TIGULLIO 2024 II Congresso Nazionale di ARITMOLOGIA

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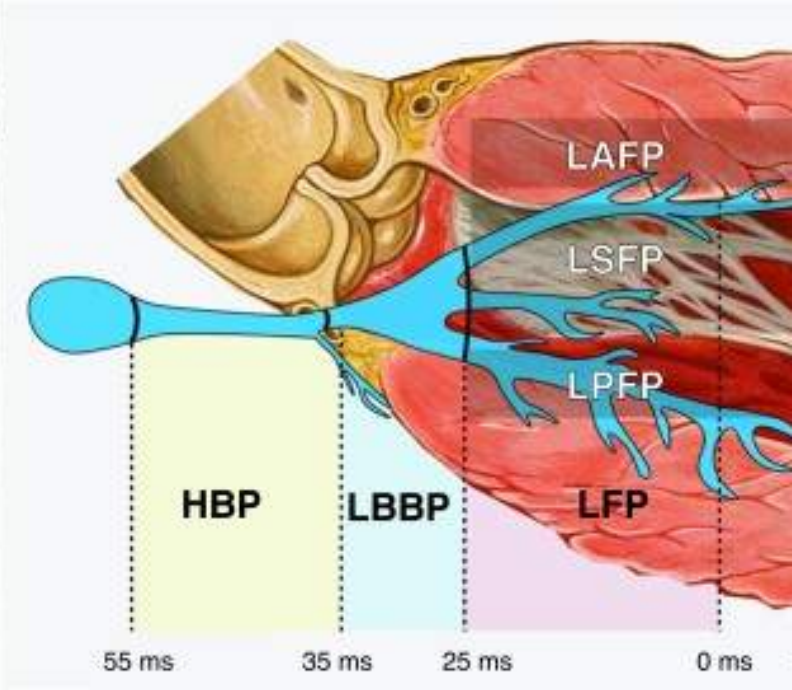
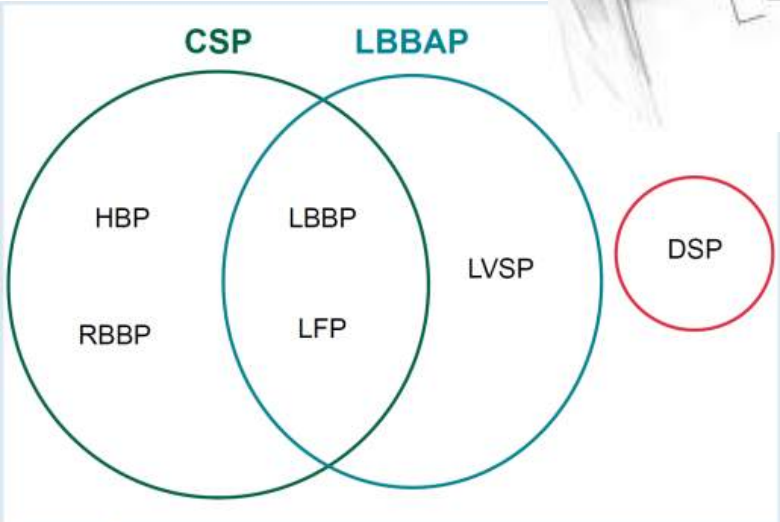
Pacing del sistema di conduzione: la programmazione del *device*

Giovanni Coluccia, MD, FAIAC **@messapus** **messapus@gmail.com**

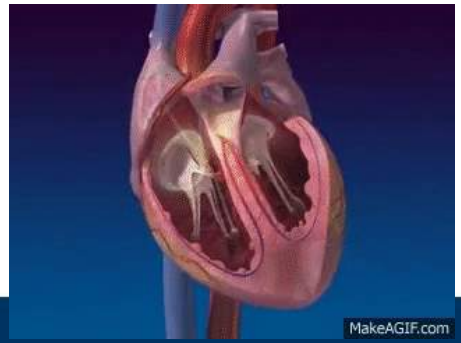
UO Cardiologia – UTIC, Ospedale "Card. G. Panico", Tricase

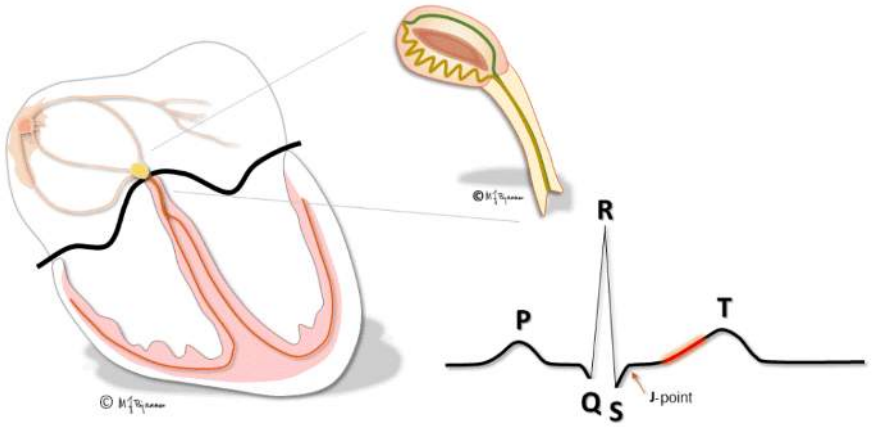
Conflitti di interesse: nessuno

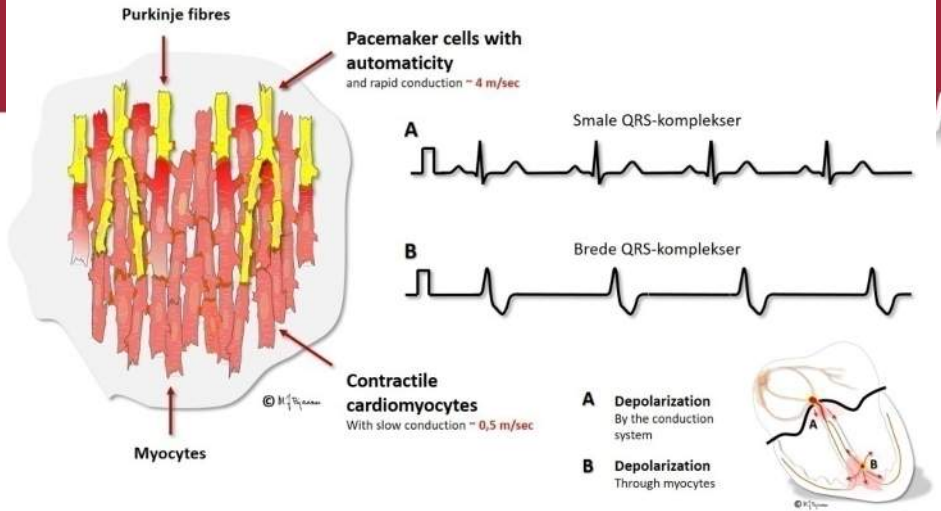




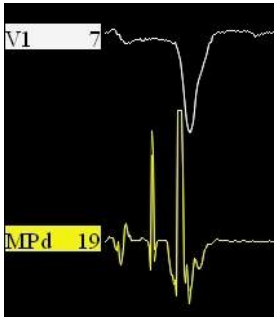
Europace (2023) **25**, 1208–1236



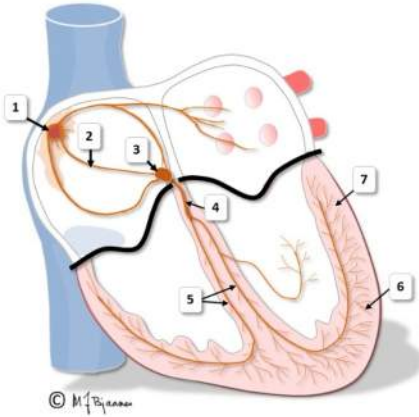


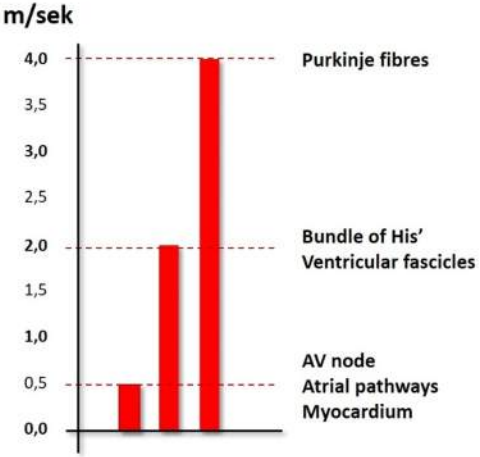


Conduction velocities



1. Sinoatrial node
2. Atrial pathways
3. AV-node
4. Bundle of His
5. Ventricular fascicles
6. Purkinje fibres
7. Myocardium





https://studmed.uio.no/elaring/fag/hjertesykdommer/en/ecg/basal_elfys.html

Programmazione del dispositivo con:

- Stimolazione del fascio di His

- Stimolazione dell'area della branca sinistra

Table 9 Pacemaker interrogation and programming approach for CPP

	HBP	LBBAP
Capture thresholds	Determine His bundle capture relative to RV capture; program output to ensure His bundle capture (at least 1 V above the threshold)	Determine LBB (LV septal) capture and anodal capture
Capture assessment algorithms	Avoid, unless known that His bundle and RV capture thresholds are similar	Capture assessment algorithms can be utilized successfully
AV delays	Program 30–50 ms shorter than conventional parameters*	Program 20–30 ms shorter than conventional parameters*
Atrial oversensing	Atrial oversensing can occur with proximal lead placement and may need appropriate programming to also avoid ventricular undersensing	
Ventricular unipolar sensing	Avoid if pacing dependent	

1	C-EO

2. In patients undergoing CSP with HBP or LBBAP, accurate demonstration of conduction system capture thresholds (including BBB correction) and myocardial capture thresholds at implant is useful for appropriate programming of the device.

Chung et al. 2023 HRS/APHRS/LAHRS Guideline on Cardiac Physiologic Pacing

Recommendations for using His bundle pacing

Recommendations	Class[a]	Level[b]
In patients treated with HBP, device programming tailored to specific requirements of HBP is recommended.[430,431]	I	C

European Heart Journal (2021) **00**, 1–94
doi:10.1093/eurheartj/ehab364

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4. To consider the latency from pacing event to V electrical activation

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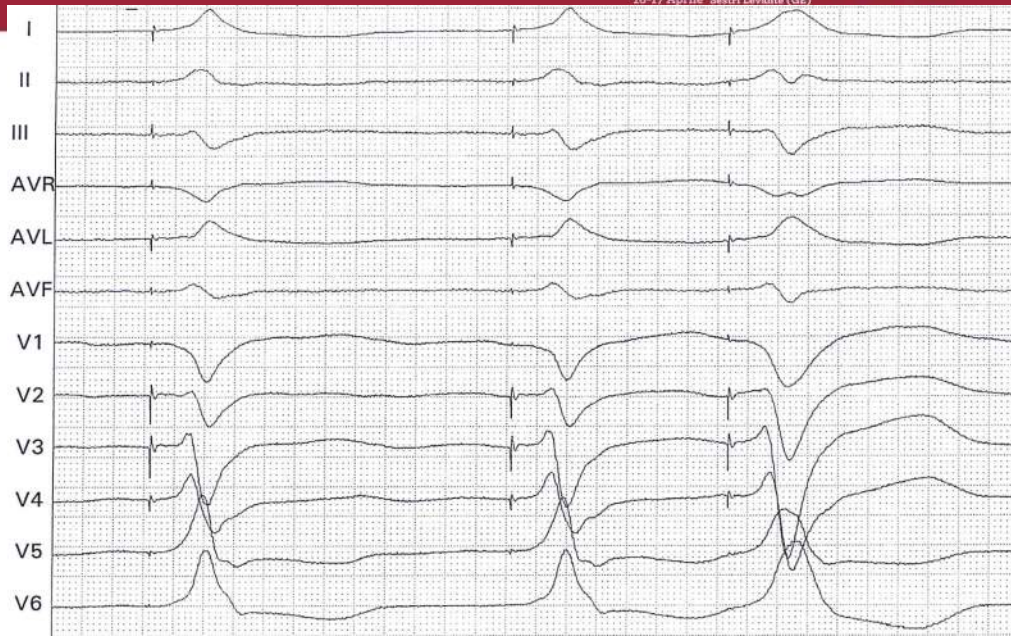
SPONTANEOUS

