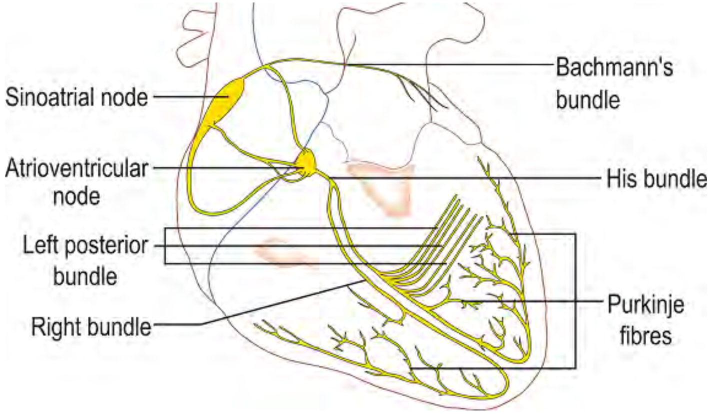
How we came here: His Bundle Pacing



Marek Jastrzebski,

Jagiellonian University in Kraków, POLAND


NOWE SPOSTRZEŻENIA I BADANIA

W PRZEDMIOCIE

Fizyologii i drobnowidzowéj Anatomii

udzielone przez naszego Członka korrespondenta

Dr. J. E. Purkiniego

p. z. Professora Fizyologii i Patologii w Wrocławiu.


ROCZNIK

WYDZIAŁU LEKARSKIEGO

W UNIWERSYTECIE

JAGIELLOŃSKIM.

Tom II.

(Z RYCINĄ).

KRAKÓW.

W TŁOCZNI STANISŁAWA GIESZKOWSKIEGO.

1839.

1839 PL / 1842 DE Jan Evangelista Purkyně described specialized conduction fibers

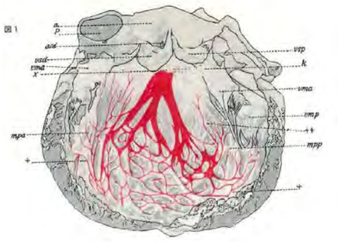
1893 Wilhelm His describes bundle penetrating AV ring

1906 Suano Tawara describes proximal and distal connection of HB

1970 Onkar Narula was the first to demonstrate feasibility of HBP

1977 Onkar Narula demonstrated QRS narrowing with pacing HB in patients with left bundle branch block confirming the idea of functional longitudinal dissociation within the HB

2000 Pramod Deshmukh et al. successfully implanted HB permanent pacing systems in humans (AF + heart failure)



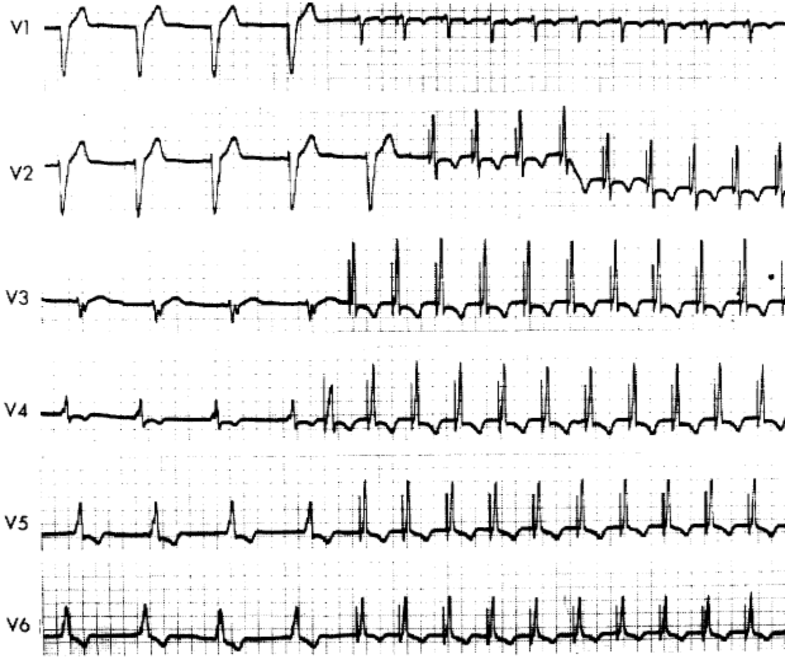
2005 Pablo Morina implanted first His-CRT

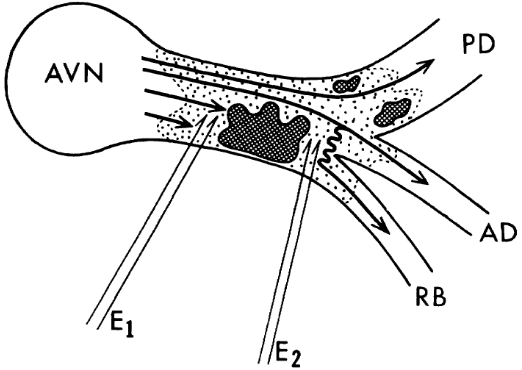
2019 First European multicentre experience article (Keene et al. JCE)

Longitudinal Dissociation in the His Bundle

Bundle Branch Block due to Asynchronous Conduction within the His Bundle in Man

ONKAR S. NARULA, M.D.





CIRCULATION VOL 56, NO 6, DECEMBER 1977

Permanent, Direct His-Bundle Pacing

A Novel Approach to Cardiac Pacing in Patients With Normal His-Purkinje Activation

Pramod Deshmukh, MD; David A. Casavant, MS;
Mary Romanyshyn, CRNP; Kathleen Anderson, BSN

Background—Direct His-bundle pacing (DHBP) produces synchronous ventricular depolarization and improved cardiac function relative to apical pacing. Although it has been performed transiently in the electrophysiology laboratory and persistently in open-chested canines, permanent DHBP in humans has not been achieved.

Methods and Results—A total of 18 patients aged 69±10 years who had a history of chronic atrial fibrillation, dilated cardiomyopathy, and normal activation (ie, QRS≤120 ms) were screened for permanent DHBP using an electrophysiology catheter. In 14 patients, the His bundle could be reliably stimulated. Of these 14, permanent DHBP using a fixed screw-in lead was successful in 12 patients. Radiofrequency atrioventricular node ablation was performed in patients exhibiting a fast ventricular response. All patients received single-chamber rate-responsive pacemakers. Acute pacing thresholds were 2.4±1.0 V at a pulse duration of 0.5 ms. Lead complications included exit block requiring reoperative adjustment and gross lead dislodgment. Echocardiographic improvement in heart function was shown by reductions in the left ventricular end-diastolic dimension from 59±8 to 52±6 mm ($P \le 0.01$) and in the end-systolic dimension from 51±10 to 43±8 mm ($P<0.01$), with an accompanying increase in fractional shortening from 14±7% to 20±10% ($P=0.05$). The left ventricular ejection fraction improved from 20±9% to 31±11% ($P<0.01$), and the cardiothoracic ratio decreased from 0.61±0.06 to 0.57±0.07 ($P<0.01$). Despite DHBP, 2 patients died at 8 and 36 months.

