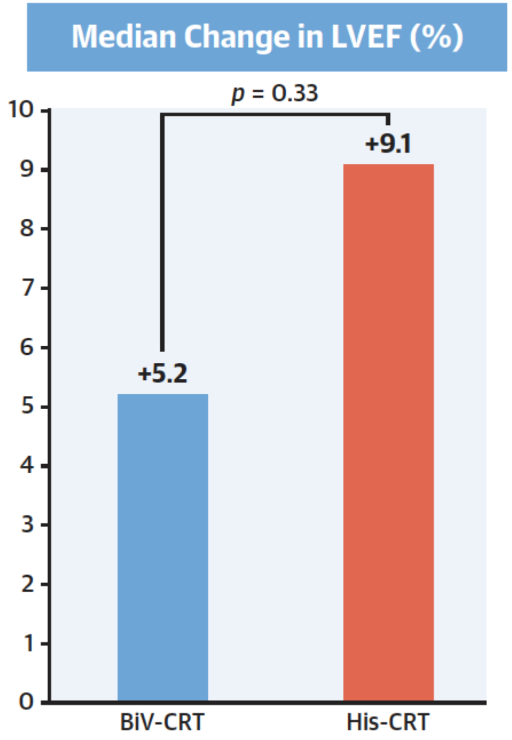
His-CRT vs. BiV-CRT

Upadhyay et al. Circ. 2019
Upadhyay et al. JACC. 2019

HIS-SYNC trial: multicenter randomized trial in CRT eligible patients







His-CRT vs. BiV-CRT

Upadhyay et al. Circ. 2019
Upadhyay et al. JACC. 2019

Table 2 Device parameters in follow-up by on-treatment group (His-CRT or BiV)

Parameter	His-CRT (n = 16)	BiV (n = 24)	*P* value
Implant measurements			
RA lead sensing (mV)	2.00 (1.50–3.80)	1.75 (1.25–3.50)	.457
RA lead capture threshold (V)	0.75 (0.60–1.25)	0.70 (0.50–1.00)	.134
RA lead pulse width (ms)	0.40 (0.40–0.50)	0.50 (0.40–0.50)	.384
RA lead impedance (ohms)	475 (399–726)	494 (399–600)	.641
RV lead sensing (mV)	10.25 (9.40–14.80)	12.00 (7.30–15.10)	.910
RV lead threshold (V)	0.50 (0.50–0.75)	0.50 (0.50–1.00)	.241
RV lead pulse width (ms)	0.40 (0.40–0.50)	0.40 (0.40–0.50)	.746
RV lead impedance (ohms)	513 (475–608)	492.50 (428–555)	.334
His or LV threshold (V)*	**2.75 (1.25–3.38)**	**0.85 (0.73–1.31)**	**.002**
His or LV pulse width (ms)	**1.00 (1.00–1.00)**	**0.50 (0.40–0.65)**	**<.001**
His or LV impedance (ohms)	**433 (340–481)**	**540 (497–680)**	**.001**
6-Month follow-up			
RA lead sensing (mV)	3.55 (2.50–4.60)	2.40 (1.95–3.55)	.111
RA lead capture threshold (V)	0.75 (0.50–0.80)	0.66 (0.55–0.81)	.721
RA lead pulse width (ms)	0.40 (0.40–0.40)	0.40 (0.40–0.40)	.684
RA lead impedance (ohms)	485 (456–513)	456 (380–513)	.345
RV lead sensing (mV)	13.65 (9.13–16.88)	12.50 (11.30–20.00)	.275
RV lead threshold (V)	0.50 (0.50–0.75)	0.75 (0.50–1.00)	.184
RV lead pulse width (ms)	0.40 (0.40–0.40)	0.40 (0.40–0.40)	.647
RV lead impedance (ohms)	456 (399–551)	428 (380–513)	.361
His or LV threshold (V)*	**2.00 (1.00–3.25)**	**0.94 (0.75–1.25)**	**.004**
His or LV pulse width (ms)	**1.00 (1.00–1.00)**	**0.40 (0.40–0.50)**	**<.001**
His or LV impedance (ohms)	**295 (284–390)**	**615 (456–703)**	**<.001**

His-pacing

Drawbacks of His bundle pacing

- Technically challenging
- Limited success: hard to fixate the lead in 10-20%
- What happens to His pacing with progression of conduction disease?
- High and unstable thresholds during follow-up
- Sensing issues
- Not possible or increasing output necessary in LBBB

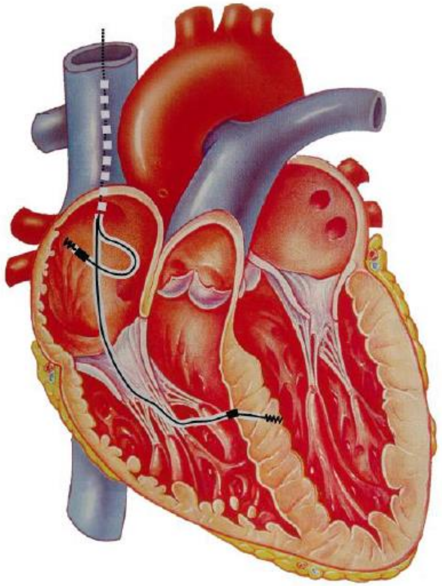
His-CRT technisch lastig maar mogelijk beter conventionele Biv-CRT

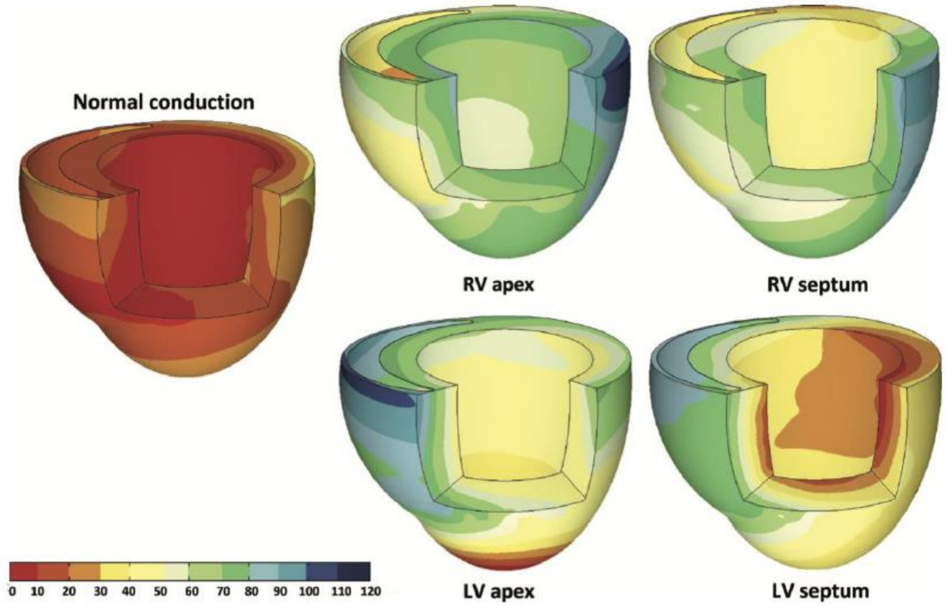
Left bundle branch (LBB) pacing

LBB-area

Left Ventricular Septal and Left Ventricular Apical Pacing Chronically Maintain Cardiac Contractile Coordination, Pump Function and Efficiency

Robert W. Mills, PhD; Richard N. Cornelussen, PhD; Lawrence J. Mulligan, PhD; Marc Strik, MD; Leonard M. Rademakers, MD; Nicholas D. Skadsberg, PhD; Arne van Hunnik, MSc; Marion Kuiper, MSc; Anniek Lampert, MSc; Tammo Delhaas, MD, PhD; Frits W. Prinzen, PhD