SELECTIVE HB CAPTURE

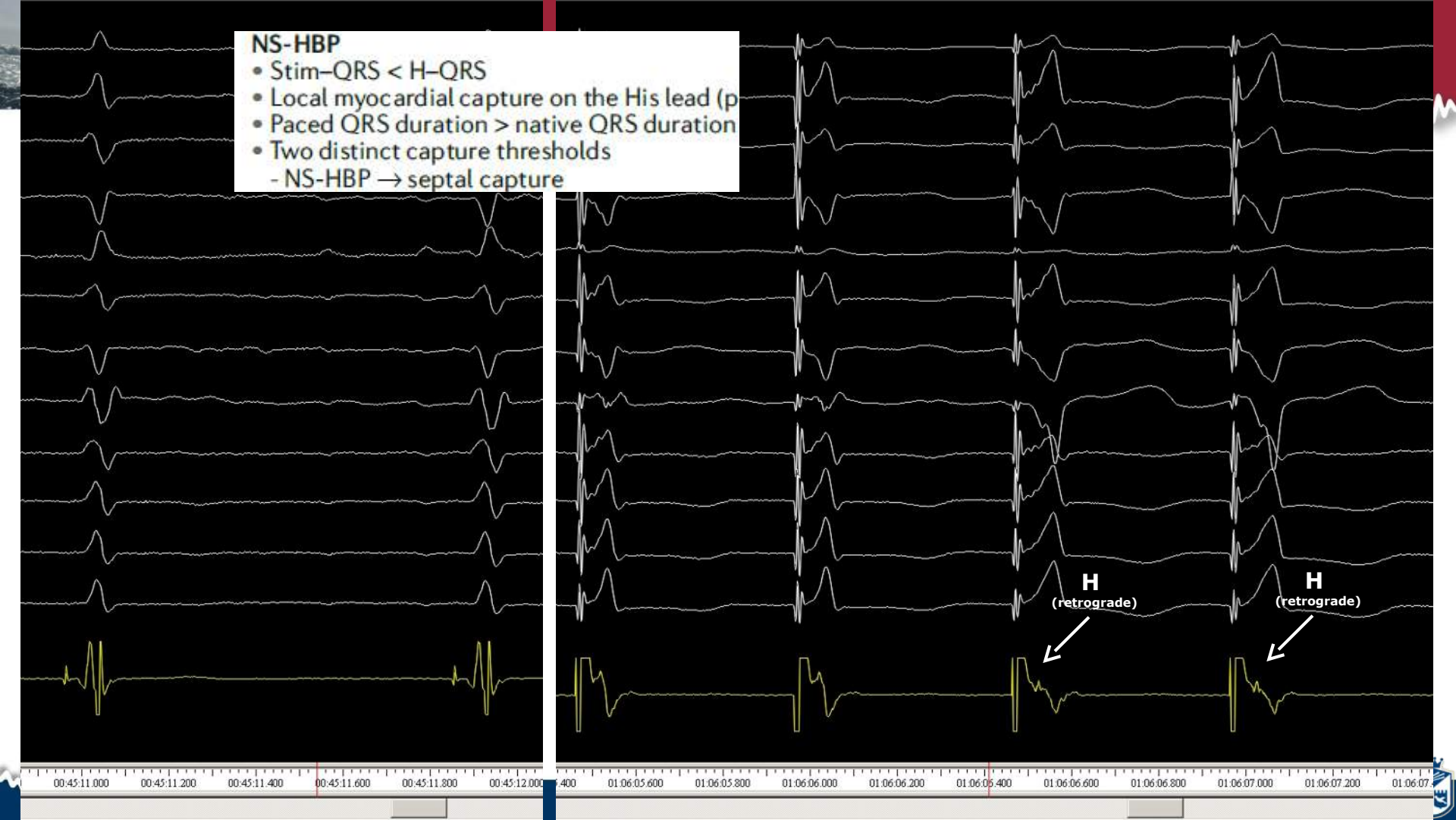


S1 600 ms **S1** 360 ms **S2**

NON-SELECTIVE HB CAPTURE

RV CAPTURE (HB refractory)


I 1
II 2
III 3
aVR 4
aVL 5
aVF 6
V1 7
V2 8
V3 9
V4 10
V5 11
V6 12
HIS 16
S-HBP
• Stim–QRS interval = H–V interval
• Discrete local ventricular EGM on His lead
• Paced QRS duration is identical to native QRS duration
• Single capture threshold for S-HBP


NS-HBP
• Stim–QRS < H–QRS
• Local myocardial capture on the His lead (p
• Paced QRS duration > native QRS duration
• Two distinct capture thresholds
- NS-HBP → septal capture
H
(retrograde)
H
(retrograde)
00:45:11.000
00:45:11.200
00:45:11.400
00:45:11.600
00:45:11.800
01:06:05.600
01:06:05.800
01:06:06.000
01:06:06.200
01:06:06.400
01:06:06.600
01:06:06.800
01:06:07.000
01:06:07.200

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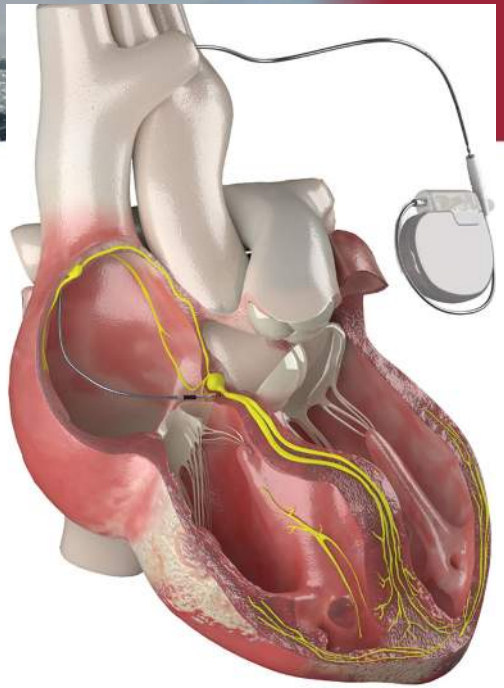

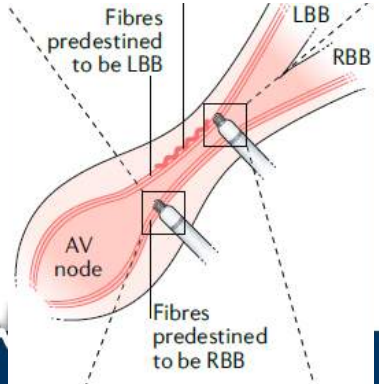
Fibres predestined to be LBB
LBB
RBB
AV node
Fibres predestined to be RBB


I 1
II 2
III 3
aVR 4
aVL 5
aVF 6
V1 7
V2 8
V3 9
V4 10
V5 11
V6 12
HIS 19


STIM
I 1
II 2
III 3
aVR 4
aVL 5
aVF 6
V1 7
V2 8
V3 9
V4 10
V5 11
V6 12
His 17
00:55:52.800
00:55:53.100
00:55:53.400
00:55:53.700
00:55:54.000
00:55:54.300
00:55:54.600
00:55:54.900
00:55:55.200
00:55:55.500
00:55:55.800
00:55:56.100
00:55:56.400
00:55:56.700
00:40:16.400
00:40:16.600
00:40:16.80

Elise Bakelants and Haran Burri

Department of Cardiology, University Hospital of Geneva, Geneva, Switzerland

Pacing polarity

- Unipolar: - lower capture threshold
  - easier detection of pacing spike
- Bipolar: - higher impedance
  - lower battery drain

Voltage

- 2 x capture threshold
- at least 1 V safety margin in non-dependent patients

Pulse width

- 0.4/.5 ms if threshold <2 V
- 1 ms if threshold >2 V

- Set an **output** allowing not only HB **capture**, but also BBB **correction**
- **Disable** automatic **capture** management **algorhythms**

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4. To consider the latency from pacing event to V electrical activation

The relationship between anatomy and electrical parameters in His bundle pacing: A transthoracic echocardiography evaluation

Giovanni Coluccia, MD [a,*,1], Jacopo Senes, MD [a], Serena Corallo, MD [a], Milena Aste, MD [a], Daniele Oddone, MD [a], Paolo Donateo, MD [a], Enrico Puggioni, MD [a], Michele Brignole, MD, FESC [a,b]

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[b] Department of Cardiovascular, Neural and Metabolic Sciences, Faint & Fall Programme, IRCCS Istituto Auxologico Italiano, San Luca Hospital, P.le Brescia, 20 – 20149, Milano, Italy

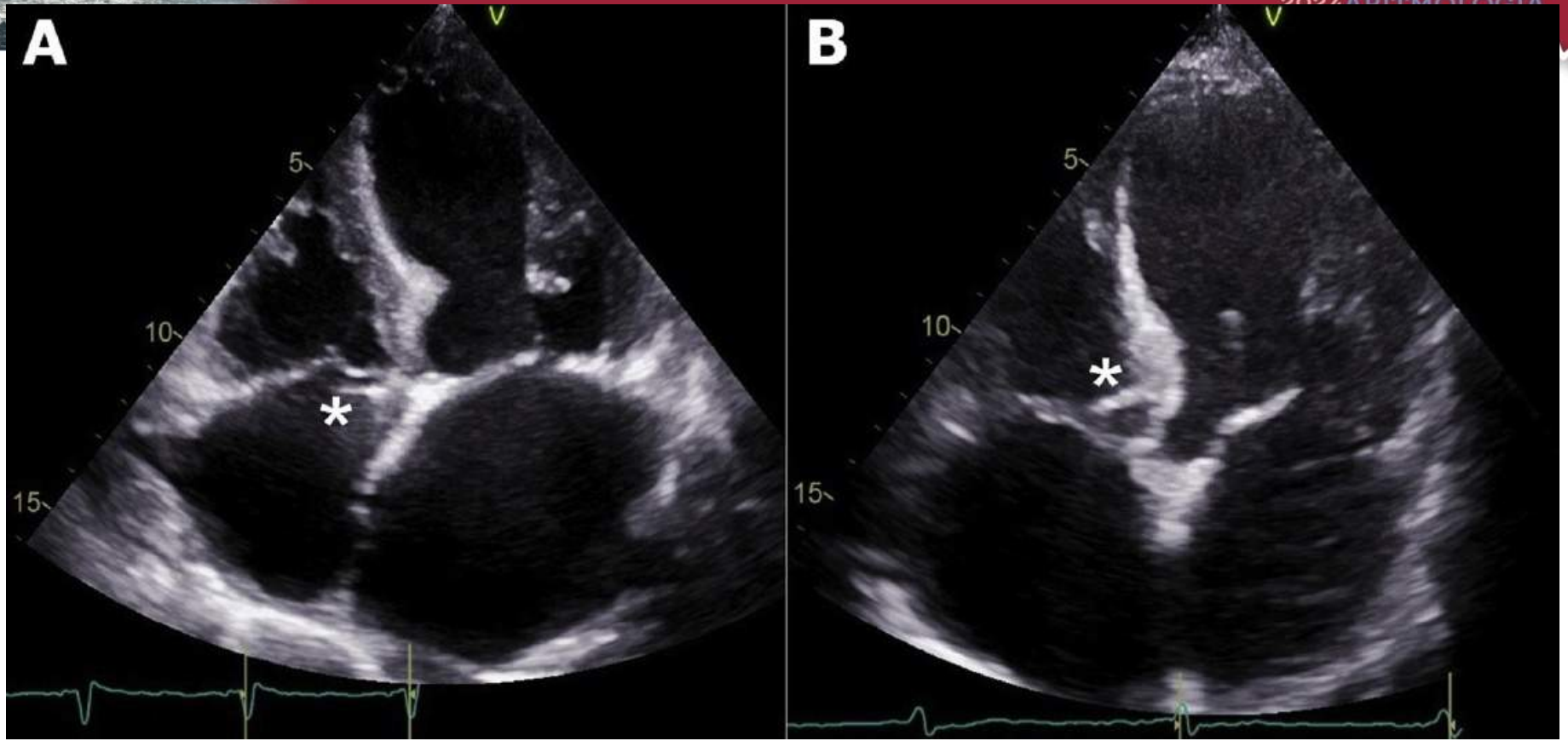
ARTICLE INFO

Journal of Electrocardiology 68 (2021) 85–89

Keywords:
His bundle pacing
Echocardiography
Cardiac conduction system anatomy
Conduction system pacing
Physiological pacing