Conclusions—Permanent DHBP is feasible in select patients who have chronic atrial fibrillation and dilated cardiomyopathy. Long-term, DHBP results in a reduction of left ventricular dimensions and improved cardiac function. **(*Circulation*. 2000;101:869-877.)**

Key Words: bundle of His ■ pacing

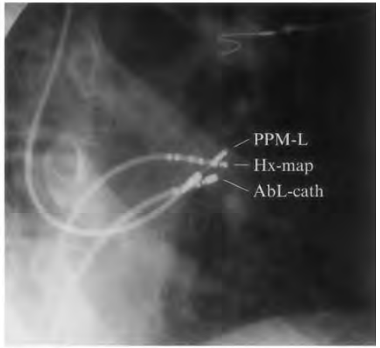


Figure 2. Right anterior oblique fluoroscopic projection demonstrating final position of His-bundle pacing electrode. PPM-L indicates permanent pacemaker lead; Hx-map, His-bundle mapping catheter; and AbL-cath, ablation catheter.

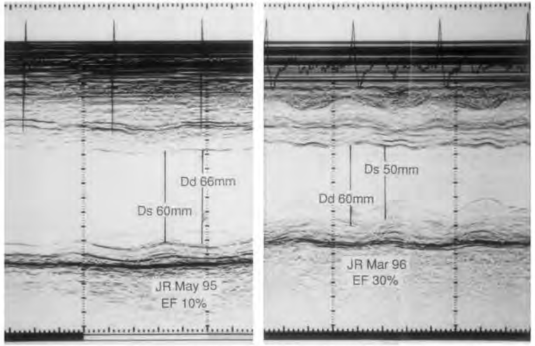
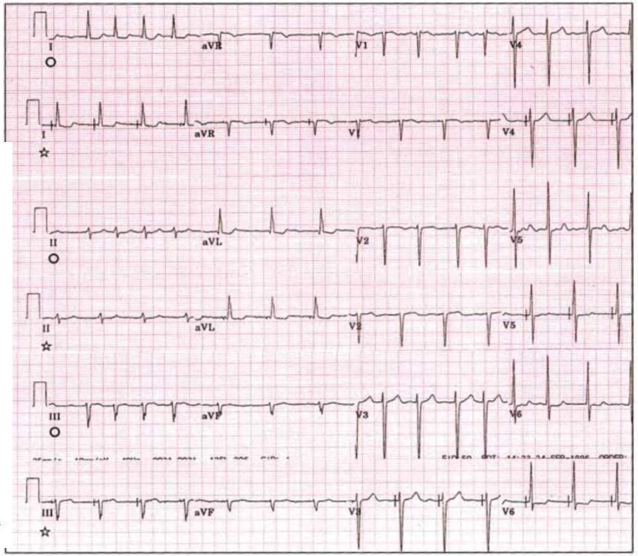


Figure 4. M-mode echocardiographic image showing reduction in LVESD and LVEDD before (left) and after (right) sustained DHBP. Ds indicates systolic dimension; Dd, diastolic dimension; EF, ejection fraction; JR, patient identifier.



Cardiac Resynchronization Through Selective His Bundle Pacing in a Patient with the So-Called InfraHis Atrioventricular Block

PABLO MORIÑA-VÁZQUEZ, RAFAEL BARBA-PICHARDO, JOSÉ VENEGAS-GAMERO, and MANUEL HERRERA-CARRANZA

From the Arrhythmia and Pacing Unit, Critical Care Department, "Juan Ramón Jiménez" Hospital, Huelva, Spain

MORIÑA-VÁZQUEZ, P., ET AL.: Cardiac Resynchronization Through Selective His Bundle Pacing in a Patient with the So-Called InfraHis Atrioventricular Block. *We present a case of infraHis AV block in which selective His bundle pacing with His-ventricular conduction through the conduction system was accomplished. While further investigations are developed, this approach may be an alternative for cardiac resynchronization in cases of difficult coronary sinus access. (PACE 2005; 28:726–729)*

His bundle pacing, cardiac resynchronization, AV block

Introduction

one His-ventricular conduction through the bun-

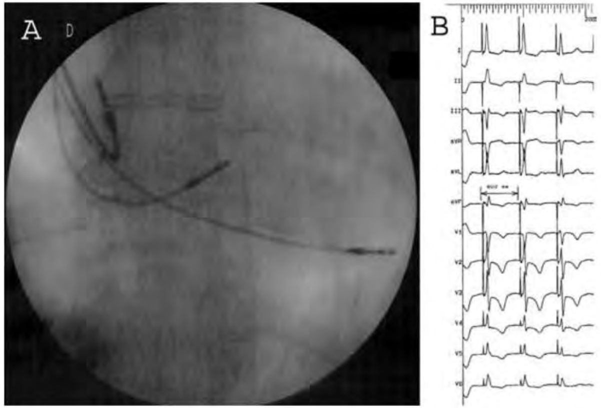


Figure 2. *Panel A: PA x-ray showing the final position of the right atrial, right ventricular, and His bundle leads. Panel B: Continuous pacing at the final position of the His bundle lead catheter beside the reference temporary catheter, the third complex is a pure His bundle capture, while the other two QRS complex are minimally fused.*

