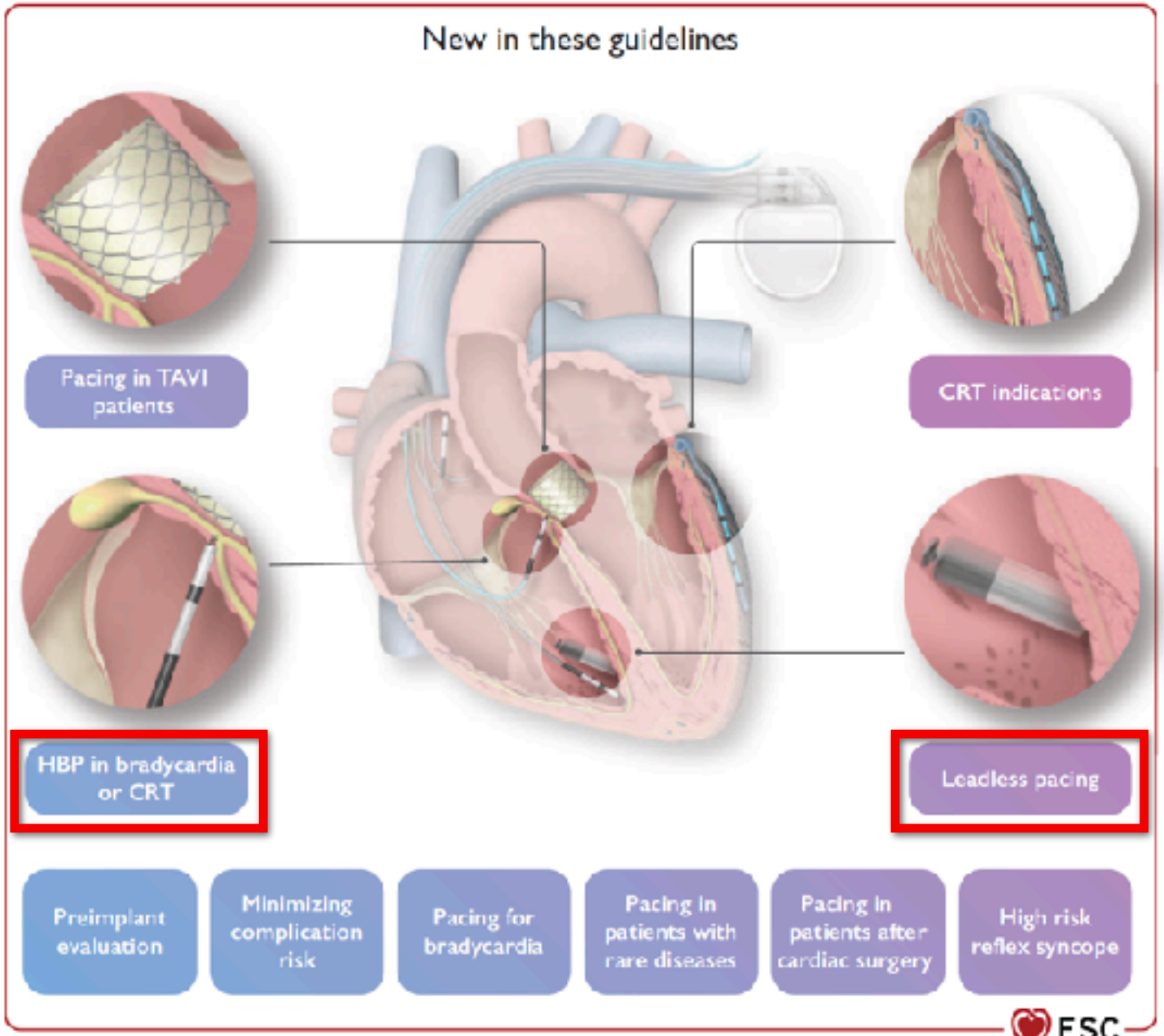
Nouveautés en stimulation

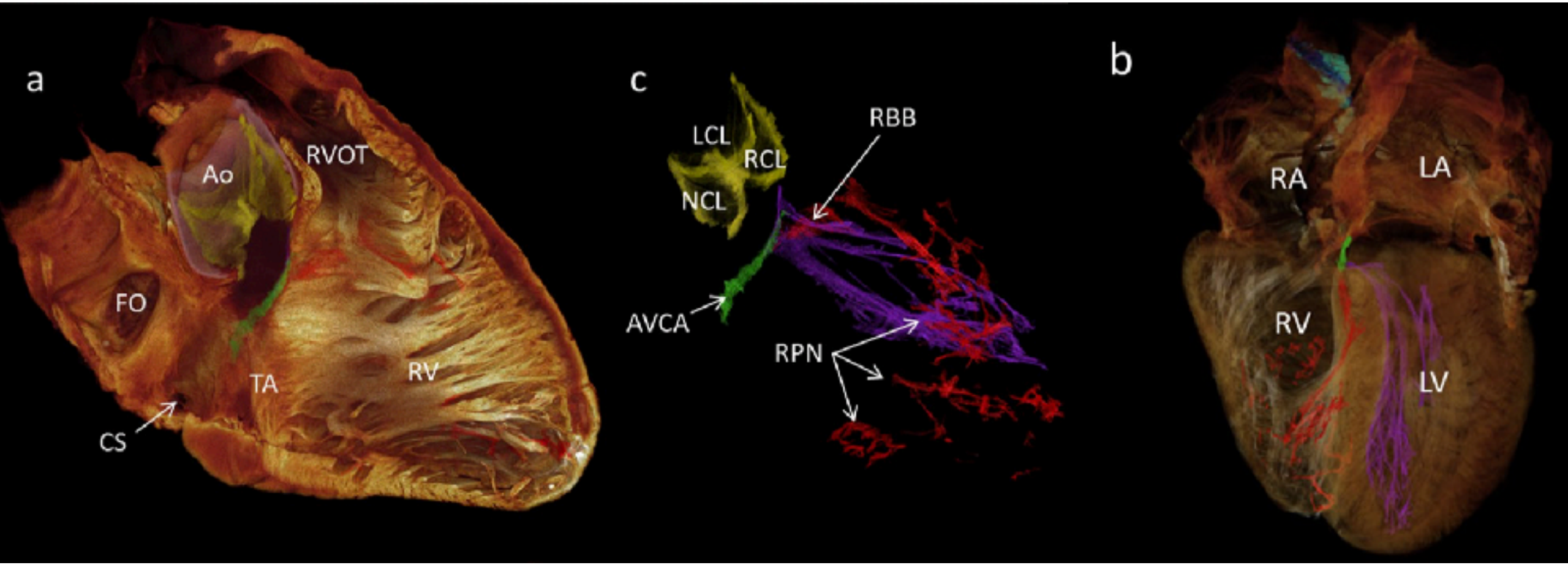
MARCHAND HUGO

03/01/2022


New in these guidelines
Pacing in TAVI patients
CRT indications
HBP in bradycardia or CRT
Leadless pacing
Preimplant evaluation
Minimizing complication risk
Pacing for bradycardia
Pacing in patients with rare diseases
Pacing in patients after cardiac surgery