Mills et al. Circ Arrhythmia Electrophysiol 2009

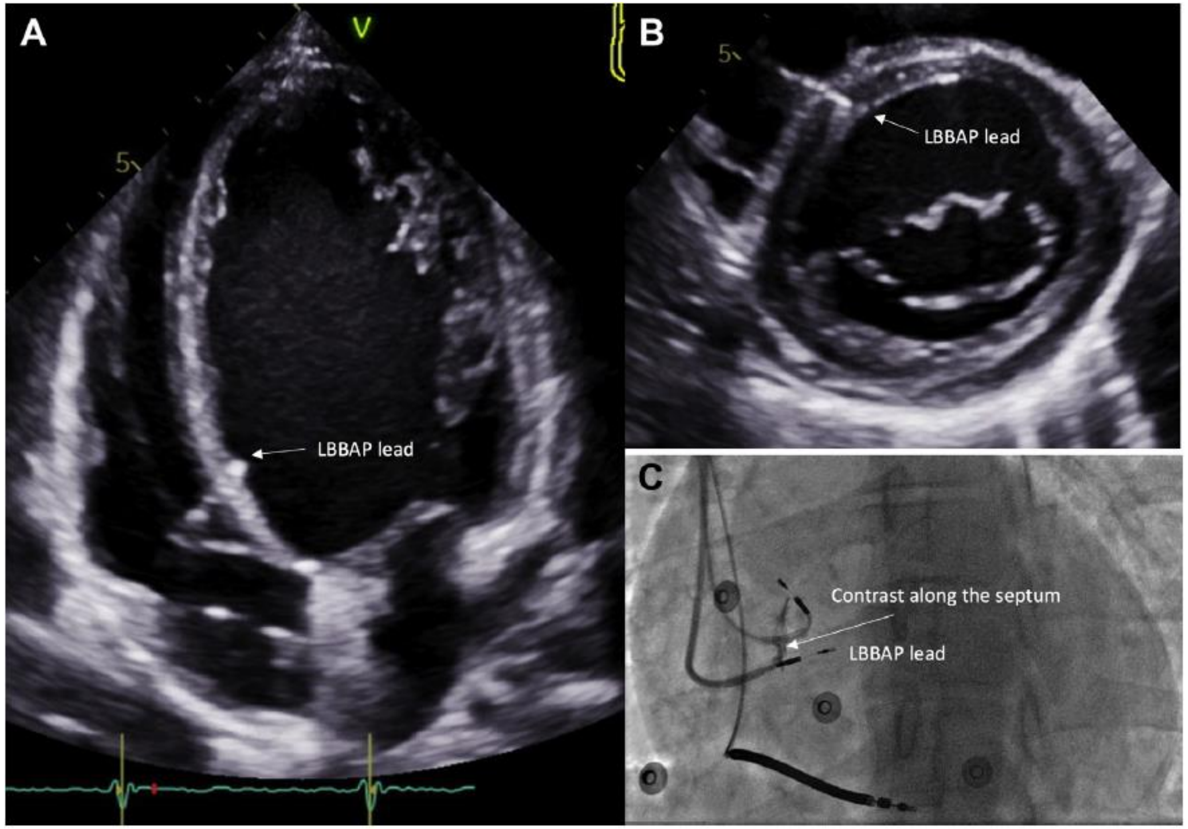
Left Bundle Branch Area Pacing for Cardiac Resynchronization Therapy

Results From the International LBBAP Collaborative Study Group

Vijayaraman et al. JACC Clin electrophysiol. 2021

Multicenter retrospective cohort

- N=325,
- LVEF<50%, NYHA>2 and CRT/pacing indication
- 85% overall success rate
- 92% success rate in LBBB patients



LBB pacing

TABLE 1 Baseline Characteristics

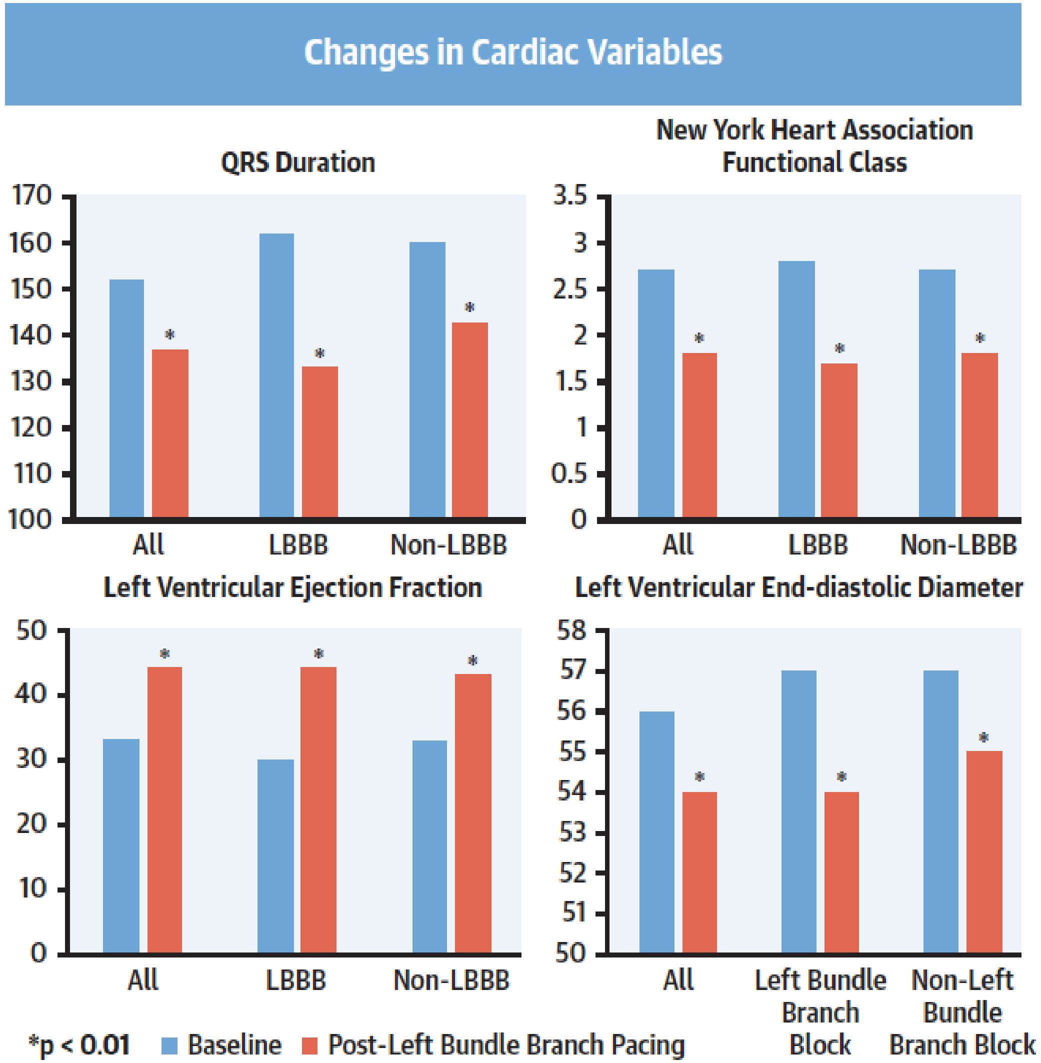
	All Patients (N = 325)
Age	71 ± 12
Female	113 (35)
Medical history	
HTN	224 (69)
DM	113 (35)
CAD	161 (50)
AF	184 (57)
Ischemic cardiomyopathy	144 (44)
Baseline NYHA functional class III or IV	209 (64)
Baseline NYHA functional class	2.7 ± 0.7
Echocardiographic parameters	
LVEF	32 ± 12
LVEDD, mm	57 ± 10
LVESV, ml	115 ± 70
LVEDV, ml	170 ± 86
LA volume index, ml/m^2	58 ± 22
IVSD, mm	11.6 ± 3
Electrocardiographic parameters	
Baseline QRS duration, ms	154 ± 32
Baseline QRS duration >150 ms	198 (61)
LBBB	126 (39)
RBBB	54 (17)
IVCD	49 (15)
RV paced	48 (14.5)
Narrow	48 (14.5)

TABLE 2 Procedural Outcomes

Procedural outcomes		
Total number of successful cases		277 (85)
Procedure duration (min)		105 ± 54
Fluoroscopy duration (min)		19 ± 15
LBBP lead fluoroscopy time (n = 153) (min)		16 ± 13
Type of device		
CRT		162 (58)
CRT pacemaker		56 (20)
CRT defibrillator		106 (38)
Dual-chamber defibrillator		5 (2)
Dual-chamber pacemaker (DDD)		87 (31)
Single-chamber pacemaker (VVI)		23 (8)
Pacing characteristics	Baseline	Follow-up
R-wave amplitude (mV)	10.6 ± 6	12.5 ± 5.7
Impedance (Ω)	674 ± 193	530 ± 123
LBBP threshold (V at 0.5 ms)	0.6 ± 0.3	0.7 ± 0.3
Stimulus to peak LV activation time (ms)	83 ± 16	
Complications		
Pneumothorax		3 (1)
Pericardial effusion		0
Device infection		2 (0.7)
Stroke		0
LV perforation		0
Lead dislodgement		7 (2.5)
Loss of left septal capture		2 (0.7)