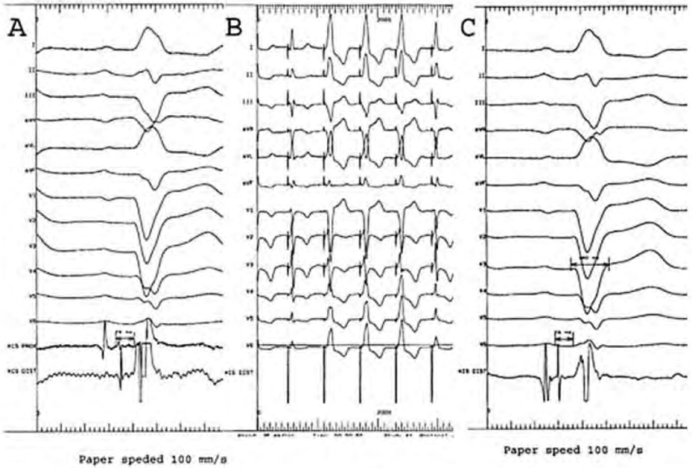
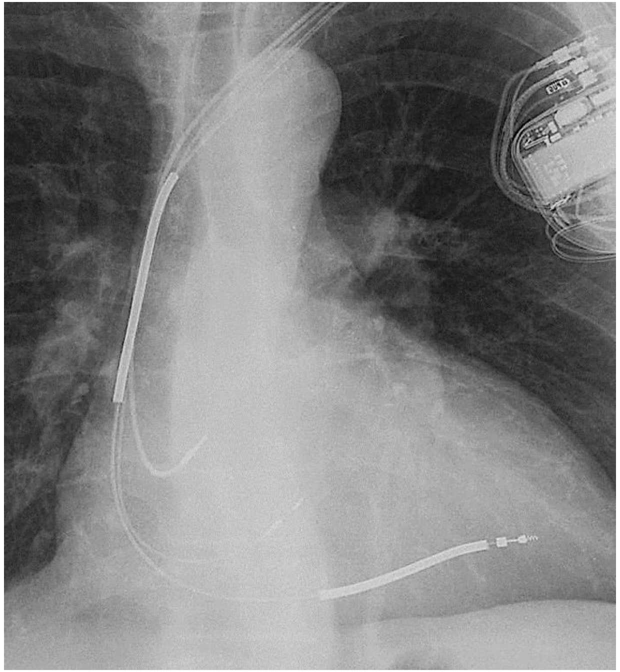
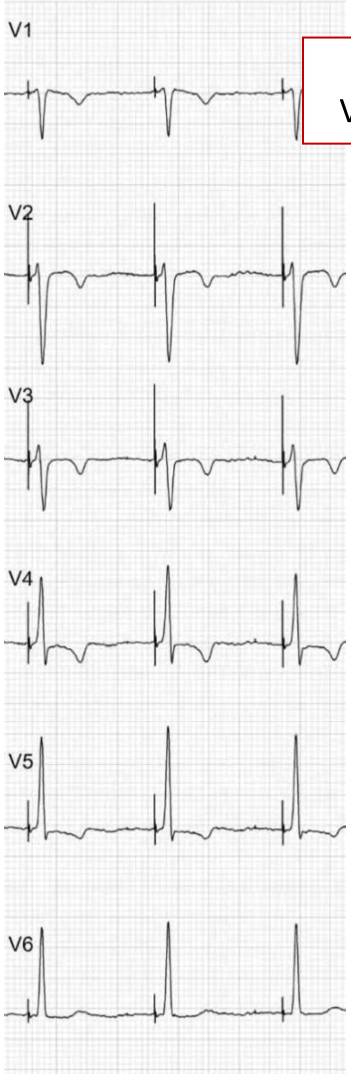


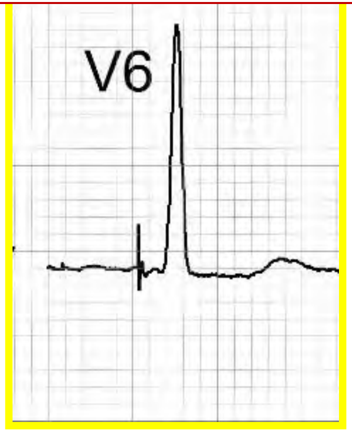
Figure 1. *Panel A: Initial ECG pattern with left BBB morphology and prolonged HV interval. Panel B: Continuous tracing while pacing through the temporary catheter mapping the His area; different morphologies of QRS complex can be observed, the first one is a pure His bundle capture conducted to the ventricles through the conduction system, the spike-Q interval is shorter than the baseline HV interval; the next QRS represents different degrees of fusion due to simultaneous capture of the His bundle and the surrounding myocardium. Panel C: Intracardiac electrogram through the permanent lead after fixation in the His bundle area.*



- 3 times failed BiV CRT (1 hour of fluoro…)
- **8th August 2015** – His pacing, 3 min fluoro…
- Super-responder, follow-up of 10 years:
  - EF: 32% → 51% (48%)
  - LVEDD: 58 mm → 53 mm
  - NYHA III/II → NYHA I
  - Threshold – 1.0 V (1.2 V)



QRS = 80 ms
V6 R-wave peak = 35 ms



DOI: 10.1111/pace.13490

DEVICES

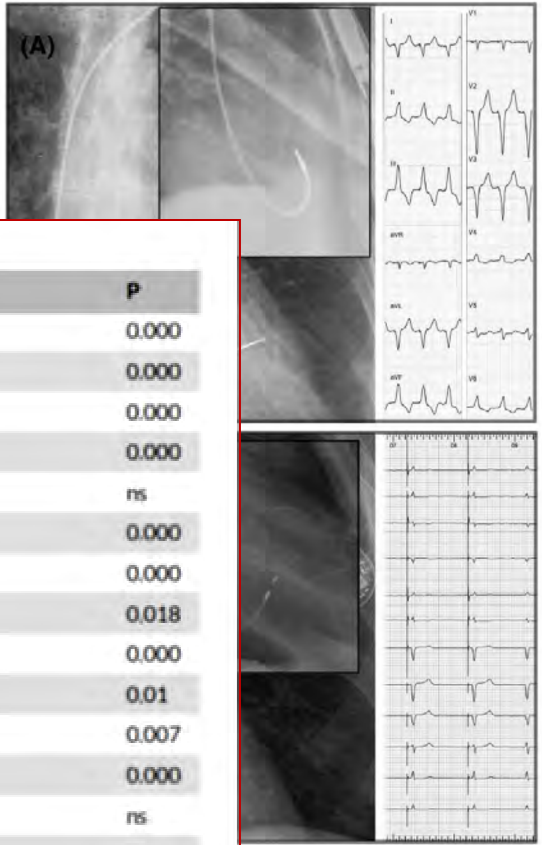
WILEY PACE

His-bundle pacing as a standard approach in patients with permanent atrial fibrillation and bradycardia