High risk reflex syncope
ESC

Stimulation hissienne (HBP)

Cible



Modified from Stephenson RS, Atkinson A, Kottas P, et al. High resolution 3-Dimensional imaging of the human cardiac conduction system from microanatomy to mathematical modeling. Sci Rep. 2017;7(1):7188. Published 2017 Aug 3.

Historique

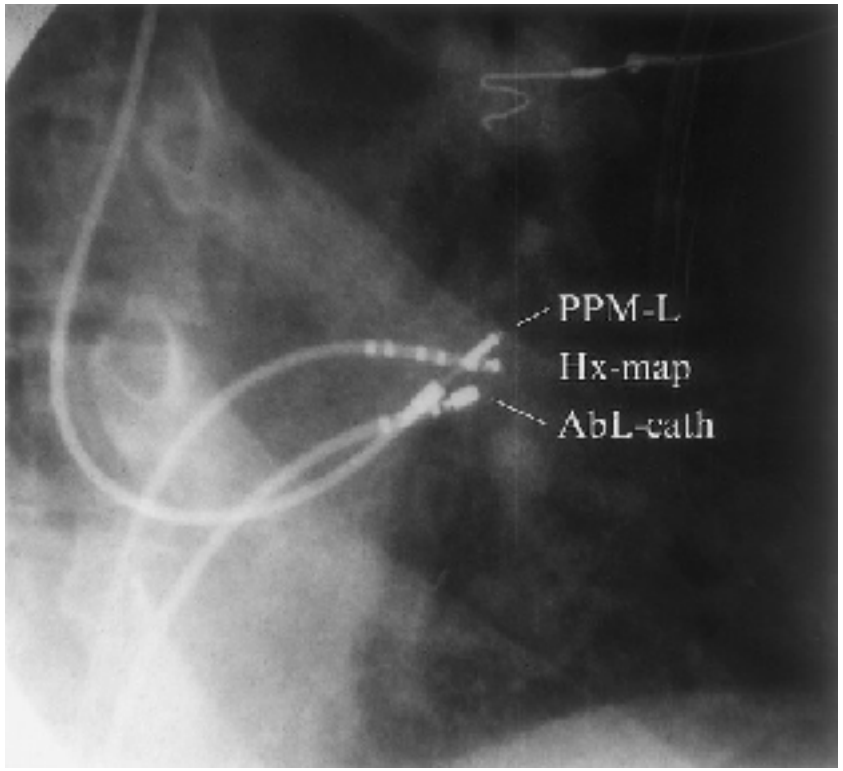
Stimulation temporaire du His décrite dès 1967[1]