Vijayaraman et al. JACC Clin electrophysiol. 2021

LBB pacing

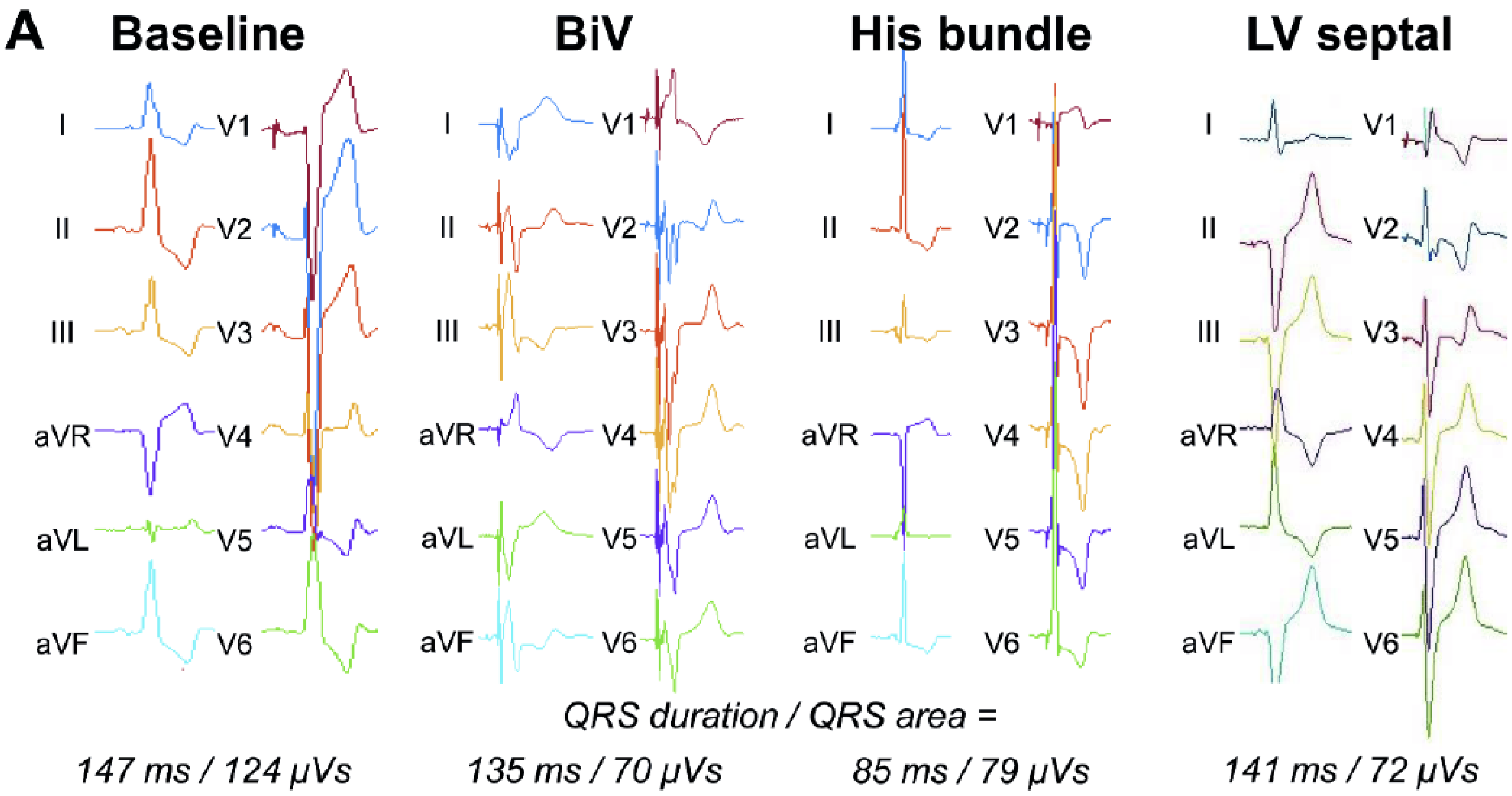


Vijayaraman et al. JACC Clin electrophysiol. 2021

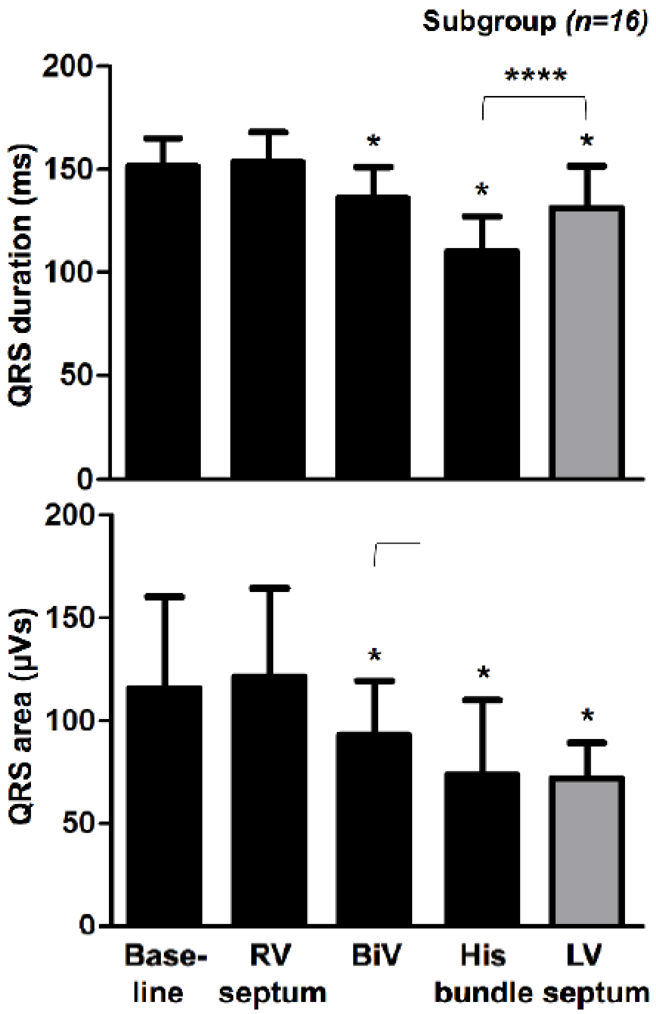
LBB-CRT technisch beter te doen dan His-CRT maar net zo goed?