Marek Jastrzębski MD, PhD | Paweł Moskal MD | Agnieszka Bednarek MD, PhD |

TABLE 2 Comparison of acute and chronic outcomes of HB and RV pacing strategy

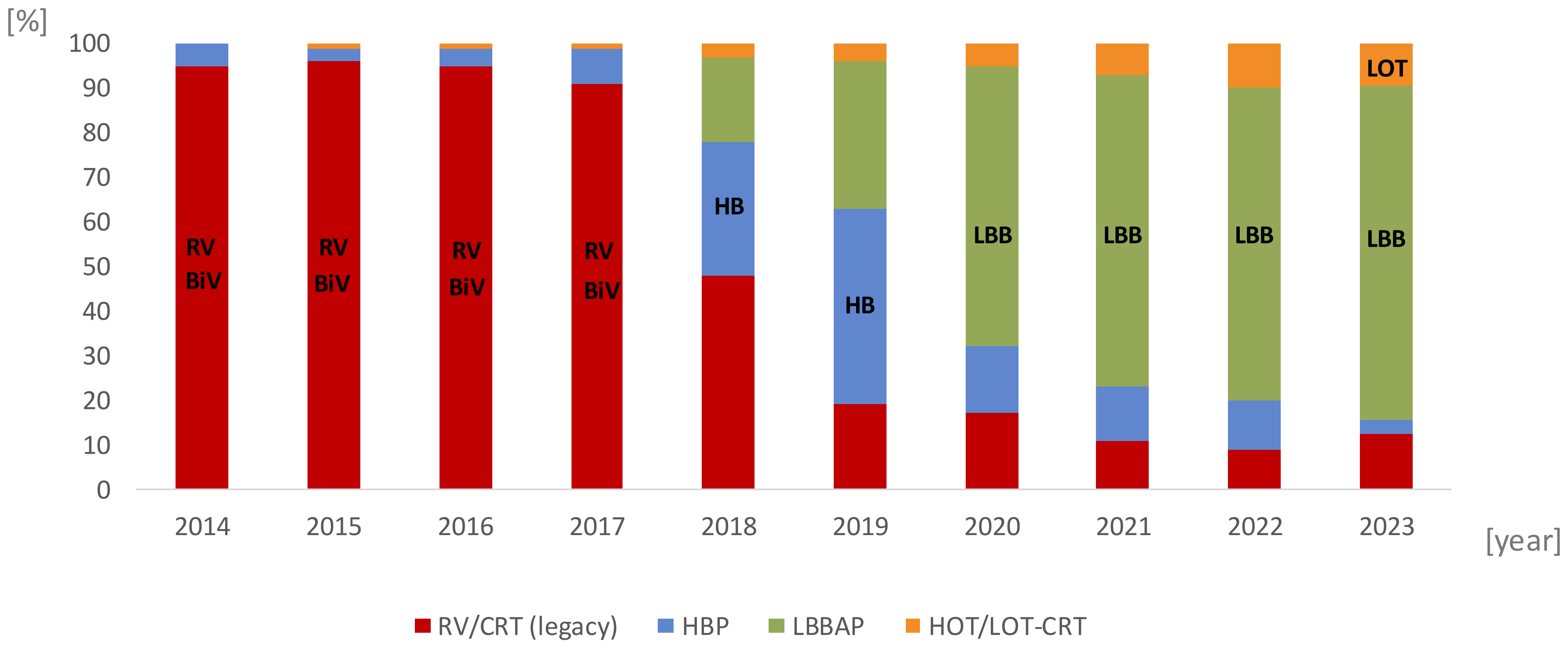
	His-bundle pacing N = 65	RV pacing N = 60	P
Procedure duration[†] [min]	64.4 ± 30.0	37.5 ± 17.2	0.000
Fluoroscopy time [min]	11.0 ± 10.7	2.5 ± 2.2	0.000
Acute capture thresholds [V]	1.6 ± 1.1	0.7 ± 0.3	0.000
Chronic capture thresholds [V]	1.5 ± 1.1	0.7 ± 0.4	0.000
Significant threshold rise[*]	3 (4.6%)	1 (1.7%)	ns
Acute sensing [mV]	4.2 ± 2.9	13.3 ± 7.0	0.000
Chronic sensing [mV]	3.6 ± 2.5	12.0 ± 7.3	0.000
Sensing issues[#]	6 (9.2%)	0	0.018
Chronic lead impedance [Ω][‡]	342.2 ± 49.4	538.2 ± 184.6	0.000
Acute procedure success rate [n]	58 (89.2%)	60 (100%)	0.01
Chronic procedure success rate [n]	57 (87.7%)	60 (100%)	0.007
Chronic current drain[§] [μAh]	3.4 ± 4.4	0.87 ± 0.83	0.000
Acute complications	0	0	ns
Long-term complications	2 (3.1%)	0%	ns
Paced QRS duration [ms]	117 ± 25	192 ± 18	0.000



PACE, 2018

Transition from legacy pacing to conduction system pacing for all-comers

3000 conduction system devices implanted in Krakow, Jagiellonian University EP Laboratory.

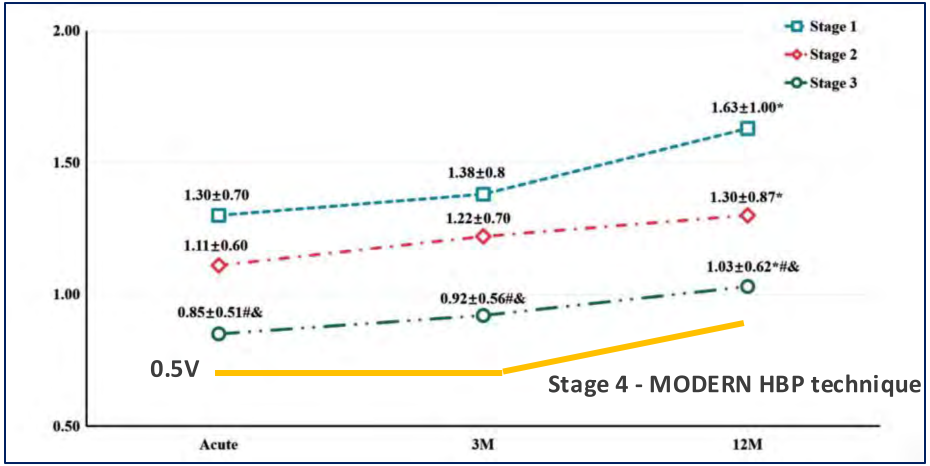


The APARA pacing protocol in Krakow

Identify HB region with contrast and attempt HBP
Primary HBP promptly obtained?
YES
NO
All HB checklist conditions fulfilled?
NO
YES
Permanent HBP / RBBP
Primary HBP pathway
Attempt LBBAP
Full success*
Permanent LBBAP
Suboptimal*
Failure
Attempt HBP as bail-out
YES
All HB checklist conditions fulfilled?
NO
YES
Permanent HBP
Bail-out HBP pathway
Patient is CRT eligible?
NO
YES
Try DSP, if failed then RSVP
Individual decision: LOT-CRT, HOT-CRT, BiV-CRT, acceptance of suboptimal HB pacing parameters, acceptance of suboptimal HBP or LBBP QRS, etc.,

His Bundle Pacing in the Era of Left Bundle Branch Pacing.
Jastrzębski M, Huang W, Vazquez PM, Vijayaraman P.,
Arrhythm Electrophysiol Rev. 2025

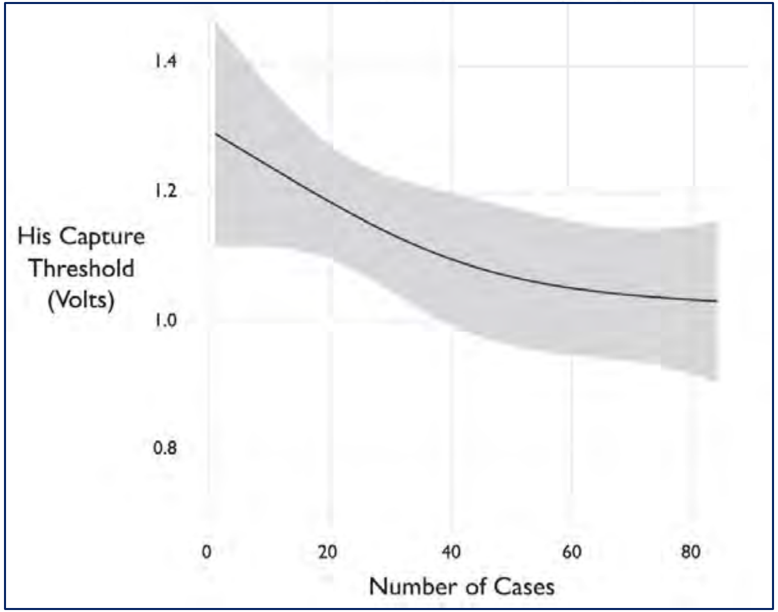
His bundle pacing technique evolves



Su, Huang et al. Pacing parameterts... Europace 2018

TABLE 3 His pacing thresholds

	Initial threshold	Follow up threshold
Lowest threshold of His bundle capture (Selective or nonselective)		
All HBP	1.4 ± 0.9 V	1.3 ± 1.2 V
	0.8 ± 0.3 ms	0.9 ± 0.2 ms
	(N = 449)	(N = 366)



Keene et al. J Cardiovasc Electrophysiol. 2019;1-10.