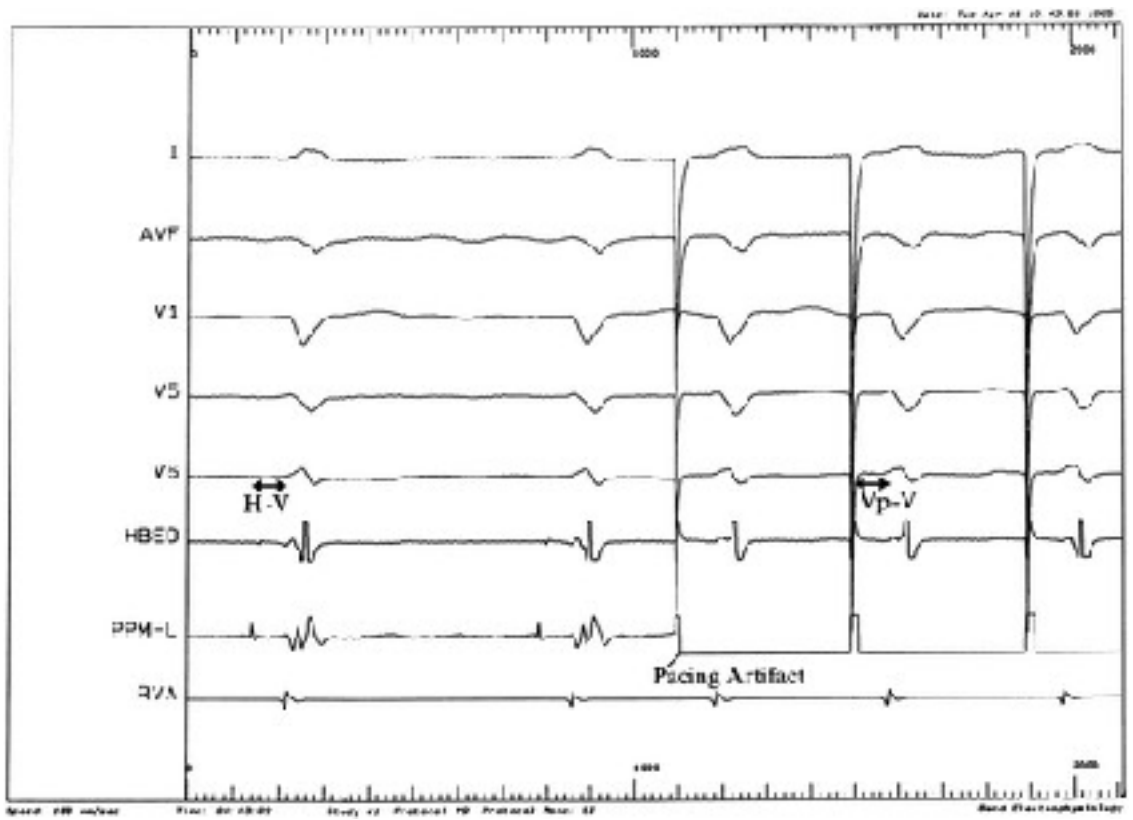
- Abord épicardique sur des chiens en cours de chirurgie cardiaque
- Puis chez l'humain avec cathéters endovasculaires

1. Scherlag BJ, Kosowsky BD, Damato AN: A technique for ventricular pacing from the His bundle of the intact heart. J Appl Physiol 1967;22:584-587.

Stimulation permanente en 2000 (1)

- 18 patients, 14 succès mais 2 déplacements
- Sonde à vis fixe avec mandrin préformé en J





1.Deshmukh P, Casavant DA, RomanyshynM, Anderson K: Permanent, direct His-bundle pacing: A novel approach to cardiac pacing in patients with normal His-Purkinje activation. Circulation 2000;101:869-877.

Alternative à la stimulation VD ?