His-CRT vs. LBB-CRT

Salden et al. JACC 2020

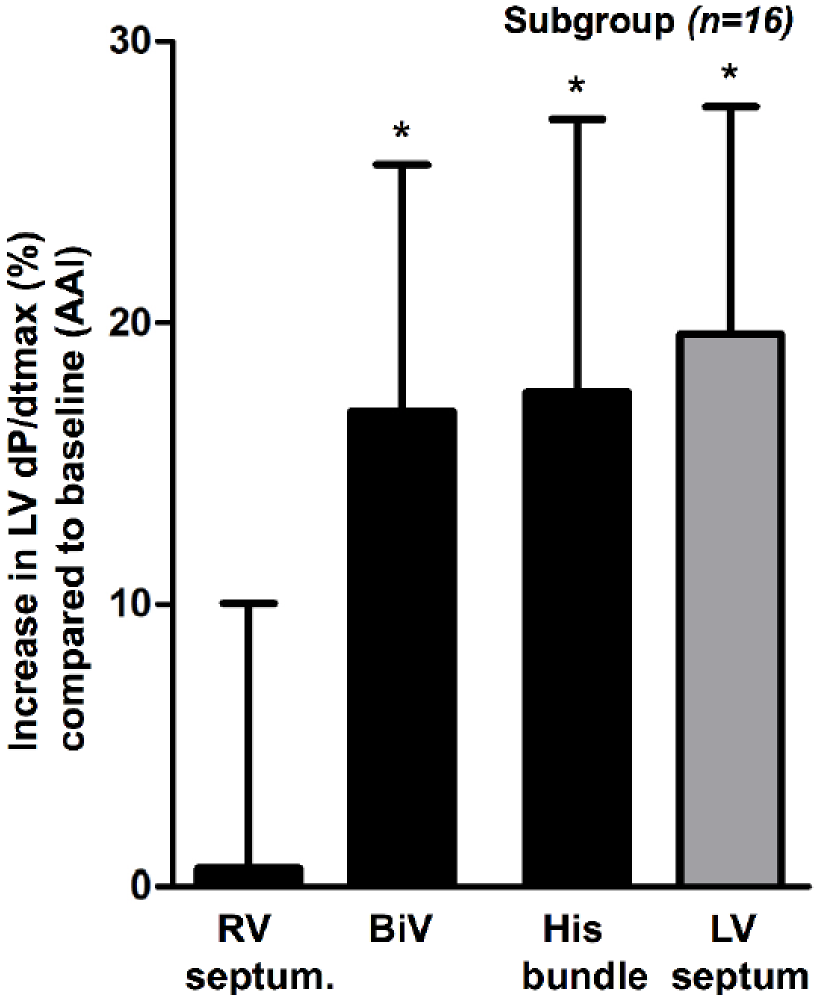


His-CRT vs. LBB-CRT



Electrophysiological effects

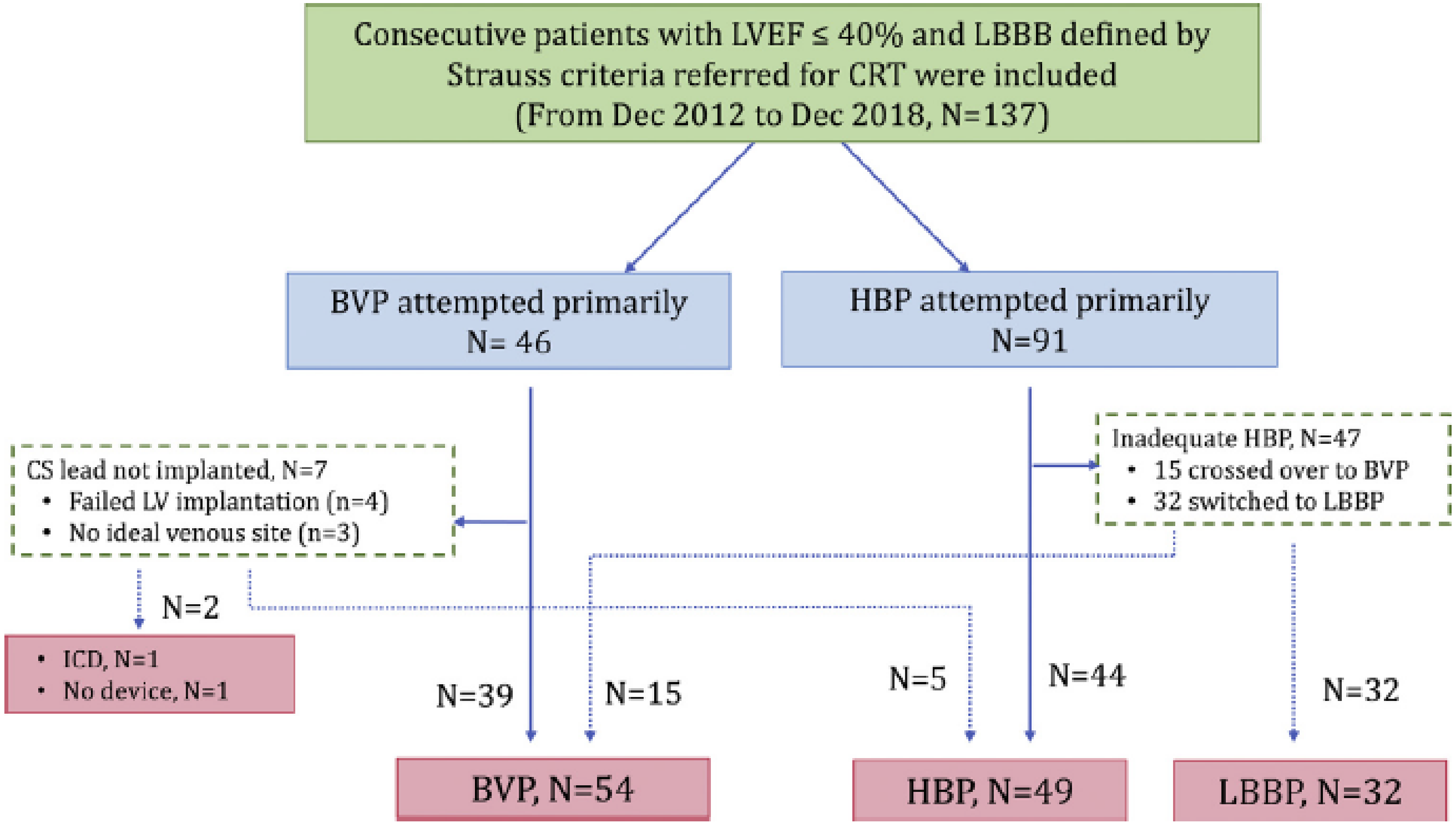
Salden et al. JACC 2020



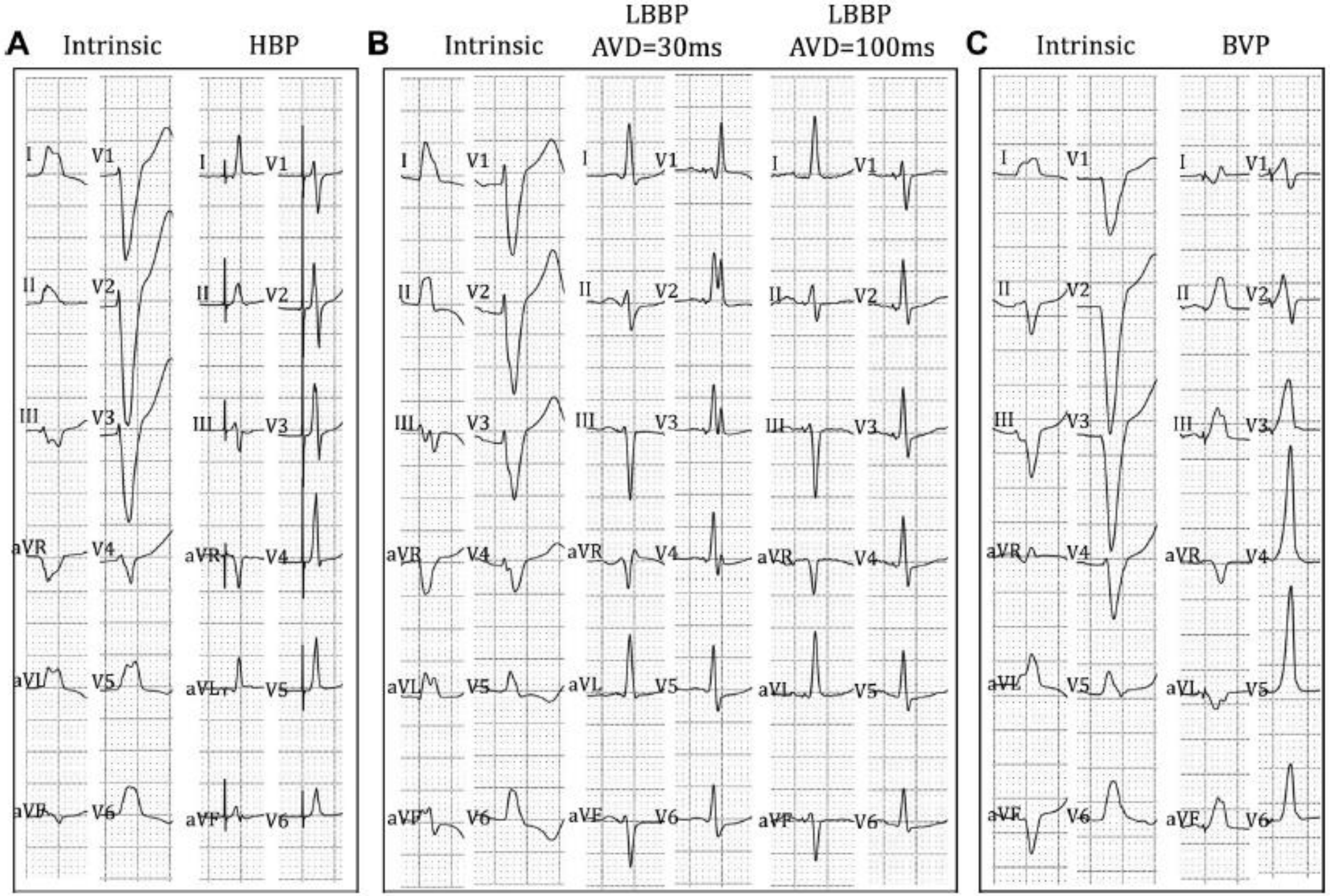
Haemodynamic effects

Zijn er studies naar His-CRT vs. LBB-CRT vs. Conventionele CRT?

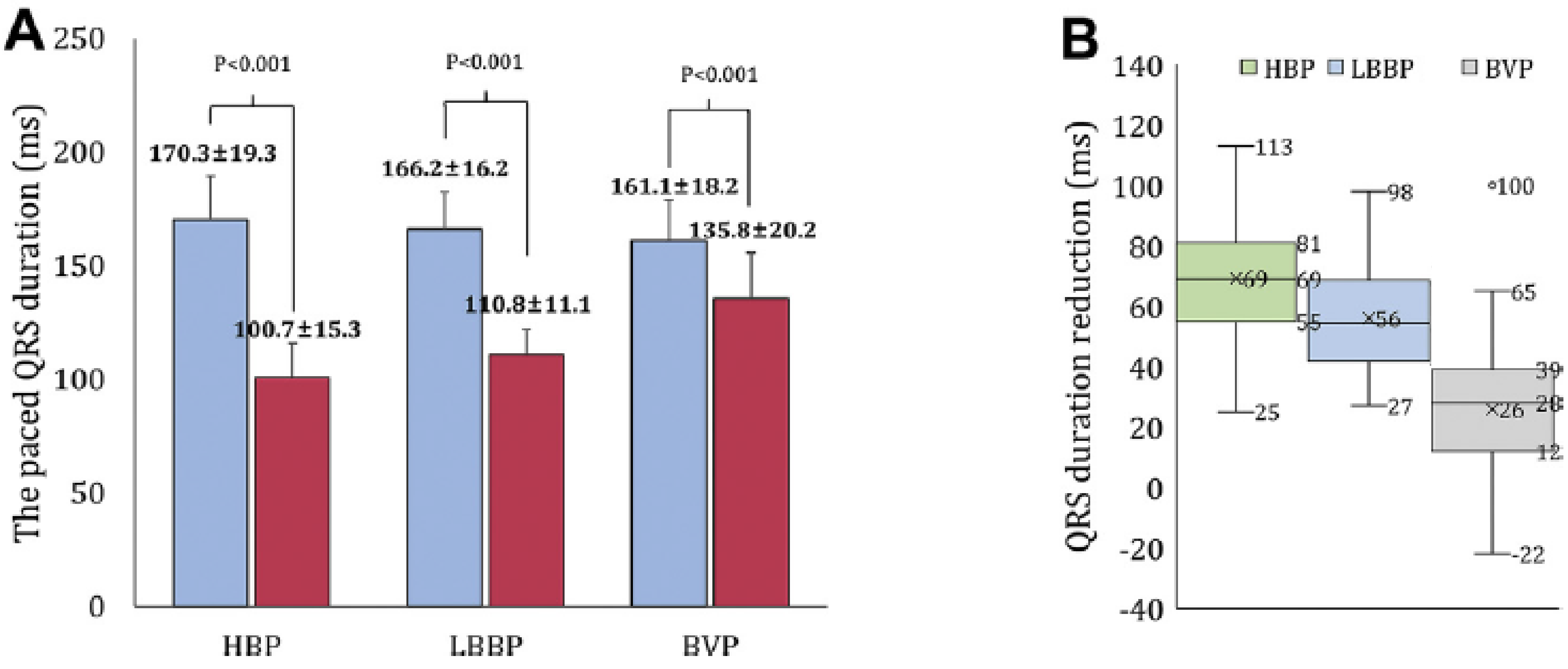
His-CRT vs. LBB-CRT vs. Conventional CRT