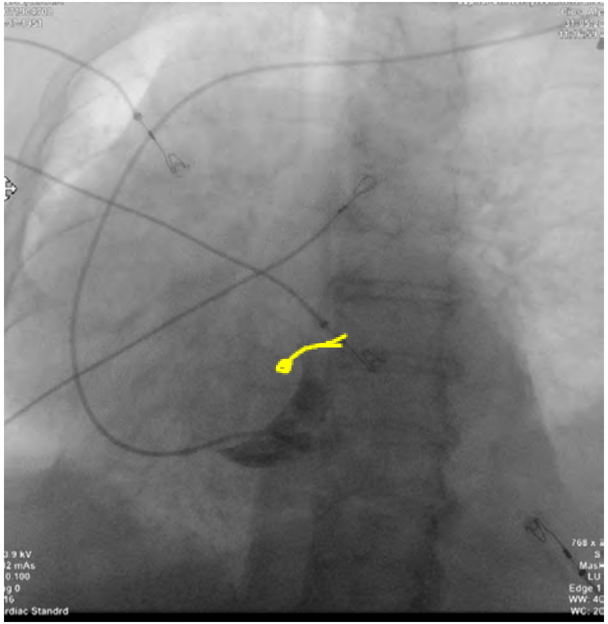
Modern HBP technique:

1) lead stability is paramount, 2) pacemapping-based, 3) COI obligatory, and 4) no borderline threshold/sensitivity accepted

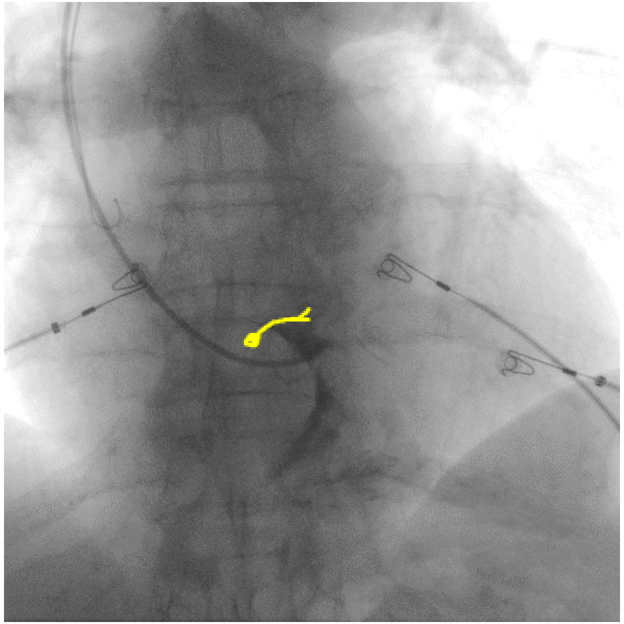
Current of injury with continuous connection of lead to EP system during lead rotation

Jastrzebski et al. His Bundle Pacing in the Era of LBBAP, Arhhytmia & Electrophysioloy Review 2025

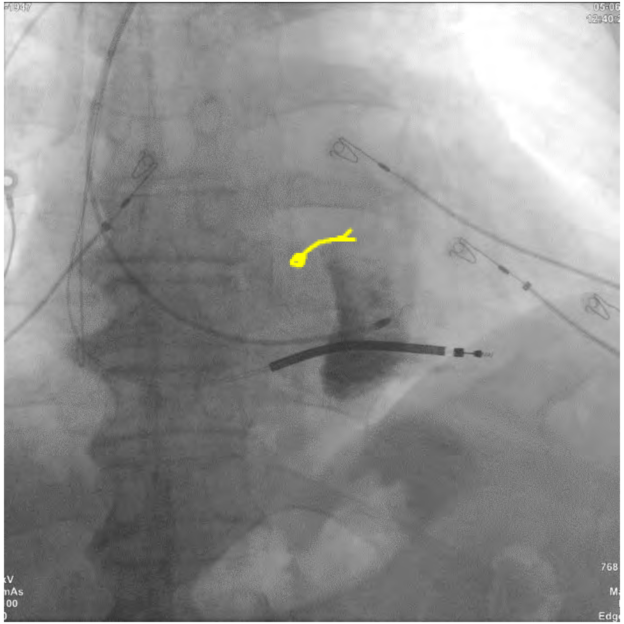
2. HBP is so easy!



Shift to the right



Standard



Gigantic RA

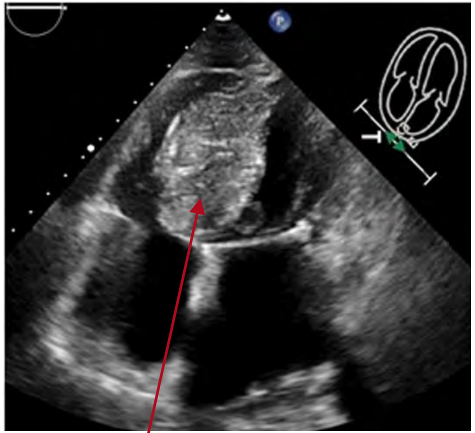
The proposed HBP implantation method focused on limiting the need for lead revision