ABSTRACT

Purpose: The implantation site of the His bundle (HB) lead may influence pacing parameters. Our aim was to characterize the anatomical location of the HB lead tip and its relationship with acute electrical parameters.
Methods: Consecutive patients who underwent HB lead implantation, guided by standard fluoroscopy and electrophysiology, were prospectively enrolled. The relationship between HB lead tip and tricuspid valve plane (TVP) was assessed with post-procedure transthoracic echocardiography.
Results: Twenty-five patients were studied. In 11 patients (44%), the HB lead tip did not cross the TVP (A group): in 7 cases it was screwed in the right atrium at a mean distance of −6.1 mm from the TVP and, in 4 cases, at the level of the tricuspid annulus. In the remaining 14 patients (56%), the lead tip crossed the TVP (V group): it was screwed in the right ventricle at a mean distance of 9.3 mm from the TVP. A and V groups had comparable HB capture thresholds (1.6 ± 1 V vs 1.7 ± 0.7 V, 1 ms pulse-width; $p = 0.66$); selective HB capture was significantly more represented in the A group (91% vs 21%; $p = 0.001$). Significantly higher R-wave amplitudes were seen in the V group (6.7 ± 3 vs 2.5 ± 1.7 mV; $p = 0.0004$), and they positively correlated with the distance from the TVP ($p = 0.0038$). Atrial oversensing was never observed.
Conclusion: In a consecutive cohort of HB pacing recipients, the rate of patients who had an effective HB capture in the atrium was substantial and was characterized by different electrophysiological properties than in the ventricle.



Journal of Electrocardiology 68 (2021) 85–89

Anatomical and electrical parameters in Atrial and Ventricular groups.

	A group (11 pts)	V group (14 pts)	*p* value
Mean distance from the tricuspid valve annulus, mm (range)	−3.9 (−11−0)	9.3 (3–16)	–
Selective His bundle capture, n (%)	10 (91)	3 (21)	0.001
His bundle capture threshold at 1 ms, V	1.6 ± 1.0	1.7 ± 0.7	0.66
HV interval after screwing, ms	57 ± 14	49 ± 8	0.17
Atrial potentials on electrogram, n (%)	7 (64)	4 (29)	0.11
R wave sensing, mV	2.5 ± 1.7	6.7 ± 3.0	0.0004

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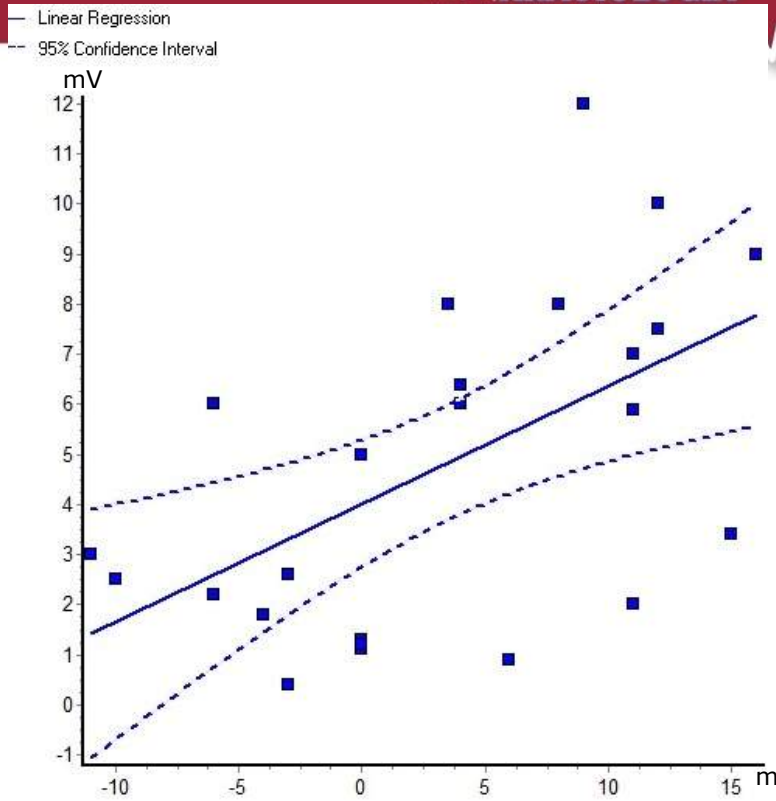

$$y = 0.236\ x + 4.022\ (p = 0.0038)$$

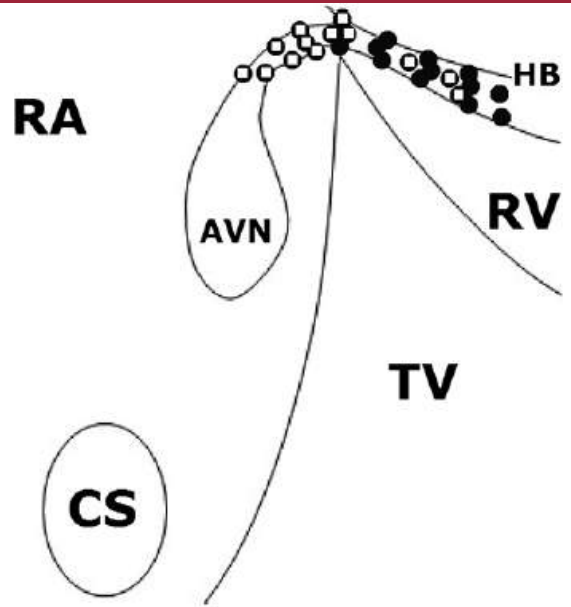

Fig. 2. Distribution of sites of lead screwing in the study population, along the His bundle (HB), in relation to the tricuspid valve (TV) septal leaflet insertion: black dots = sites of non-selective capture; white-core dots = sites of selective capture. Other abbreviations: AVN = compact atrio-ventricular node; CS = coronary sinus ostium; RA = right atrium; RV = right ventricle.

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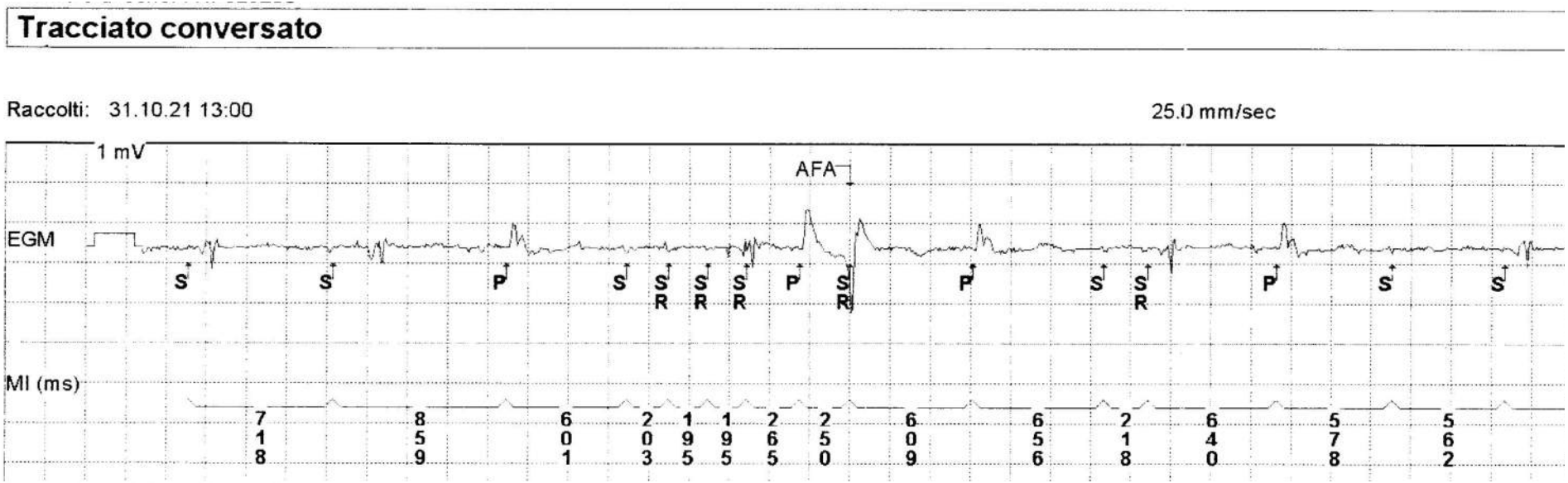
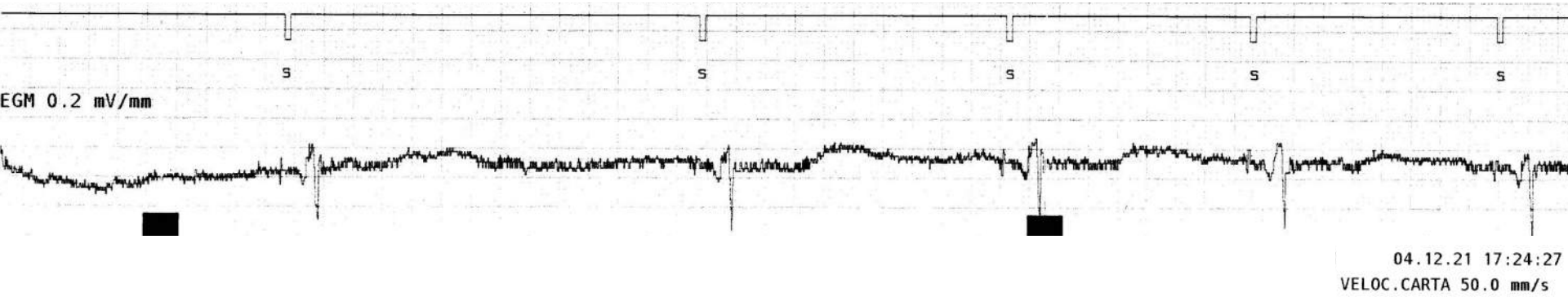
Permanent atrial fibrillation. Single chamber PM; His bundle lead. Permanent programming: AAIR 70-130 ppm, sensitivity 0.25 mV (BI). Pacing percentage: 99%.

In the arrhythmia registry, a single "high atrial frequency" ("AFA") episode, revealing **atrial waves oversensing**.