Stimulation ventriculaire droite délétère

- Augmentation de l'incidence de FA
- Désynchronisation et remodelage VG, altération de la FEVG
- Réhospitalisation, mortalité

Position de sonde VD apicale ou septale, sans différence

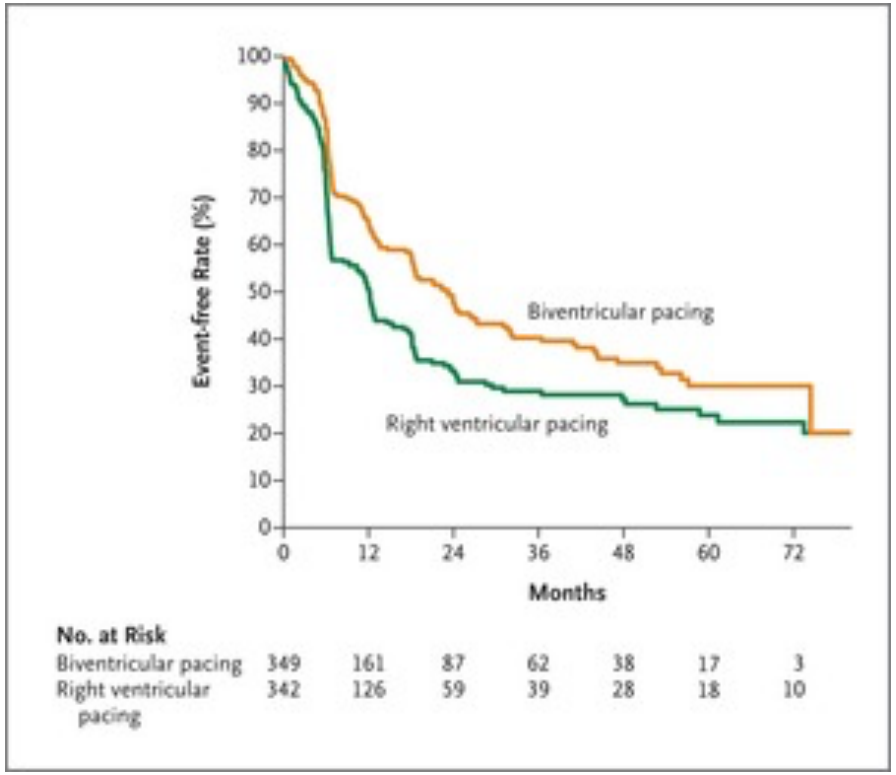
Table 2 Summary of studies comparing right ventricular apical pacing and right ventricular outflow tract septal pacing in patient populations requiring cardiac resynchronization therapy.

Study	Patients (*n*)	Follow-up (months)	Effect	Criteria
Thébault et al., 2012 [46]	346	12.6	NS	Heart failure; mortality; echo data
Rönn et al., 2011 [47]	33 AF	6	NS	Heart failure; echo data
Kristiansen et al., 2012 [45]	85	6	NS	Heart failure; echo data
Khan et al., 2011 [44]	131	6	NS	Heart failure; echo data
All four studies	595	8	NS	Heart failure; echo data

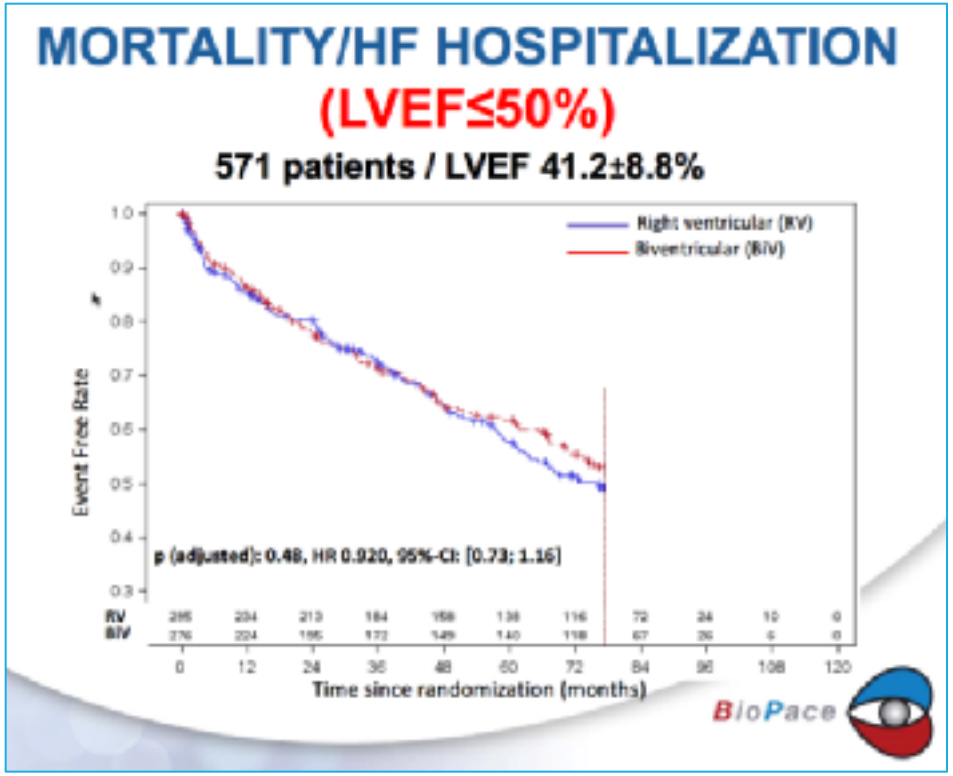
AF: atrial fibrillation; NS: not significant.