CHECKLIST-based HBP implantation

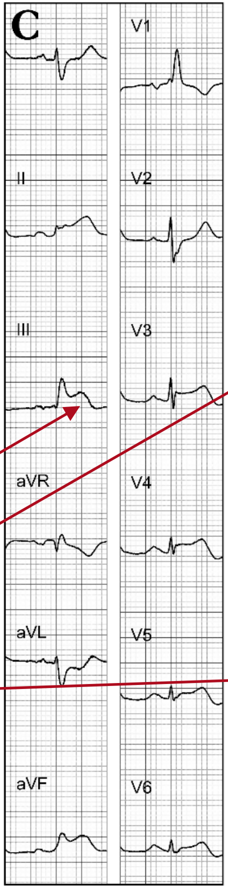
1. For primary HBP, prefer patients with narrow QRS or isolated RBBB.
2. Follow a standardized lead implantation/fixation technique.
   a. Contrast. Use it routinely as a first step in determining the HB area (tricuspid valve summit), giving preference to the distal HB, i.e., HB on the ventricular side.
   b. Strong lead rotation. Rotation of the lead must always result in a noticeable build-up of torque, which is maintained for a moment until the lead is released, resulting in a vigorous counterclockwise rotation of the lead to release the excess torque.
   c. Mandatory bonus lead rotations. After assessing the pacing parameters in a slack position, push the introducer catheter back to the septum and always perform vigorous bonus lead rotations, ending like the initial rotations with a build-up of torque and again with an evident counterclockwise rebound of the lead. Using the push/pull technique, regain the slack and reassess the pacing and electrophysiologic parameters (COI, sensitivity, etc.).
   d. Stability check. Before slitting of the guiding catheter: several push/pull with increasing/decreasing lead slack should not affect the endocardial signal (COI, HB potential amplitude) and pacing parameters.
   e. Optimized slack. Ensure presence of “J” rather than “L” type lead slack during deep inspiration and lack of forceful lead rocking with heartbeats.
3. Absolutely do not accept suboptimal/borderline HB pacing sites/acute outcomes:
   a. Acute/subacute (end of procedure) pacing threshold must be ≤ 1.5 V @ 0.4 ms. With a large COI and progressive threshold decrease every 5-10 minutes, a slightly higher subacute threshold may be acceptable.
   b. Sensing in bipolar mode must be > 2 mV unless sensing is provided by a separate RV lead (CRT device with indications for RV defibrillation lead implantation or with an old, abandoned RV lead).
   c. Persistent (i.e., > 5 min) HB current of injury (COI), or development of a negative HB potential, after lead deployment is mandatory, unless the acute pacing threshold is truly very low (< 1.0 V).
   d. HV during sensing or pacing at the working output (< 3 V) must be < 55 ms
   e. Paced V6 RWPT must be < 110 ms
   f. Fast incremental pacing at the working output to a cycle length of ≤ 300 ms must document 1:1 conduction via HB without evident HV prolongation or QRS prolongation not related to RBBB aberration or loss of septal myocardial capture.

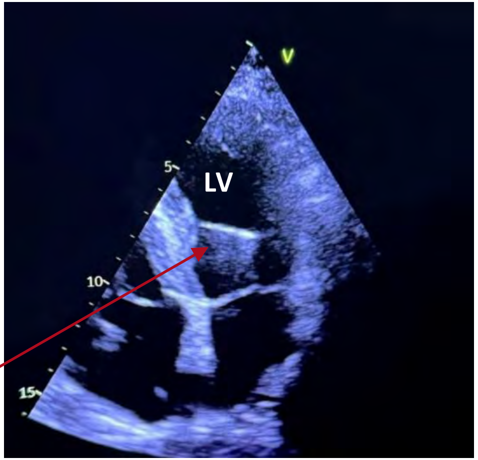
Jastrzebski et al. His Bundle Pacing in the Era of LBBAP, Arrhytmia & Electrophysioloy Review 2025

1. HBP is SAFER than LBBAP, no septal damage



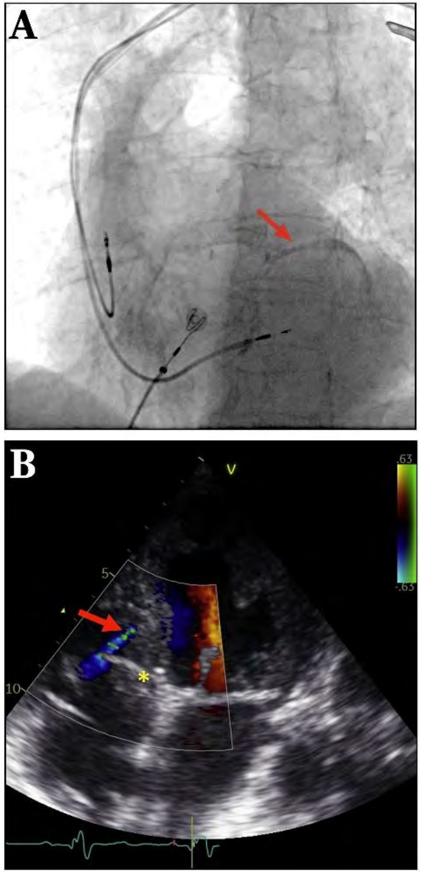
Trivedi et al. J Am Coll Cardiol Case Rep. 2023