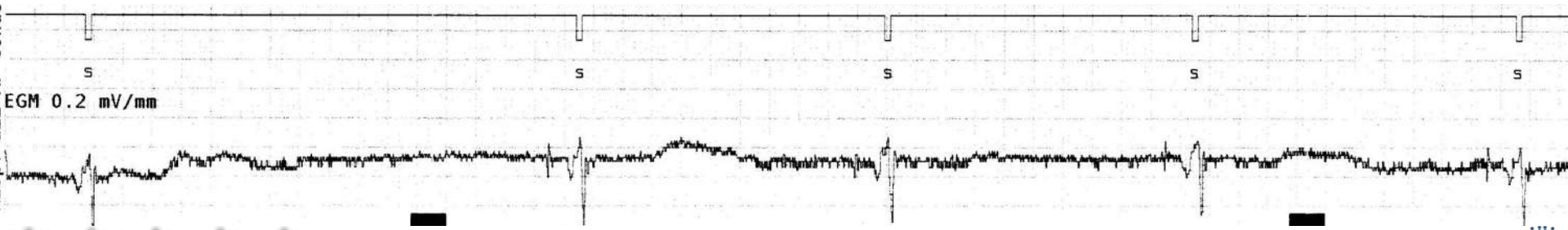


Temporary mode: AAI 30 ppm; sensitivity 0,25 mV (BI)



R wave amplitude: 1.5 mV (BI); HB wave amplitude: 0.35 mV (BI).

Temporary mode: AAI 30 ppm; sensitivity 0,5 mV (BI)



Sensing polarity

- Bipolar: - first choice
- Unipolar: - when difficult to avoid A oversensing in BI (adjust sensitivity to avoid noise detection)

- In case of **low R wave** sensing and single chamber pacemaker, consider **AAI**(R) mode and report it in notes
- When in the RV port, finely tune the **sensitivity**, especially in case of low R wave sensing and/or risk of A / HB oversensing
- **Disable automatically-adjusting** sensitivity

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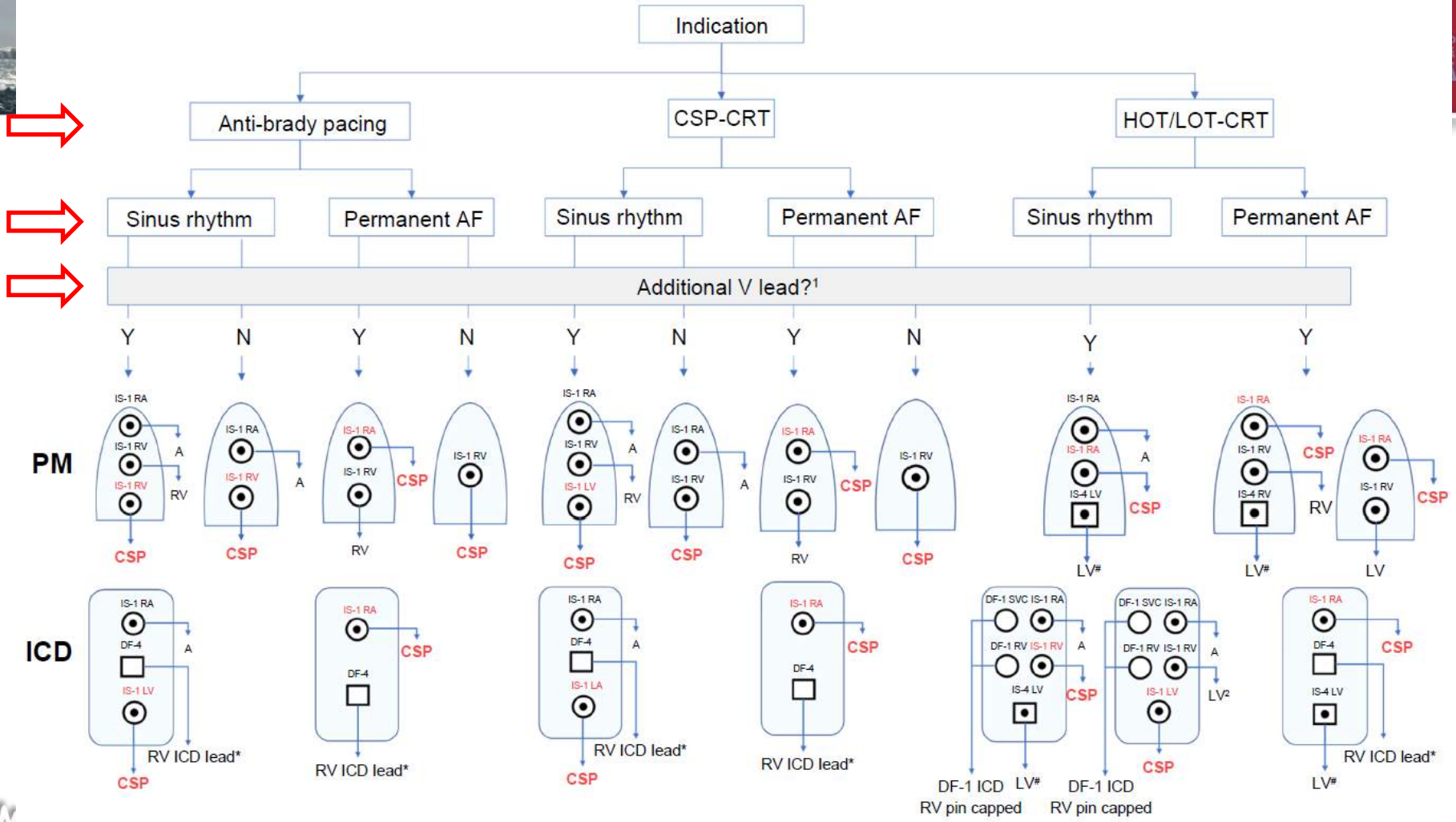
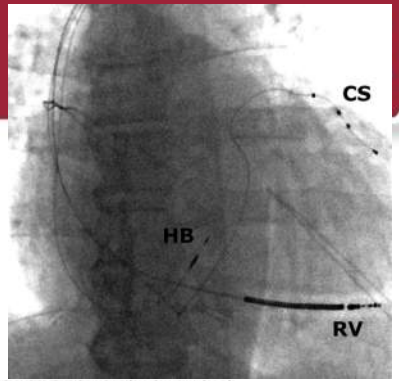

Indication
Anti-brady pacing
CSP-CRT
HOT/LOT-CRT
Sinus rhythm
Permanent AF
Sinus rhythm
Permanent AF
Sinus rhythm
Permanent AF
Additional V lead?[1]
Y
N
Y
N
Y
N
Y
N
Y
Y
PM
ICD
IS-1 RA
IS-1 RV
IS-1 LV
IS-1 LA
IS-4 LV
DF-4
DF-1 SVC
DF-1 RV
A
RV
LV
LV#
CSP
RV ICD lead*
LV²
DF-1 ICD
RV pin capped

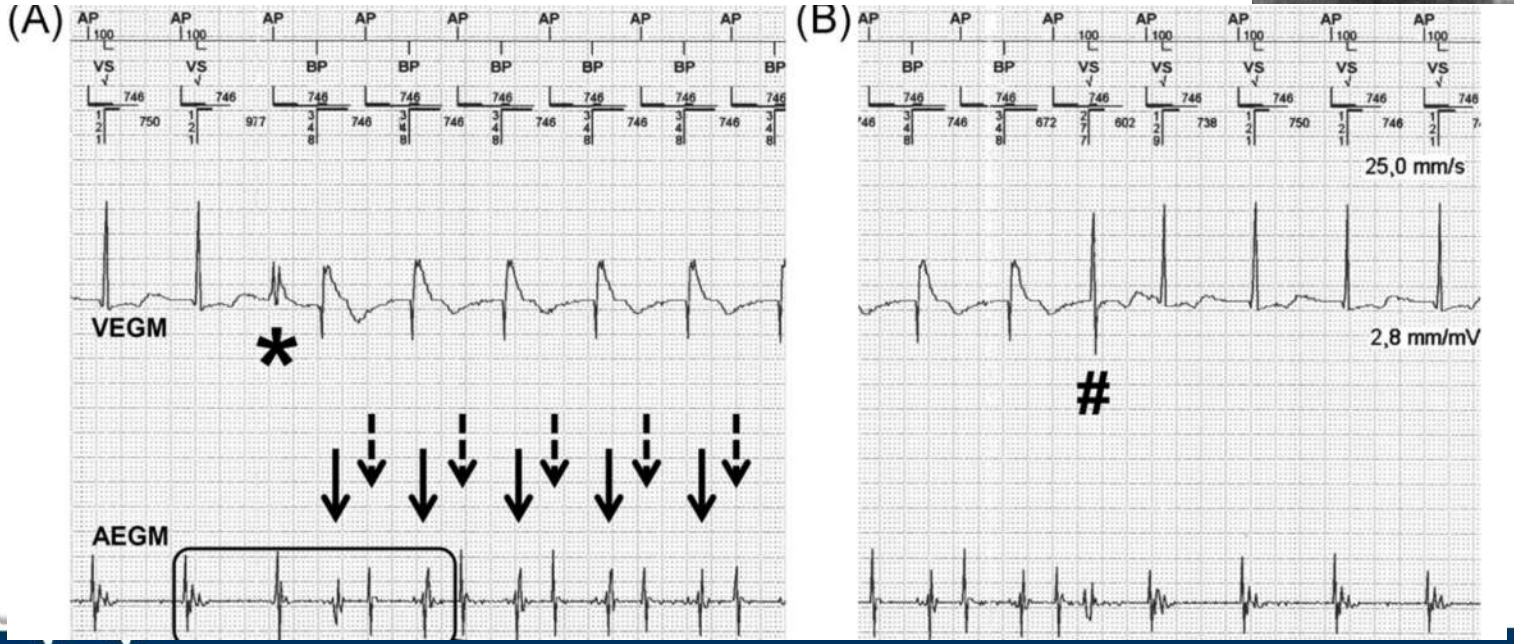
Received: 4 April 2019 | Revised: 15 May 2019 | Accepted: 29 May 2019
DOI: 10.1111/jce.14011

WILEY

Loss of His bundle capture due to repetitive non–re-entrant "ventriculohisian" synchrony

Giovanni Coluccia MD | Daniele Oddone MD | Michele Brignole MD, FESC





Circulation: Arrhythmia and Electrophysiology

REVIEW

Device Programming for His Bundle Pacing

Circ Arrhythm Electrophysiol. 2019;12:e006816. DOI: 10.1161/CIRCEP.118.006816

ABSTRACT: Although permanent His bundle pacing was first reported almost 2 decades ago, it is only recently gaining wider adoption, following facilitation of the implant procedure by dedicated tools. An additional challenge is programming the system, as His bundle pacing may have specific configurations and require special considerations which current implantable pulse generators are not designed for. The aim of this article is to provide practical recommendations for programming His bundle pacing, to deliver optimal therapy and ensure patient safety.