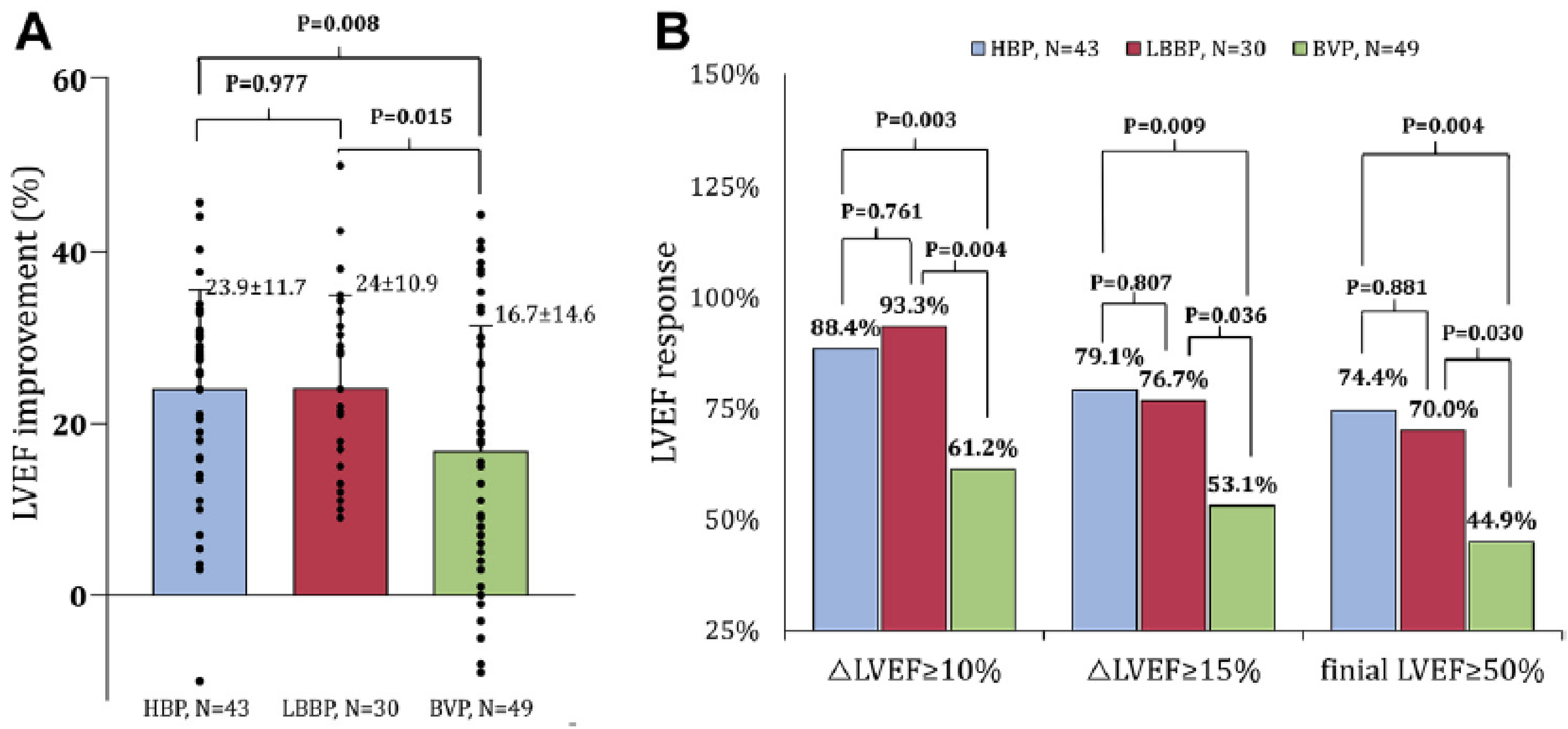
His-CRT vs. LBB-CRT vs. Conventional CRT



His-CRT vs. LBB-CRT vs. Conventional CRT



His-CRT vs. LBB-CRT vs. Conventional CRT



His-CRT & LBB-CRT lijken beter dan conventionele CRT

Maar hoe op lange(re) termijn?

HBP long-term

Heart failure and cardiomyopathies

ORIGINAL RESEARCH ARTICLE

Long-term outcomes of His bundle pacing in patients with heart failure with left bundle branch block

Weijian Huang,[1,2] Lan Su,[1,2] Shengjie Wu,[1,2] Lei Xu,[1,2] Fangyi Xiao,[1,2] Xiaohong Zhou,[3] Guangyun Mao,[4] Pugazhendhi Vijayaraman,[5] Kenneth A Ellenbogen[6]

- Single centre prospective observational study
- 74 patients with HFrEF, LBBB and QRS>130ms, NYHA 2-4 (CRT candidates)
- HIS pacing with leads implanted when threshold <3 V @ 1 ms or <3.5 V @ 0.5 ms