The 4th late perforation in my EP lab / 2500 cases

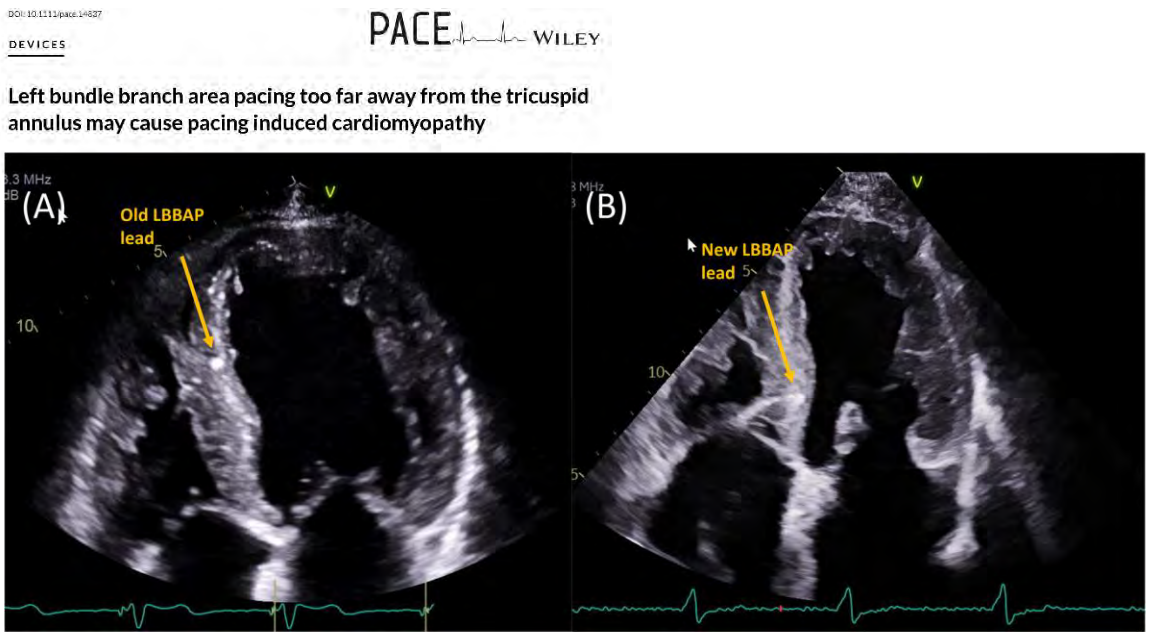
Kato et al. JACC EP



MELOS study, Jastrzebski et al. Eur Heart J 2022

LBBAP outcomes…

2. HBP is the pinacle of physiological pacing while, „physiological” LBBAP is often NOT PHYSIOLOGICAL

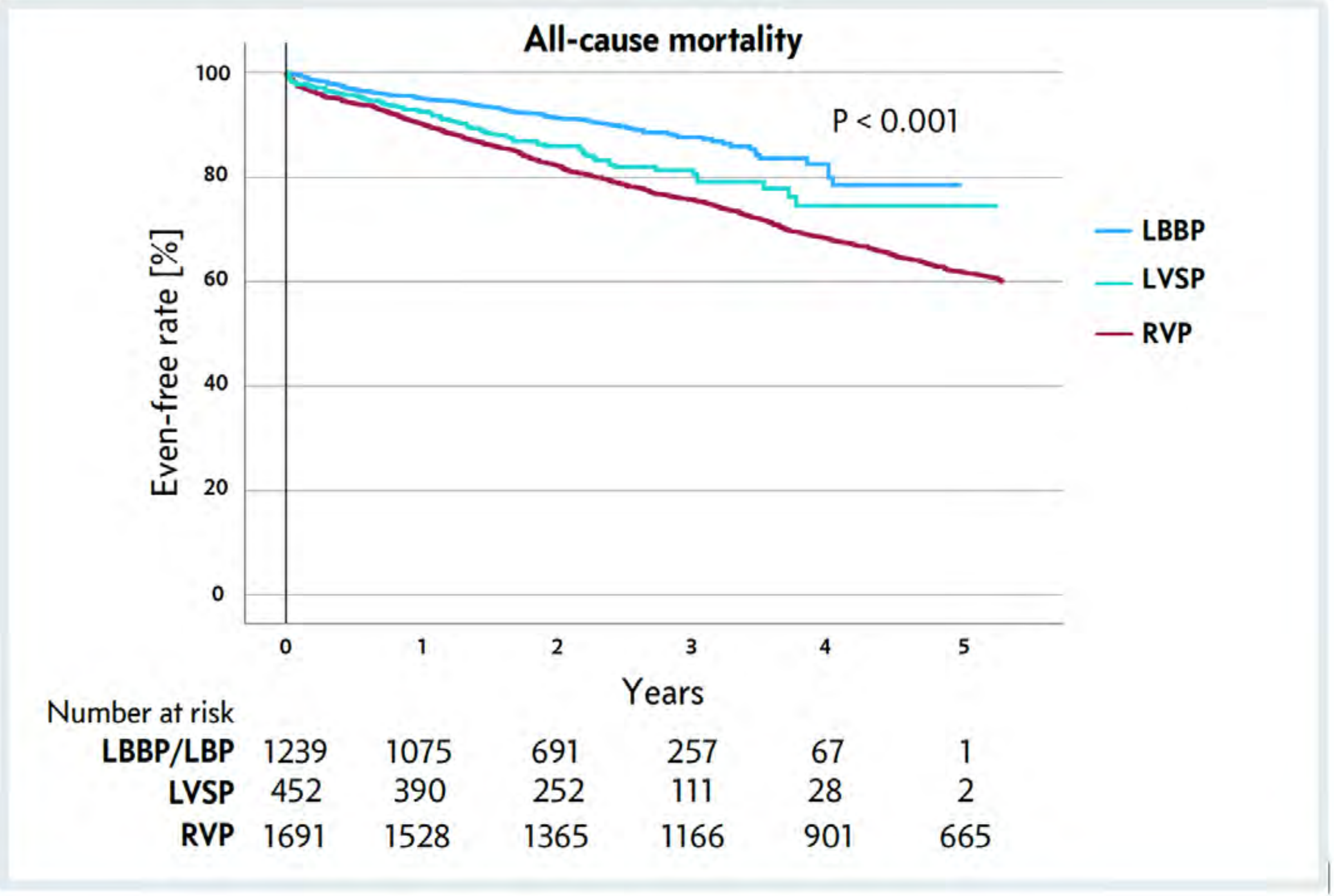

DOI: 10.1111/pace.14837

DEVICES

PACE WILEY

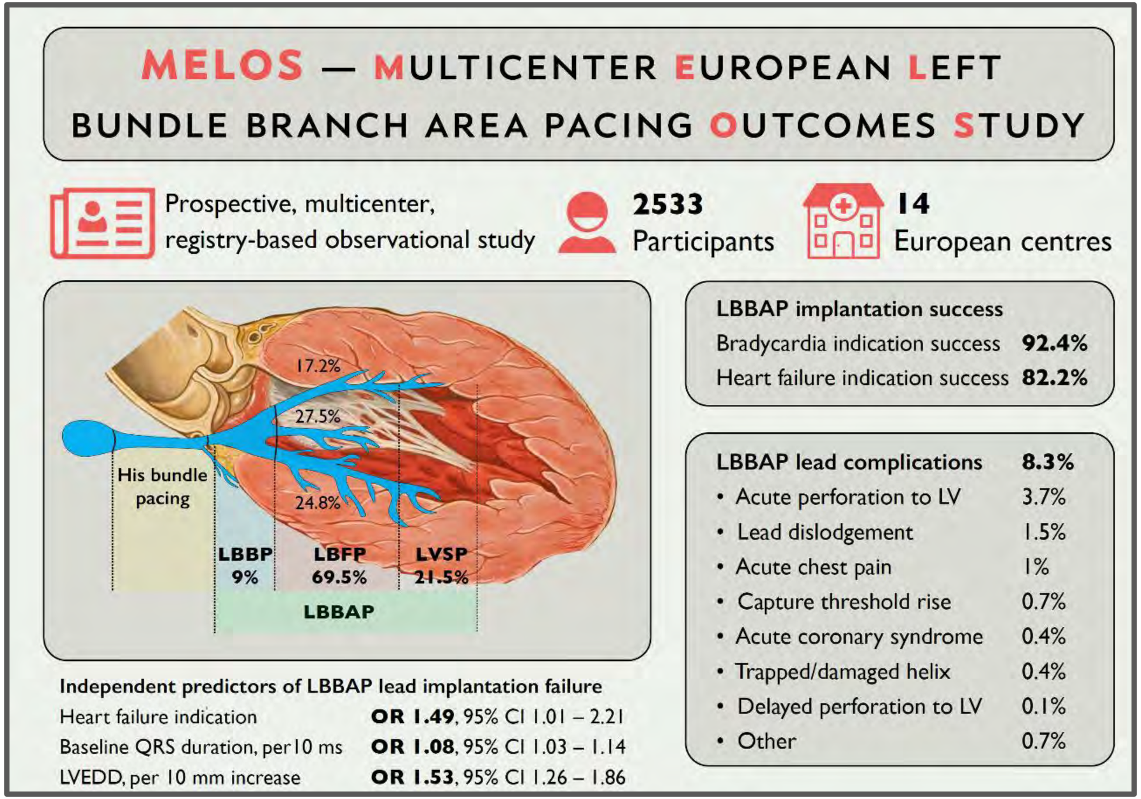
Left bundle branch area pacing too far away from the tricuspid annulus may cause pacing induced cardiomyopathy

Left bundle branch area pacing too far away from the tricuspid annulus may cause pacing induced cardiomyopathy, Michael Meyers MD, Xiaoke Liu MD, PhD, PACE 2024