Haran Burri, MD
Daniel Keene, MD
Zachary Whinnett, MD
Francesco Zanon, MD
Pugazhendhi Vijayaraman, MD

- When in the **A port**:
  - disable ventricular **safety pacing**
  - in ICD, disable 1:1 tachycardia **discriminators**
  - set high **sensitivity** or **DVI** mode
  - adjust appropriate **pAV interval** (20-40 ms longer than AP-VS interval)

-When in the **LV port**, set the maximum allowed VV interval to anticipate the "LV" (HB) pacing

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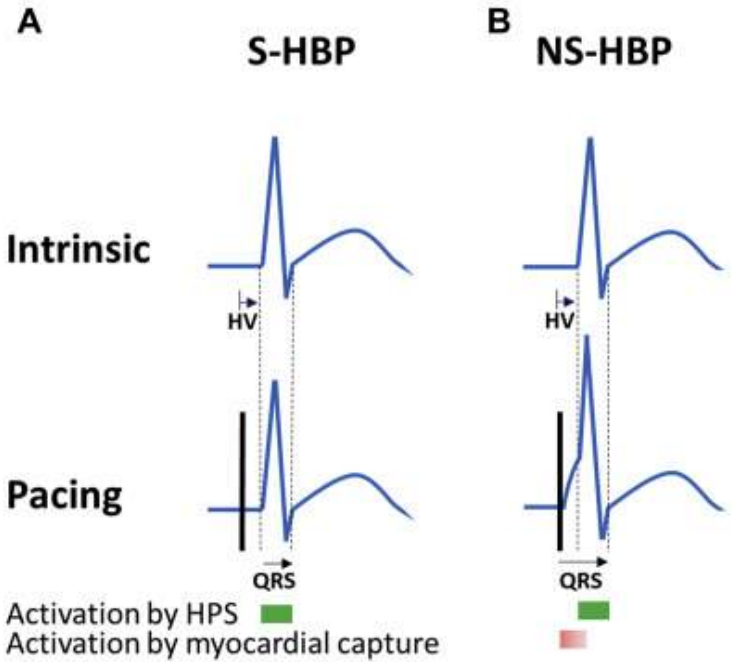

NON SELECTIVE **SELECTIVE**

HB CAPTURE

Troubleshooting and programming considerations for His bundle pacing

Daniel L. Lustgarten, MD, PhD, FHRS,* Parikshit S. Sharma, MD, MPH, FACC, FHRS,† Pugazhendhi Vijayaraman, MD, FHRS‡

Nominally programmed AV delays

The programmed AV delay is the most unique aspect of HBP. The HBP-programmed AV delay must take into account the time it takes for the stimulus onset to conduct through the His-Purkinje system, in contrast to RV pacing where ventricular activation onset is coincident with the stimulus. In the setting of patients with AV nodal conduction disease, nominally programmed AV delays will result in AV dyssynchrony. For example, if the nominal sensed AV delay is 180 ms, during atrial sensing the effective AV delay will be 230 ms, assuming an HV time of 50 ms. Longer AV delays decrease the diastolic filling time and increase the risk of diastolic regurgitation, both of which compromise cardiac output. Conversely, programming a very short AV delay output. Conversely, programming a very short AV delay will compromise the atrial kick's contribution to ventricular filling, especially detrimental in patients with compromised LV function.

If the AV delay is programmed too long in patients with preserved AV conduction, intrinsic conduction can compete with HBP and, if the latter is being used to normalize the QRS, compromise therapy (Supplemental Figure 4). For example, if a patient has a PR interval of 200 ms and an HV interval of 40 ms, programming an AV delay >160 ms will result in pseudofusion.

Heart Rhythm 2019;16:654–662

Circulation: Arrhythmia and Electrophysiology

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If the His lead is connected to a ventricular port, one should bear in mind the **latency** in ventricular activation resulting from HV conduction, and shorten the programmed AVI accordingly. The HV interval can be measured by the stimulus to QRS onset in case of selective capture. With **nonselective capture**, it is at present **unclear** if the AVI should be adjusted.

AVI: His lead in RV/ LV port	Usual AVI minus HV interval (or stimulus to QRS onset)	AV hysteresis may be programmed if V pacing needs to be avoided.

Circ Arrhythm Electrophysiol. 2019;12:e006816. DOI: 10.1161/CIRCEP.118.006816

Permanent His Bundle Pacing: A programming and troubleshooting guide

Jillian L. Hanifin, Venkatesh Ravi, Richard G. Trohman, Parikshit S. Sharma*

Rush University Medical Center, Chicago, IL, USA

If AV block is the reason for implant, the AV delays should be **shortened**. On average, the paced AV delay is programmed **approximately** 130 ms and the sensed AV delay is approximately 100 ms. The AV delays for AV block are shortened to accommodate for the HV interval (usually 35–55 ms) and may vary from patient to patient based on measurements that are taken at implant.

HBP issues	Consequence	Best practices at implant	Troubleshooting options
Long programmed AV delays	Pseudofusion	Measure intrinsic AV conduction time and adjust for HV interval	Shorten Paced/sensed AV intervals if indication for implant was AV block

Indian Pacing and Electrophysiology Journal 20 (2020) 121–128

Elise Bakelants · Alwin Zweerink · Haran Burri
Cardiac Pacing Unit, Cardiology Departement, University Hospital of Geneva, Genève, Switzerland

Programming and follow-up of patients with His bundle pacing

When programming AV intervals, the His pace to QRS onset delay should be **subtracted** from the programmed AV delay.

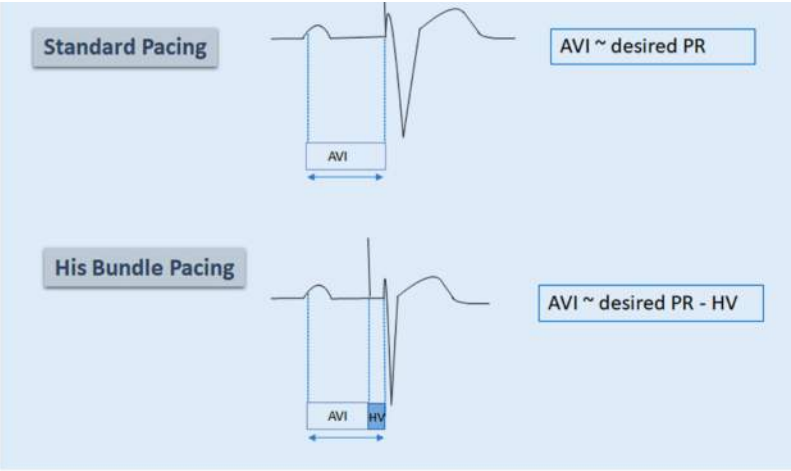


Fig. 2 ▲ Programming of atrioventricular intervals (*AVI*) for His bundle pacing. Note that the AVI needs to be shortened, as the His ventricular (*HV*) delay results in latency before QRS onset

Paced and sensed AV delay	Subtract HV interval (e.g. 40 ms) from desired AV interval (e.g. 180 and 140 ms, i.e. program to 140 and 100 ms instead)

Herzschrittmachertherapie + Elektrophysiologie Published online: 30 April 2020

Troubleshooting Programming of Conduction System Pacing

Elise Bakelants and Haran Burri

Department of Cardiology, University Hospital of Geneva, Geneva, Switzerland

When the HB lead is connected to the RV port in patients in sinus rhythm with an atrial lead, the His-ventricle (HV) interval should be accounted for and subtracted from the **desired** AV delay. In case of **selective** HBP, one can measure the spike-QRS onset delay, or simply use a default value of 40 ms.

AV delay	HBP lead in ventricular port: Subtract HV interval (e.g. 40 ms) from desired AV interval

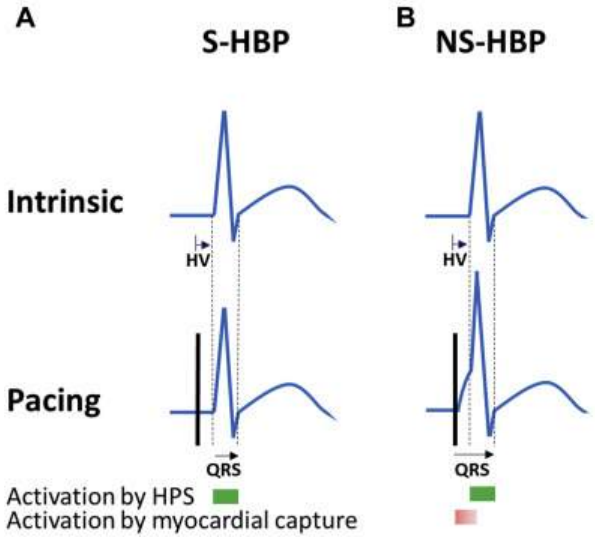
DOI: 10.1111/jce.15927

ORIGINAL ARTICLES

Optimization of the atrioventricular delay in conduction system pacing

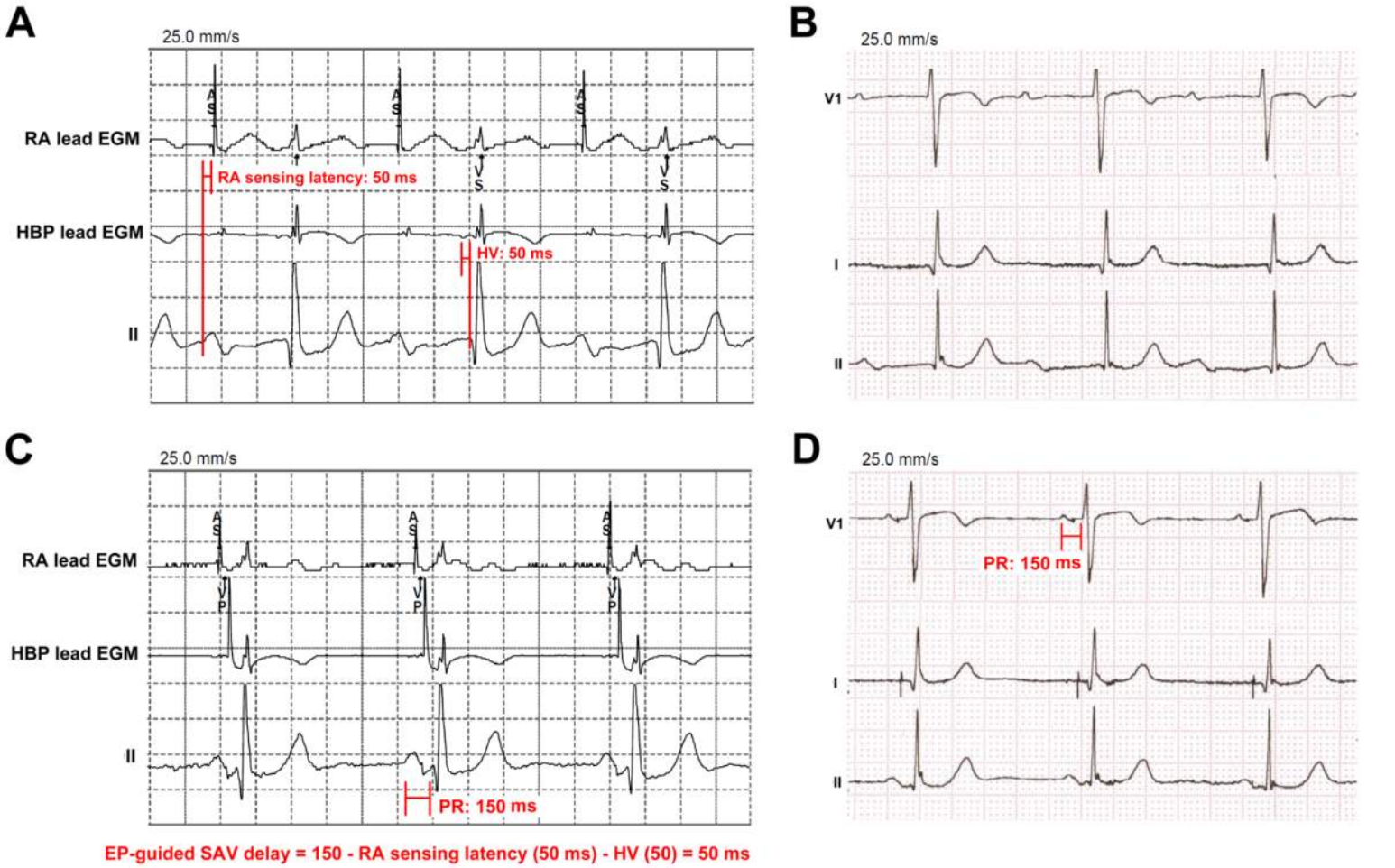
Giovanni Coluccia MD[1] | Gabriele Dell'Era MD[2] | Chiara Ghiglieno MD[2]
Federica De Vecchi MD[2] | Enrico Spinoni MD[2] | Matteo Santagostino MD[2]
Alessandro Guido MD[1] | Maria Zaccaria MD[1] | Giuseppe Patti MD[2] |
Michele Accogli MD[1] | Pietro Palmisano MD[1]

The **EP-guided** AV delay was defined as the programmed AV delay leading to a **PR** interval on the surface ECG of **150** ms in s-HBP and LBBAP or **150-HV** in ns-HBP.