HBP long-term

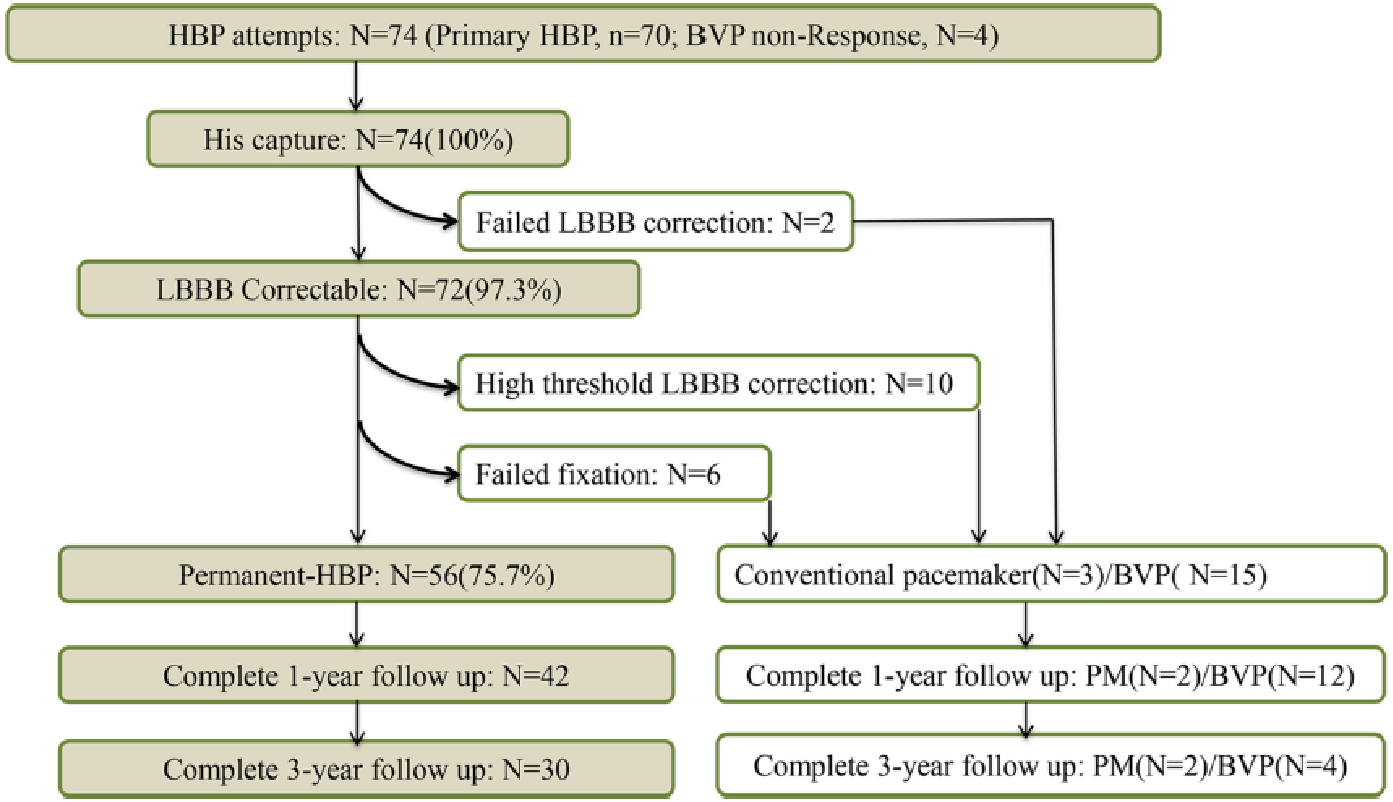


Table 1 Baseline characteristics of the subjects

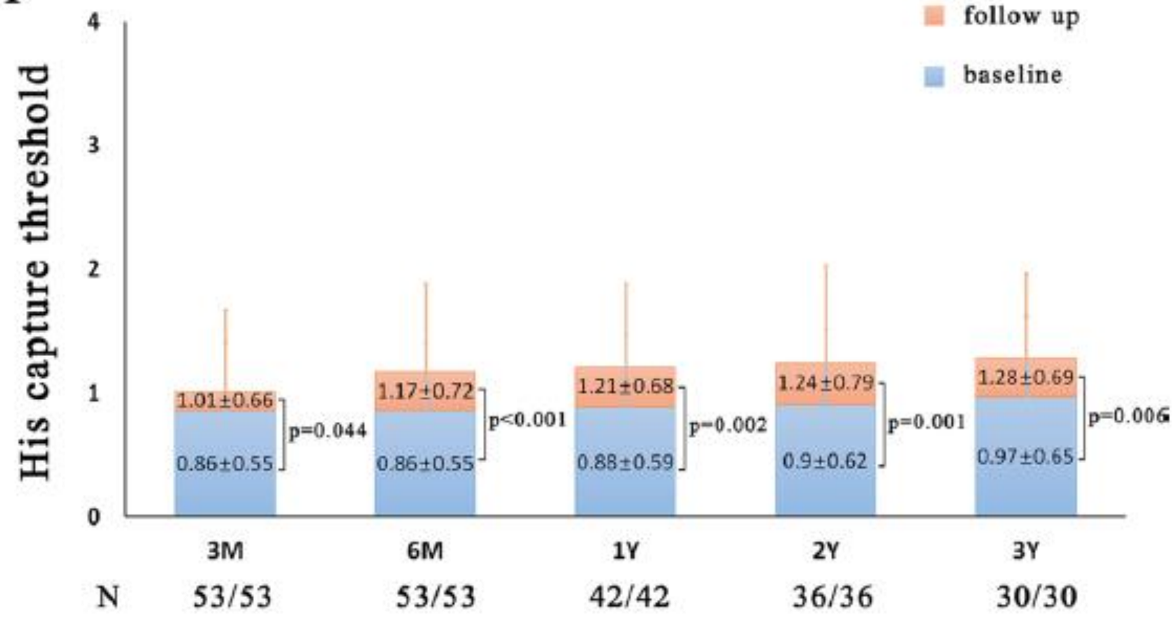
Parameters	Total (n=74)	pHBP (n=56)	npHBP (n=18)	P values
Male	43 (58.1%)	32 (57.1%)	11 (61.1%)	0.767
Age	69.6±9.2	68.6±9.5	72.8±7.49	0.086
Diabetes	11 (14.9%)	7 (12.5%)	4 (22.2%)	0.530
Renal dysfunction	11 (14.9%)	8 (14.3%)	3 (16.7%)	0.894
Hypertension	34 (45.9%)	23 (41.1%)	11 (61.1%)	0.138
NICM	63 (85.1%)	46 (82.1%)	17 (94.4%)	0.371
ICM	6 (8.1%)	6 (10.7%)	0 (0%)	0.341
CAD	28 (37.8%)	21 (37.5%)	7 (38.9%)	0.916
PCI	9 (12.2%)	7 (12.5%)	2 (11.1%)	0.797
Arrhythmia				
Persistent AF	14 (18.9%)	13 (23.2%)	1 (5.6%)	0.187
AV node ablation	8 (10.8%)	8 (14.3%)	0 (0%)	0.207
Paroxysmal AF	4 (5.4%)	3 (5.4%)	1 (5.6%)	0.974
AV block	12 (16.2%)	8 (14.3%)	4 (22.2%)	0.669
Echocardiogram				
LVEF	34.0±10.3	33.3±10.0	36.3±11.2	0.279
LVESV	125.8±55.1	127.0±57.8	122.4±45.5	0.763
Medication				
Diuretic	69 (93.2%)	52 (92.9%)	17 (94.4%)	0.759
β-Block	57 (77.1%)	45 (80.3%)	12 (66.7%)	0.379
ACEI/ARB	65 (87.8%)	48 (85.7%)	17 (94.4%)	0.568