MELOS RELOADED, in review, n = 3382

3. HBP is often successful in failed or challenging LBBAP cases

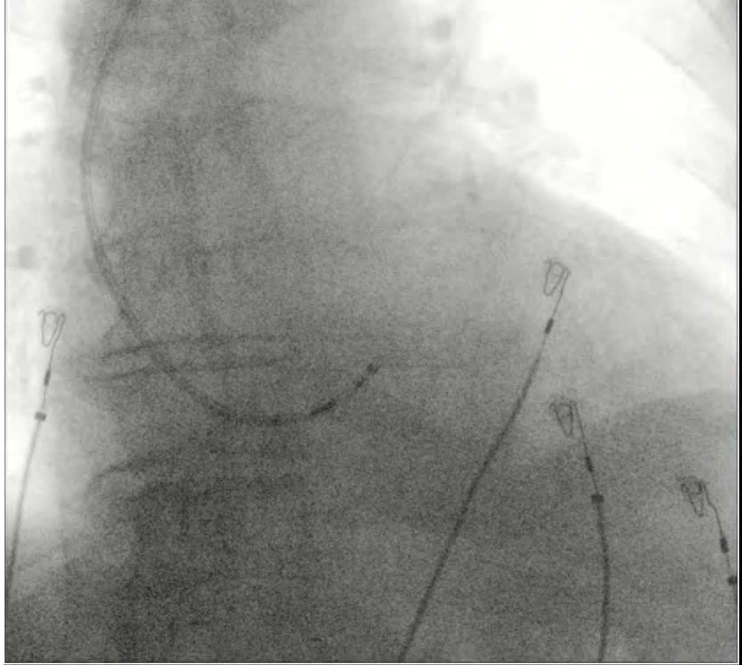


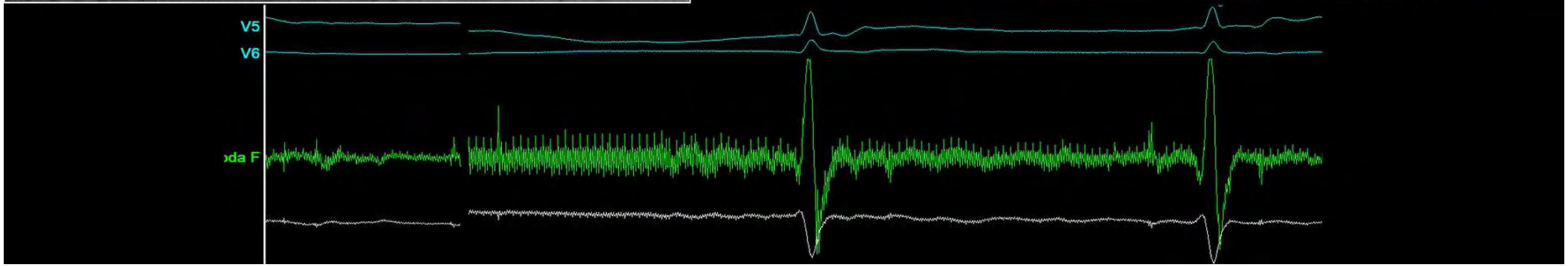
Jastrzebski et al. Left bundle branch area pacing outcomes: the multicentre European MELOS study. Eur Heart J, 2022;43:4161-4173.

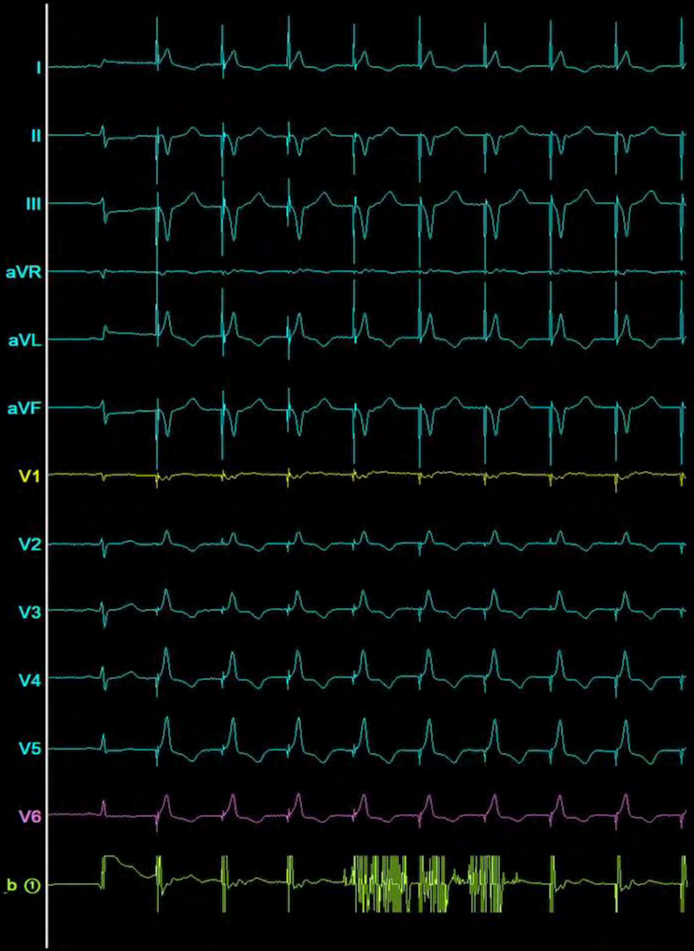
Take Home:

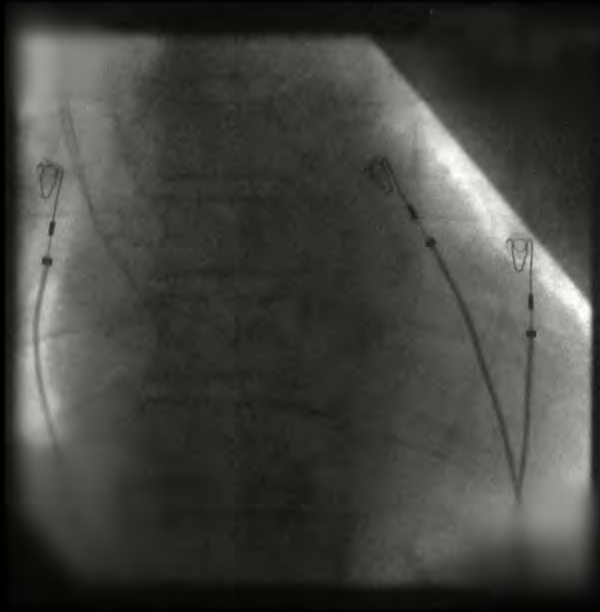
1. HBP is an important and evolving CSP method
2. HBP is safer and more physiological than LBBAP
3. With the modern HBP technique capture threshold is no longer an issue
4. It is excellent bail-out option for failed LBBAP

Thank you!




V5
V6





HBP implantation using continuous pacing technique.