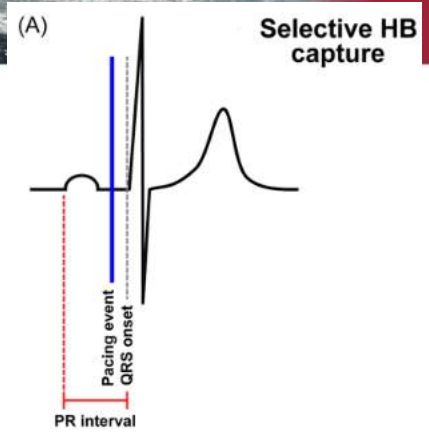
In selective and non-selective **HBP** patients:

EP-guided sAV delay (ms) = 150 - RA sensing latency - HV



EP-guided SAV delay = 150 - RA sensing latency (50 ms) - HV (50) = 50 ms

J Cardiovasc Electrophysiol. 2023;34:1441–1451



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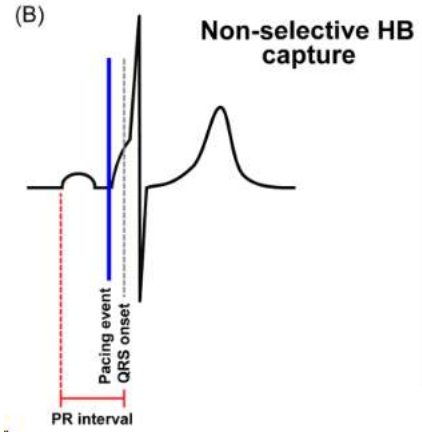

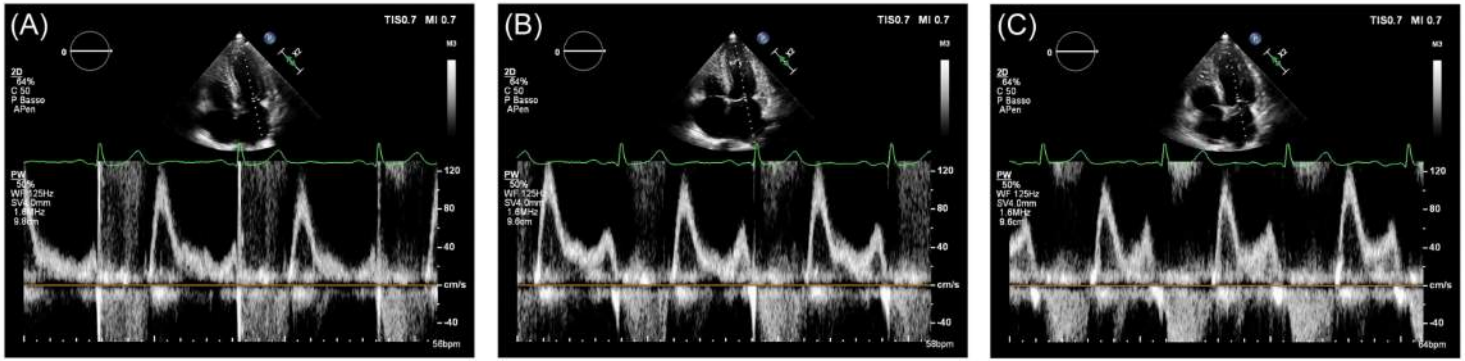

J Cardiovasc Electrophysiol. 2023;34:1441–1451

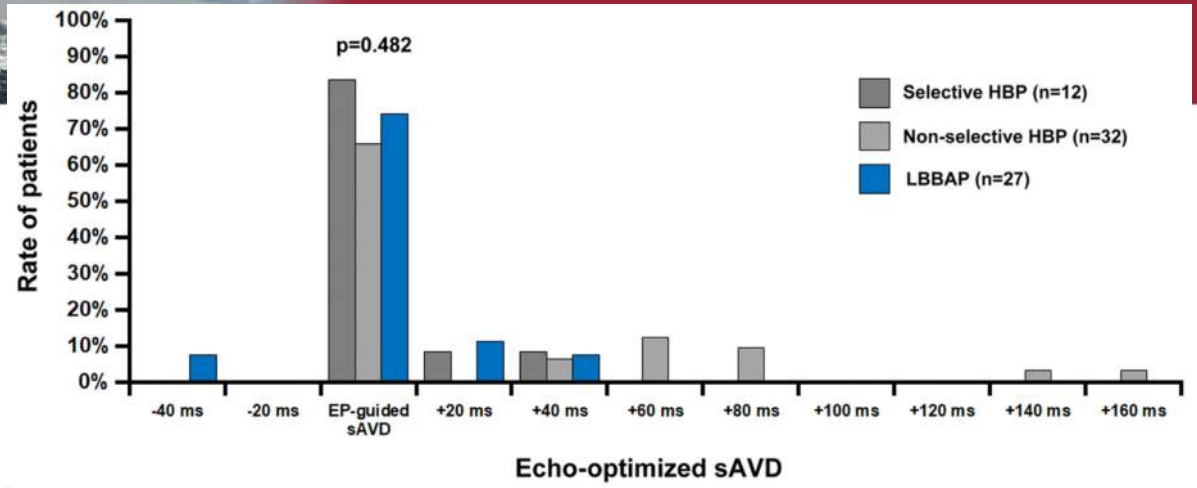

TABLE 3 Predictors of discordance between EP-guided AV delay and echo-optimized AV delay in the overall study population: univariate and multivariate Cox proportional hazards analysis.

Variable	Univariable analysis		Multivariable analysis	
	Hazard ratio (95% CI)	*p* Value	Hazard ratio (95% CI)	*p* Value
LA anteroposterior diameter >40 mm	2.674 (0.93–7.73)	.065	1.241 (0.24–6.30)	.795
LA area >20 cm^2	17.086 (4.65–62.84)	**<.001**	6.888 (1.27–37.25)	**.025**
RASL time >40 ms	9.75 (2.93–32.41)	**<.001**	5.498 (1.36–22.25)	**.017**
EP-guided sAVD >80 ms	0.274 (0.09–0.87)	**.023**	0.574 (0.13–2.56)	.467

Note: Bold type indicates significant *p* values.

J Cardiovasc Electrophysiol. 2023;34:1441–1451

Programmazione del dispositivo con:

- Stimolazione del fascio di His

- Stimolazione dell'area della branca sinistra

In LBBAP

- Electrical **parameters** generally similar to or even better than conventional RV pacing
- Limited / no use of **backup** leads
- Pacing **output**: program to allow conduction system capture
- Pacing configuration: based on the effect of **anodal capture**
- **Automated capture** verification algorhythms: generally working as in conventional RV pacing
- **Sensing** configuration: bipolar
- Automatic **sensitivity**: generally Ok
- **AV intervals**: mechanics and BBB correction

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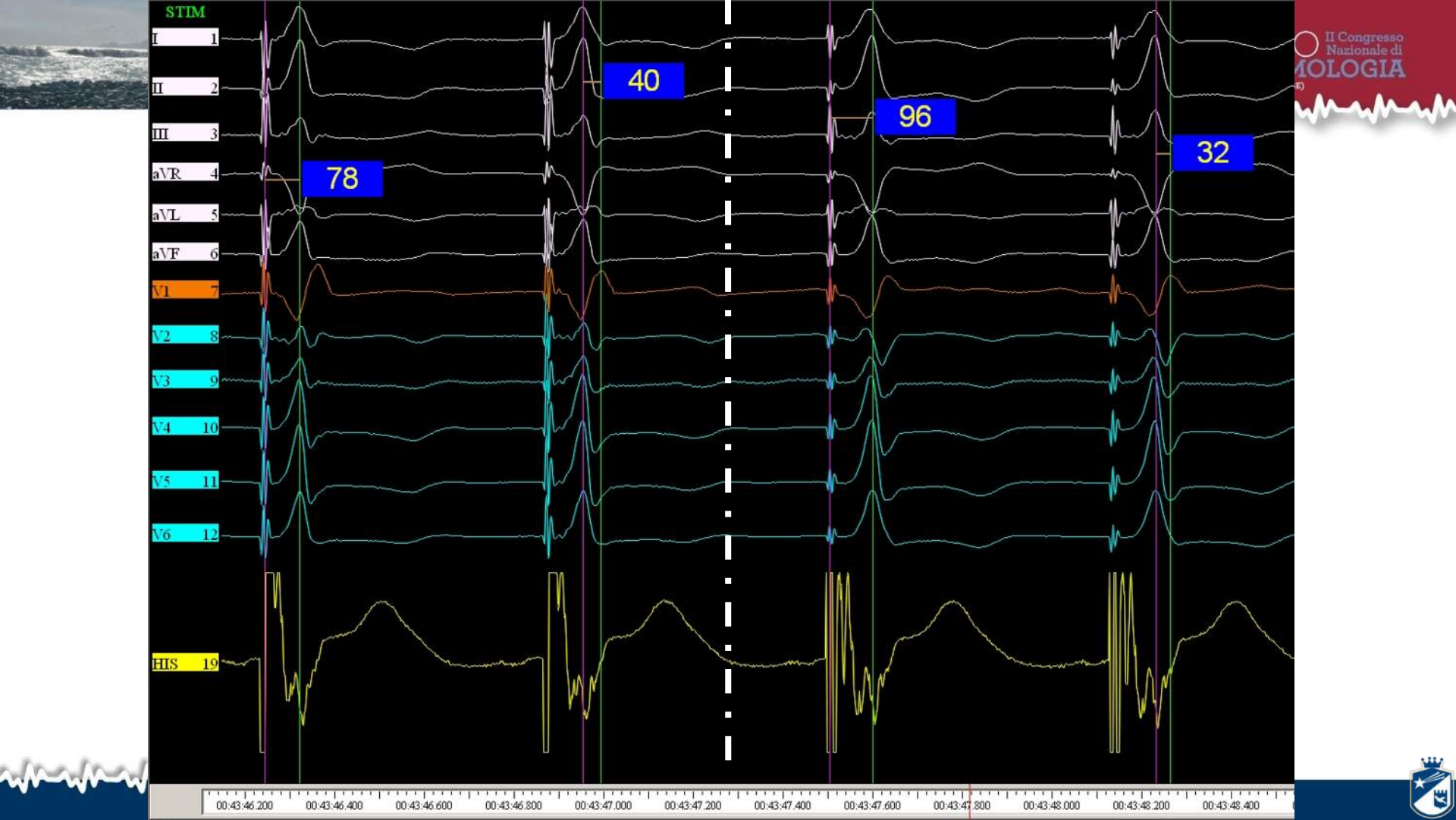
STIM
I 1
II 2
III 3
aVR 4
aVL 5
aVF 6
V1 7
V2 8
V3 9
V4 10
V5 11
V6 12
HIS 19
78
40
96
32
00:43:46.200
00:43:46.400
00:43:46.600
00:43:46.800
00:43:47.000
00:43:47.200
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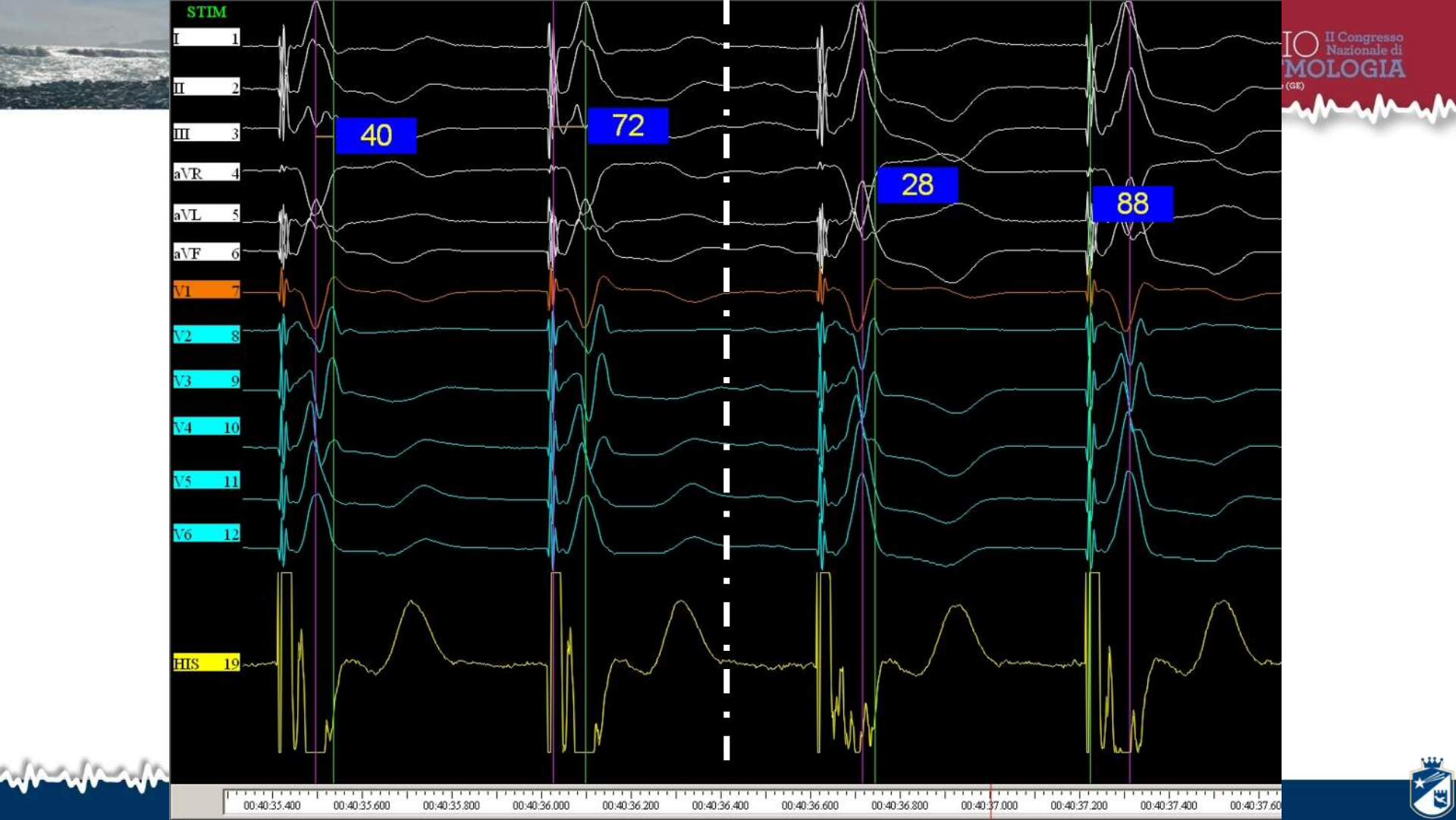
00:43:47.600
00:43:47.800
00:43:48.000
00:43:48.200
00:43:48.400