Huang et al. Heart 2019

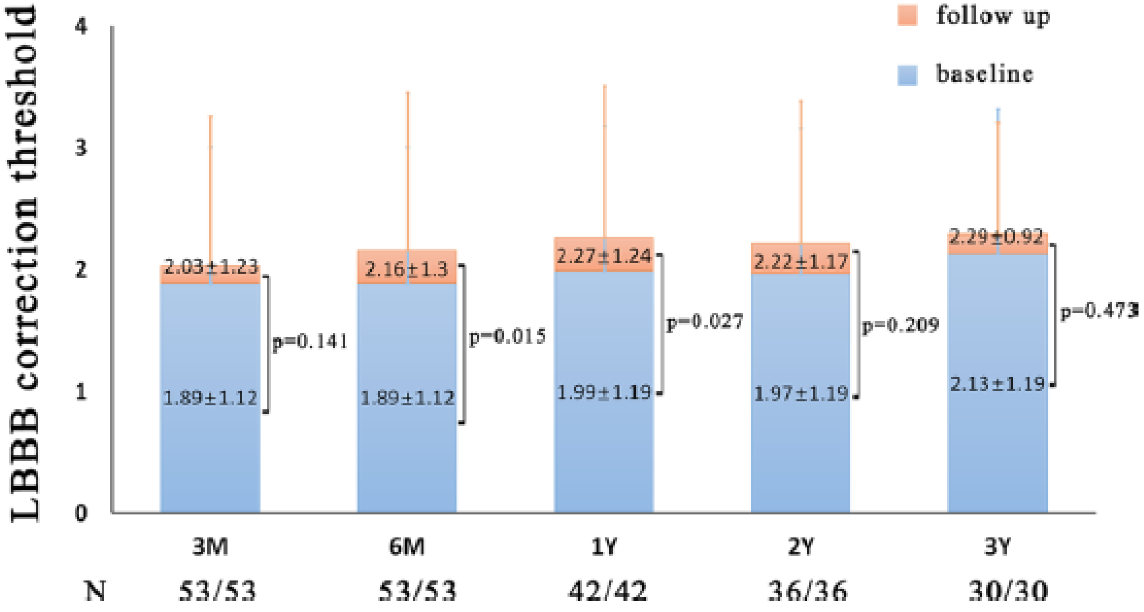
HBP long-term

Huang et al. Heart 2019

A

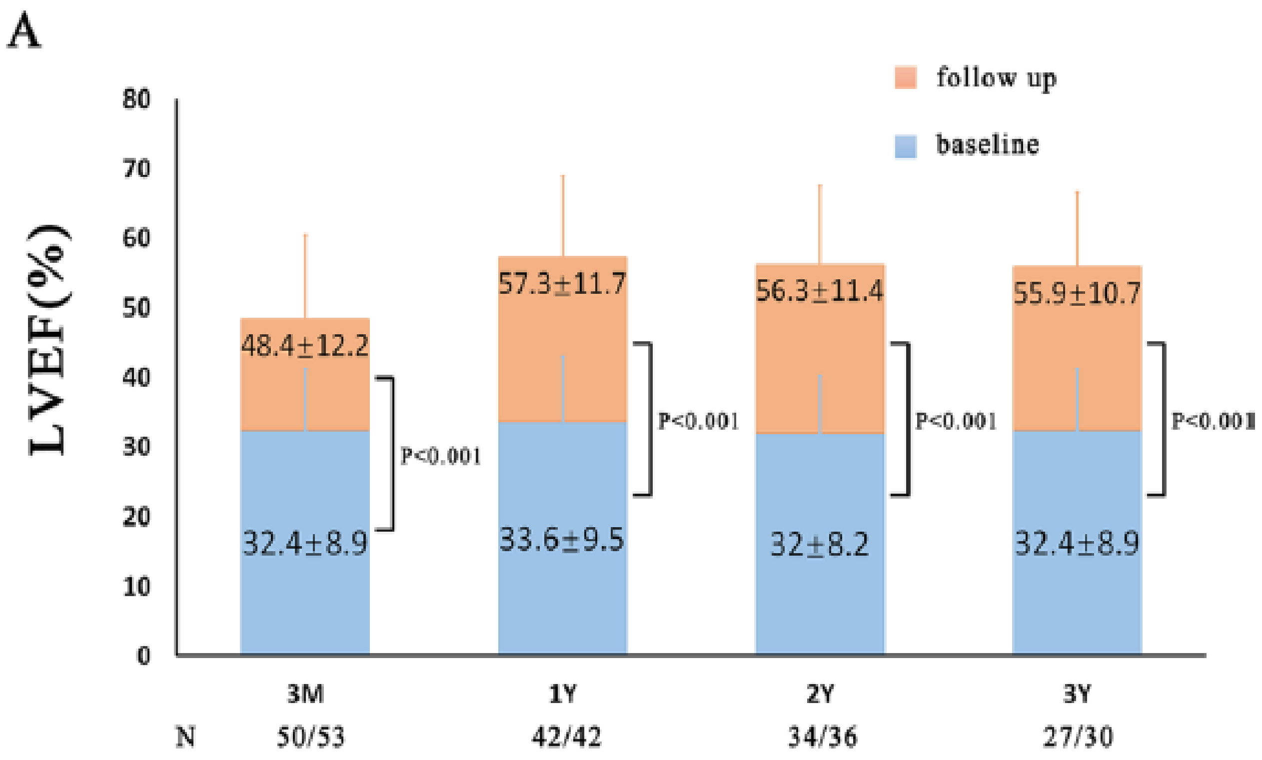


B



HBP long-term

3 yr follow-up



Huang et al. Heart 2019

LBB long-term

ORIGINAL ARTICLE

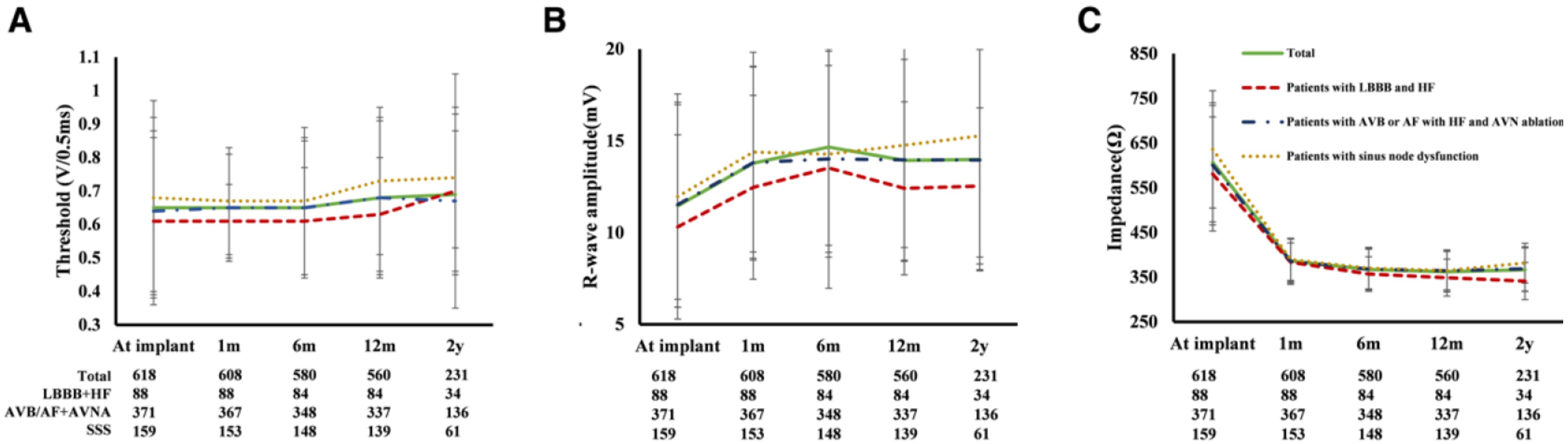
Long-Term Safety and Feasibility of Left Bundle Branch Pacing in a Large Single-Center Study

Consecutive patients with pacing/CRT indication n=632

- 2 year follow-up (n=231)
- 97,8% success rate (LBB capture)

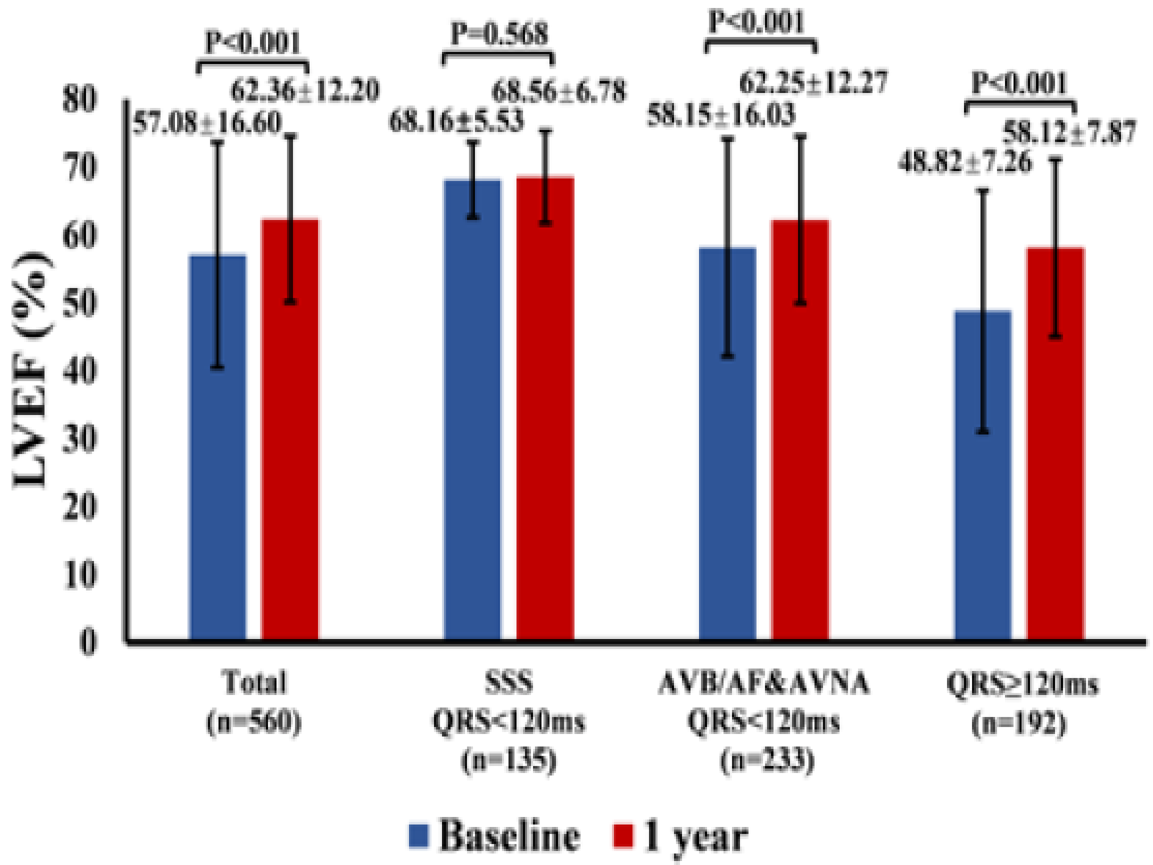
	All patients	LBBB	AVB/AF+AVNA	SSS
N	618	88	371	159
Preimplant QRS, ms	114.20±32.40	167.22±18.99	108.41±26.69	98.75±19.31
Post-LBBP QRS, ms	112.94±16.81	124.02±24.15	111.35±14.41	110.59±14.83
Sti-LVAT, ms	73.87±11.36	79.40±11.34	73.78±11.89	71.04±8.80
Preimplant mean QRS axis	20.50 (−16.00 to 56.00)	−9.00 (−39.00 to 42.25)	27.00 (−15.00 to 61.00)	28.00 (−2.50 to 53.00)
Post-LBBP mean QRS axis	20.00 (−17.00 to 54.00)	35.50 (−3.00 to 54.75)	16.00 (−18.00 to 55.00)	18.00 (−15.25 to 52.50)
Preimplant QRS transition zone	3.50 (1.50 to 3.50)	4.50 (3.50 to 4.50)	2.50 (1.50 to 3.50)	2.50 (1.50 to 3.50)
Post-LBBP QRS transition zone	1.50 (1.50 to 2.50)	1.50 (1.50 to 3.50)	1.50 (1.50 to 2.50)	1.50 (1.50 to 2.50)

LBB long-term



Su et al. Circ Arrhythm Electrophysiol. 2021

LBB long-term



Su et al. Circ Arrhythm Electrophysiol. 2021

His-CRT & LBB-CRT lijken op lange(re) termijn (best) goed te blijven gaan

His-CRT vs. LBB-CRT vs. Conventional CRT

His:	*LBB:*	*Conventional:*
PRO's • Full normalisation of conduction	PRO's • Larger area to capture • Higher succes rate • Better thresholds • No need for backup lead	PRO's • Large experience • Quadripolar leads • Good thresholds
CON's • More difficult implant • Higher thresholds • AVN-ablation more difficult	CON's • Procedure endpoint • Septal perforation • Septal scar/LVH • RBTB	CON's • Non-responders ++

His-CRT vs. LBB-CRT vs. Conventional CRT

- Of nog andere combinaties?

His + LBB

EP CASE EXPRESS

doi:10.1093/europace/euy293
Online publish-ahead-of-print 24 December 2018

Non-invasive electrocardiographic imaging of His-bundle and peri-left bundle pacing in left bundle branch block

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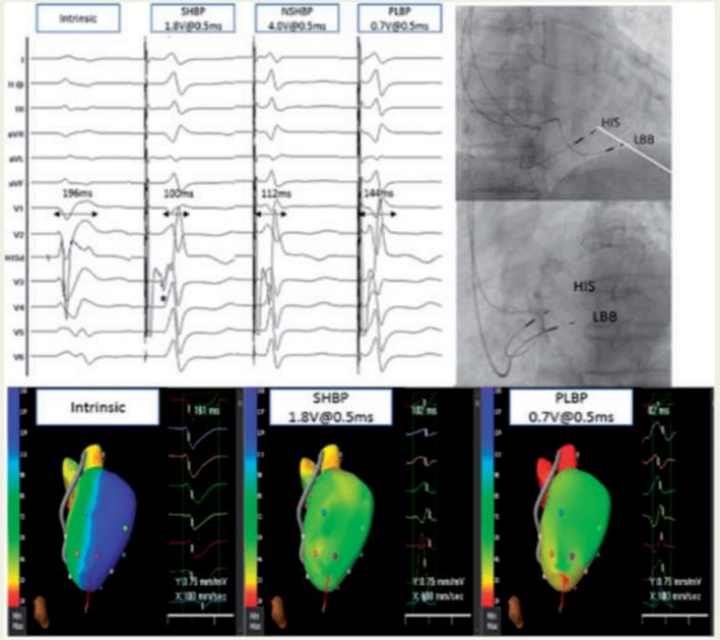
We reported a case of using non-invasive global epicardial electrogram electrocardiographic imaging (ECGi) mapping to demonstrate both His-bundle pacing (HBP) and peri-left bundle pacing (PLBP) were able to synchronize the electrical activation pattern of a lady with left bundle branch block (LBBB). Selective HBP (SHBP) with threshold of 1.8 V at 0.5 ms and sensing of 3.2 mV achieved correction of the LBBB and shortening of QRS width from baseline. Non-selective HBP (NSHBP) was observed at higher pacing output. Peri-left bundle pacing resulted in narrowing of QRS width and emergence of qR pattern in lead V_1 indicating capturing of the left bundle. The pacing threshold was 0.8 mV at 1.0 ms and sensing was 4.5 mV.

Electrocardiographic imaging recording of the intrinsic rhythm showed a line of conduction block in the left ventricle (LV) with the latest activation in posterolateral LV. In contrary, both SHBP and PLBP demonstrated synchronous activation of the LV. The LV total activation time for intrinsic rhythm, SHPB, and PLBP were 110 ms, 36 ms, and 42 ms, respectively. The total global activation time for intrinsic rhythm, SHPB, and PLBP were 117 ms, 38 ms, and 48 ms, respectively.



In this case report the advantages of PLBP over SHBP, by pacing more distally and further away from the membranous septum, were lower pacing threshold and increased R-wave sensing.

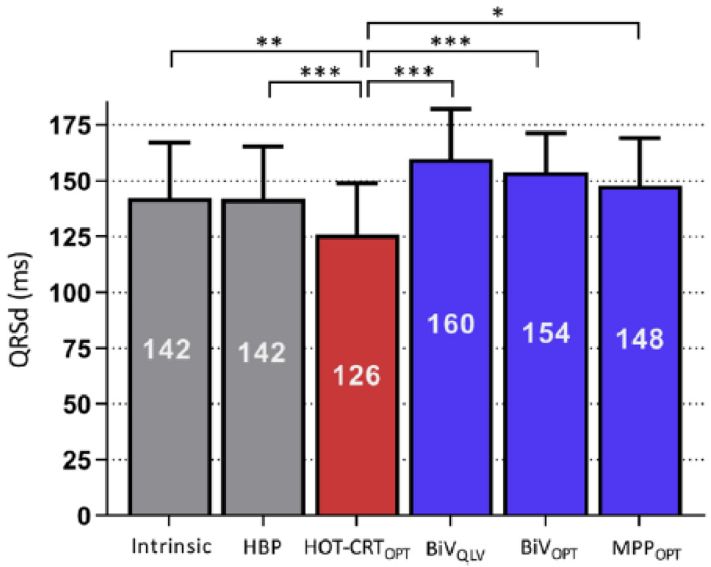
The full-length version of this report can be viewed at: https://www.escardio.org/Education/E-Learning/Clinical-cases/Electrophysiology.

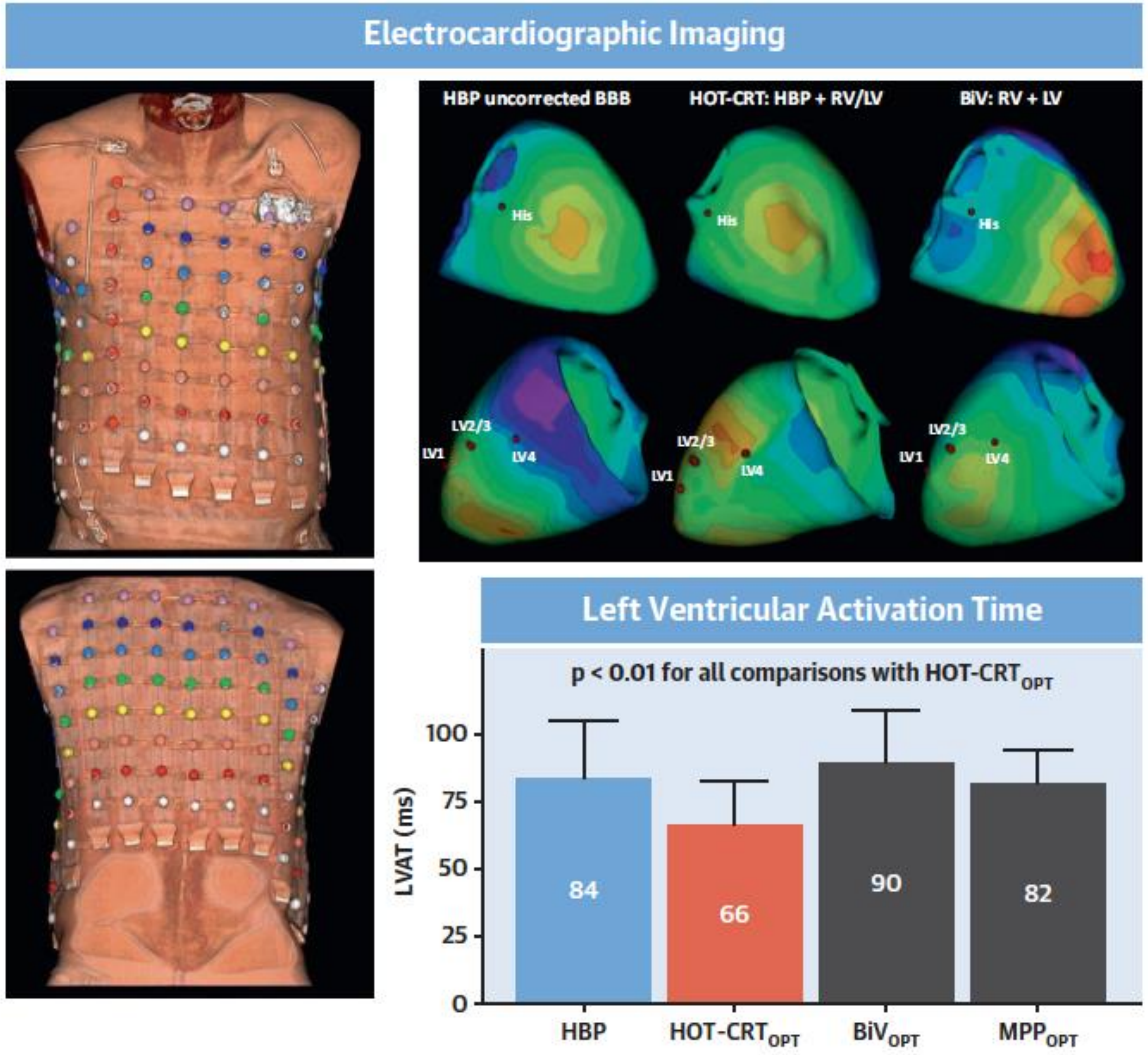
His + conventional

His-Optimized Cardiac Resynchronization Therapy With Ventricular Fusion Pacing for Electrical Resynchronization in Heart Failure

Alwin Zweerink, MD,[a] Stepan Zubarev, MD,[b] Elise Bakelants, MD,[a] Danila Potyagaylo, PhD,[c] Carine Stettler, RN,[a] Mikhail Chmelevsky, MD,[b] Elise Dupuis Lozeron, PhD,[d] Anne-Lise Hachulla, MD,[e] Jean-Paul Vallée, MD,[e] Haran Burri, MD[a]

FIGURE 1 12-Lead ECG Results





LBB + RV

- Correction for conduction delay to RV
- Prevention of RV heart failure
- Work for the futur

His/LBB-pacing

- *Waarom?*
- *Wie?*

His/LBB-pacing

- *Waarom ?*

- *Wie?*

Wie?

- Zoals CRT-indicatie? Dus bij patiënten met reeds Hartfalen?

- Iedereen waar je veel pacing verwacht?

- *Wat zeggen de guidelines?*

Wie?

ESC guidelines on pacing (2021):

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.	IIa	B
HBP may be considered as an alternative to right ventricular pacing in patients with AVB and LVEF >40%, who are anticipated to have >20% ventricular pacing.	IIb	C

Wie?

ESC guidelines on pacing (2021):

Recommendation	Class	Level
In patients treated with His bundle pacing, implantation of a right ventricular lead used as “backup” for pacing should be considered in specific situations (e.g. pacemaker-dependency, high-grade atrioventricular block, infra-nodal block, high pacing threshold, planned atrioventricular junction ablation) or for sensing in case of issues with detection (e.g. risk of ventricular undersensing or oversensing of atrial/His potentials)	IIA	C

EHRA 2021

Concluderend

- CSP toch de toekomst maar plek nog onduidelijk, met name:

  - behandeling van hartfalen / dyssynchronie

  Of

  - voorkomen van hartfalen / dyssynchronie

- His vs. LBB vs. LV-lead

- Andere combinaties?

- Meer kennis en studies nodig!


Goed zo Vokko!
Eindelijk snap je het..
Prof. dr. Kevin Verhoeven

?