STIM
I 1
II 2
III 3
aVR 4
aVL 5
aVF 6
V1 7
V2 8
V3 9
V4 10
V5 11
V6 12
HIS 19
40
72
28
88
00:40:35.400
00:40:35.600
00:40:35.800
00:40:36.000
00:40:36.200
00:40:36.400
00:40:36.600
00:40:36.800
00:40:37.000
00:40:37.200
00:40:37.400

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STIM
I 1
II 2
III 3
aVR 4
aVL 5
aVF 6
V1 7
V2 8
V3 9
V4 10
V5 11
V6 12
HIS 19
5:22.200
01:05:22.500
01:05:22.800
01:05:23.100
01:05:23.400
01:05:23.700
01:05:24.000
01:05:24.300
01:05:24.600
01:05:24.900
01:05:25.200
01:05:25.500
01:05:25.800
01:05:26.100


STIM
I 1
II 2
III 3
aVR 4
aVL 5
aVF 6
V1 7
V2 8
V3 9
V4 10
V5 11
V6 12
HIS 19
00:46:24.900
00:46:25.200
00:46:25.500
00:46:25.800
00:46:26.100
00:46:26.400
00:46:32.400
00:46:32.700
00:46:33.000
00:46:33.300
00:46:33.600
00:46:33.900

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Received: 6 January 2023 | Revised: 26 May 2023 | Accepted: 24 June 2023
DOI: 10.1111/pace.14777

PACE

ORIGINAL ARTICLE

Left bundle branch area pacing (LBBAP) Auto Threshold algorithms Evaluation for Conduction System Pacing: The LATECS pilot Trial

Chiara Ghiglieno MD[1,2] | Gabriele Dell'Era MD[1] | Alessandro Veroli MD[1,2] | Federica De Vecchi MD[1] | Matteo Santagostino MD[1] | Stefano Porcellini MD[1] | Giuseppe Patti MD[1,2]

Methods: Consecutive patients receiving ATM-capable CIED and LBBAP in our hospital were enrolled in this prospective, observational trial; they were evaluated 3 months after implant, comparing pacing thresholds manually assessed and obtained via ATM. Subsequent remote follow-up was carried on when available.

Results: Forty-five patients were enrolled. ATM for LBBAP lead provided consistent results in all the patients and was therefore activated; mean value of manually obtained LBBAP capture threshold was 0.66 ± 0.19 V versus ATM of 0.64 ± 0.19 V. TOST analysis showed equivalence of the two measures ($p = .66$). At subsequent follow-up (mean follow up 7.7 ± 3.2 months), ATM was effective in assessing pacing thresholds and no clinical adverse event was observed.

Conclusions: ATM algorithms proved equivalent to manual testing in determining capture threshold and were reliably employed in patients receiving LBBAP CIED.

ESC European Society of Cardiology
Europace (2024) 26, 1–5 https://doi.org/10.1093/europace/euad359

RESEARCH LETTER

Autothreshold algorithm feasibility and safety in left bundle branch pacing

Elena Sola-García [1,2]*, Manuel Molina-Lerma [2,3], Juan Jiménez-Jáimez [2,3], Rosa Macías-Ruiz [2,3], Pablo J. Sánchez-Millán [2,3], Luis Tercedor [2,3], and Miguel Álvarez [2,3]

Methods and results A prospective, non-randomized, single-centre comparative study was conducted. Consecutive patients with indication for cardiac pacing were enrolled. Implants were performed in the left bundle branch area or the right ventricle endocardium at the discretion of the operator. Left bundle branch pacing was determined according to published criteria. Autothreshold algorithm was activated in both groups whenever allowed by the device. Seventy-five patients were included, with 50 undergoing LBBP and 25 receiving conventional pacing. Activation of the autothreshold algorithm was more feasible in later phases, showing a favourable trend towards bipolar pacing. Failures in algorithm activation were primarily due to insufficient safety margins (82.8% in LBBP and 90% in conventional pacing). The remainder was attributed to atrial tachyarrhythmias (10.3% and 10%, respectively) and electrical noise (the remaining 6.9% in the LBBP group). In the LBBP group, there were not statistically significant differences between manual and automatic thresholds, and both remained stable during follow-up (mean increase of 0.50 V).

Conclusion The autothreshold algorithm is feasible in LBBP, with a favourable trend towards bipolar pacing. Automatic thresholds are similar to manual in patients with LBBP, and they remain stable during follow-up.

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- **Sensing** configuration: bipolar
- Automatic **sensitivity**: generally Ok
- **AV intervals**: mechanics and BBB correction

Troubleshooting Programming of Conduction System Pacing

Elise Bakelants and Haran Burri

Department of Cardiology, University Hospital of Geneva, Geneva, Switzerland

For an **LBBAP** lead connected to the RV port, one can program the AV delay as usual, as the delay between the left bundle branch potential and QRS onset is **negligible** (<20 ms). Direct LBB capture may even not be present in a substantial proportion of these patients.

AV delay	HBP lead in ventricular port: Subtract HV interval (e.g. 40 ms) from desired AV interval	LBBAP lead in ventricular port: Subtract LBB-V interval (e.g. 20 ms) from desired AV interval

Arrhythmia & Electrophysiology Review 2021;10(2):85–90.

DOI: 10.1111/jce.15927

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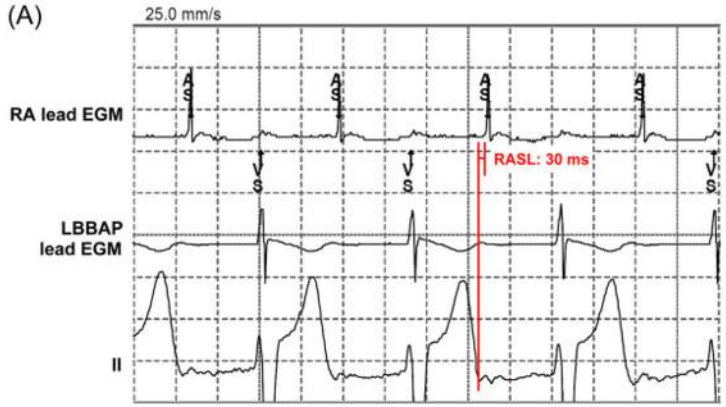
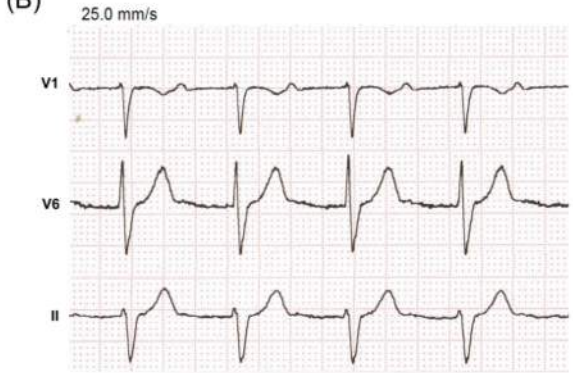
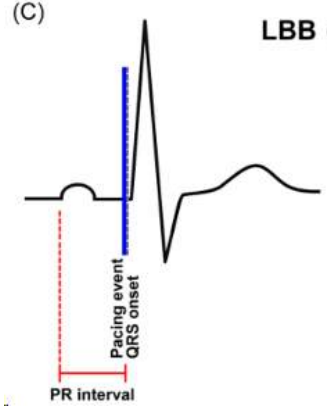
In **LBBAP** patients:

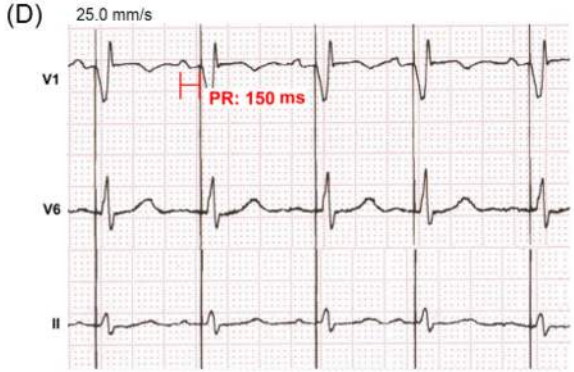
EP-guided sAV delay (ms) = 150 - RA sensing latency







EP-guided sAVD = 150 - RASL (30 ms) = 120 ms



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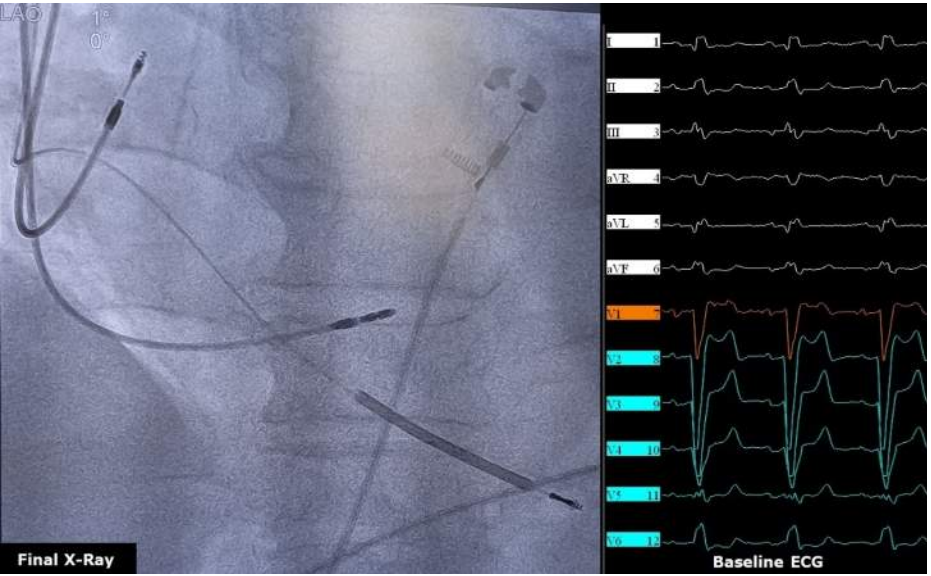
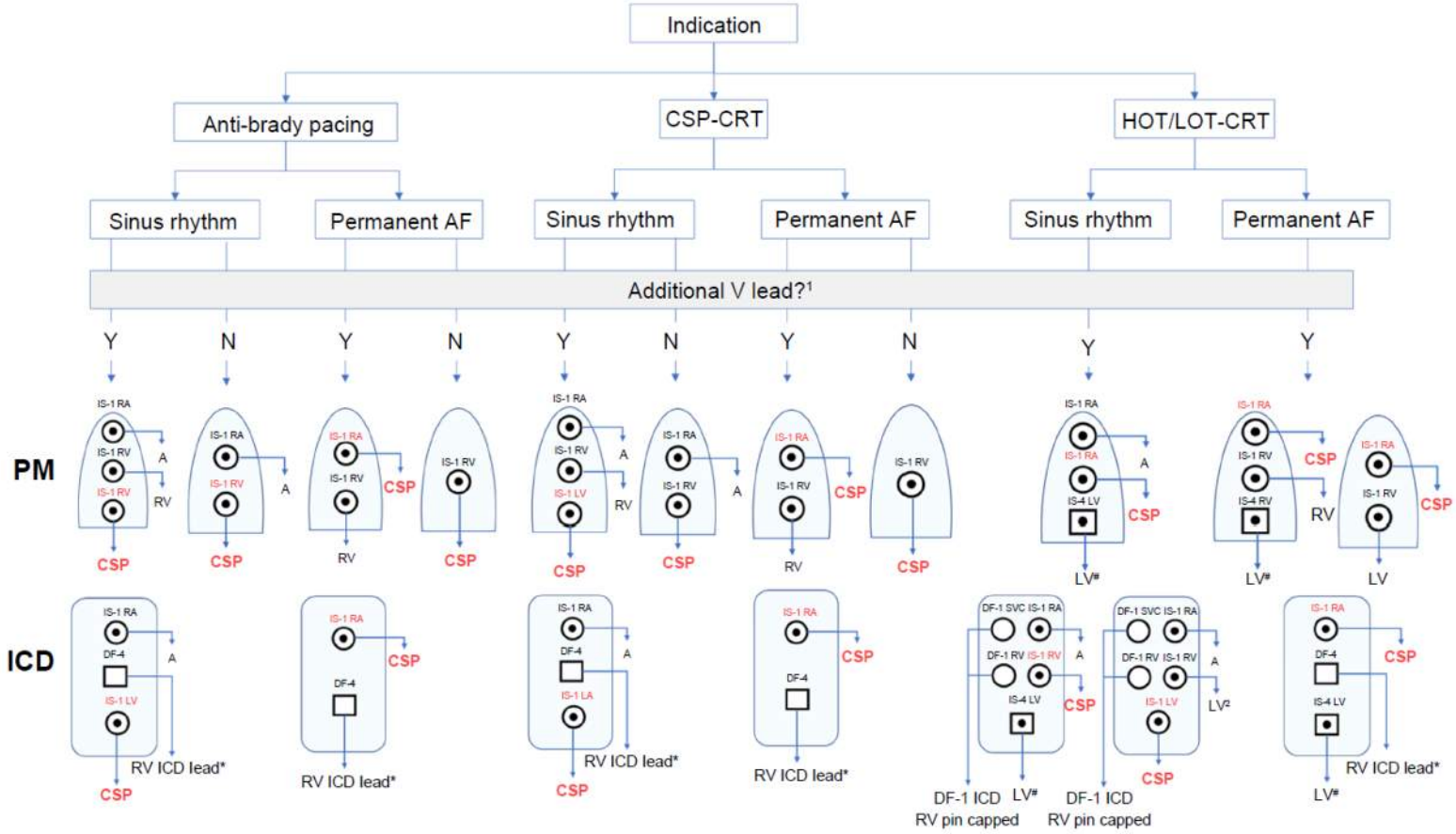
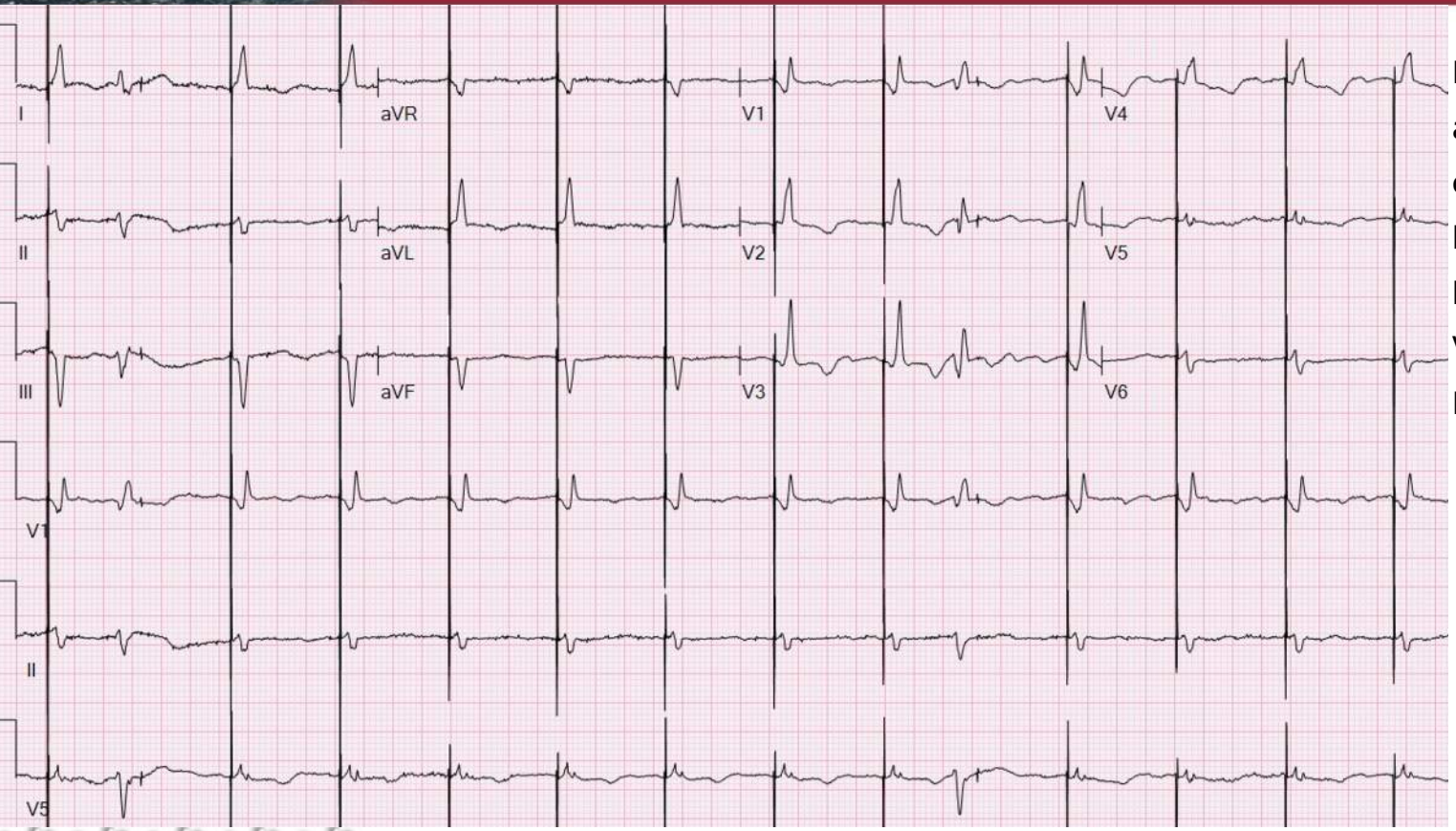

Final X-Ray
Baseline ECG


STIM
I 1
II 2
III 3
aVR 4
aVL 5
aVF 6
V1 7
V2 8
V3 9
V4 10
V5 11
V6 12
sAV delay = 70
sAV delay = 80
sAV delay = 90
Unipolar LBBAP – different sAV delays (ms)


Indication
Anti-brady pacing
CSP-CRT
HOT/LOT-CRT
Sinus rhythm
Permanent AF
Sinus rhythm
Permanent AF
Sinus rhythm
Permanent AF
Additional V lead?[1]
Y
N
Y
N
Y
N
Y
N
Y
Y
PM
ICD
IS-1 RA
IS-1 RV
IS-1 LV
DF-4
IS-1 LA
IS-4 LV
DF-1 SVC
DF-1 RV
A
RV
CSP
LV#
LV
LV²
RV ICD lead*
DF-1 ICD
RV pin capped



Permanent AF. Pace and ablate; dual chamber PM; LBBAP lead in the A port and backup RV lead in the V port. Programming: DDDR.

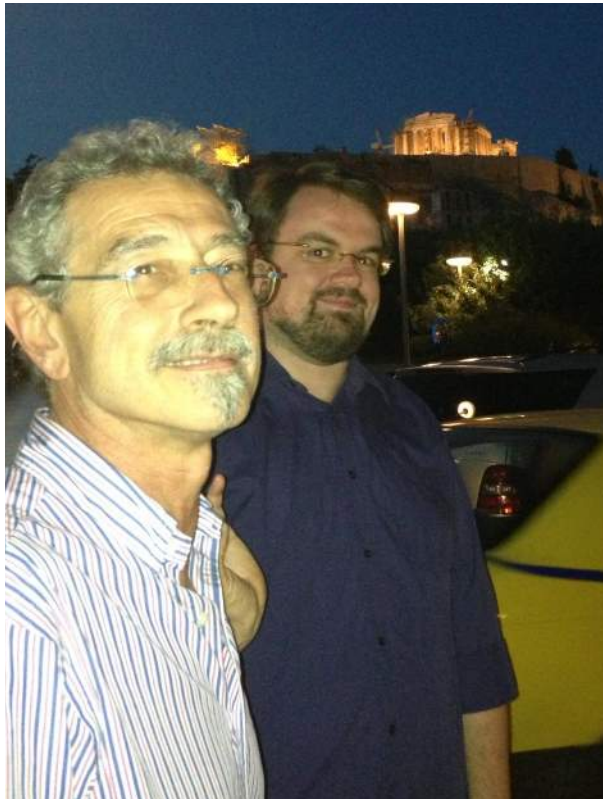
In conclusion, some key points...

- **Effective** conduction system pacing not only depends on successful device **implantation** but also on proper device **programming**.
- Current impulse **generators** are not specifically **designed** for CSP.
- Different pacing system **configurations** are used depending on the underlying heart **rhythm** (sinus rhythm or permanent atrial arrhythmia) and the **aim** of pacing.
- Depending on the device configuration, different **programming issues** may arise.

- A **tailored** device **programming** should take into account the pathophysiology of conduction system, the individual pacing outcome and patient needs, the device features and programmable parameters.

Ezio Soldati

*** 6/7/1957 + 9/4/2024**



EHRA Congress, Atene, Giugno 2013

Grazie!