FE modérément altérée et stimulation permanente

BLOCK-HF



BIOPACE



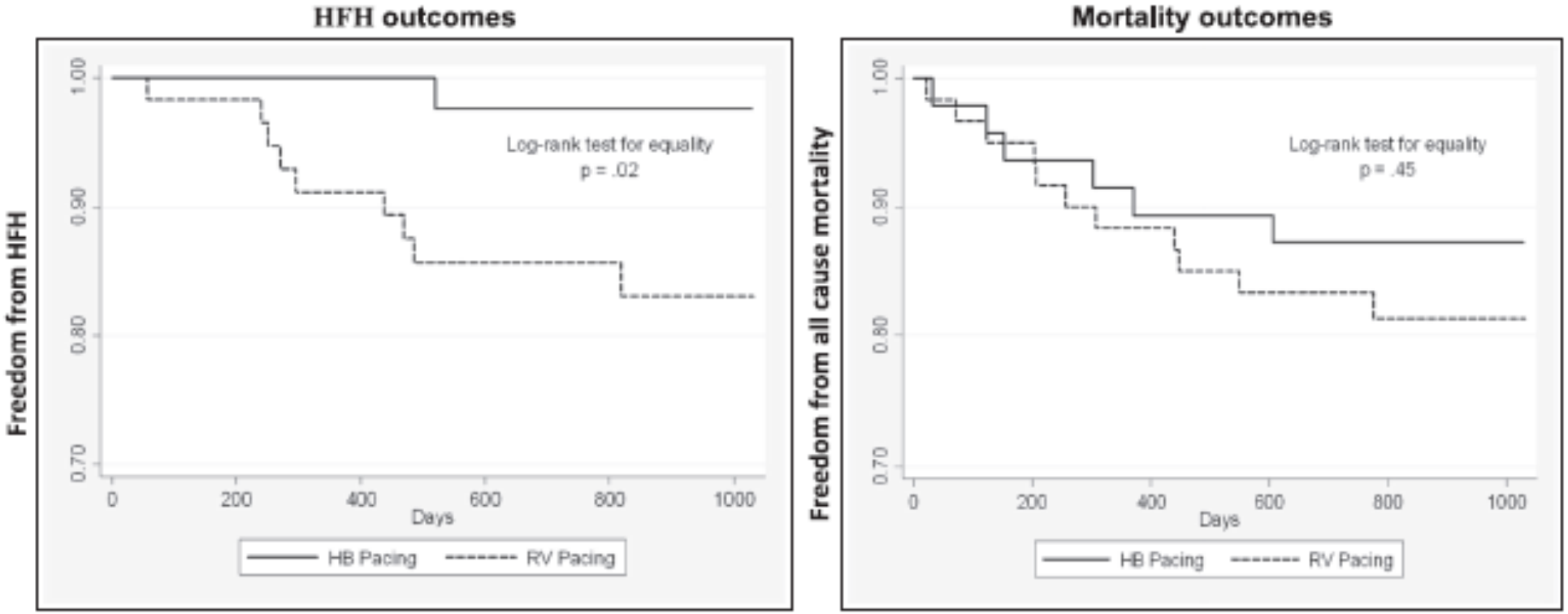


Figure 5 Kaplan-Meier survival curves depicting heart failure hospitalization (HFH) and all-cause mortality outcome differences in patients with >40% ventricular pacing, comparing His-bundle (HB) pacing with right ventricular (RV) pacing.

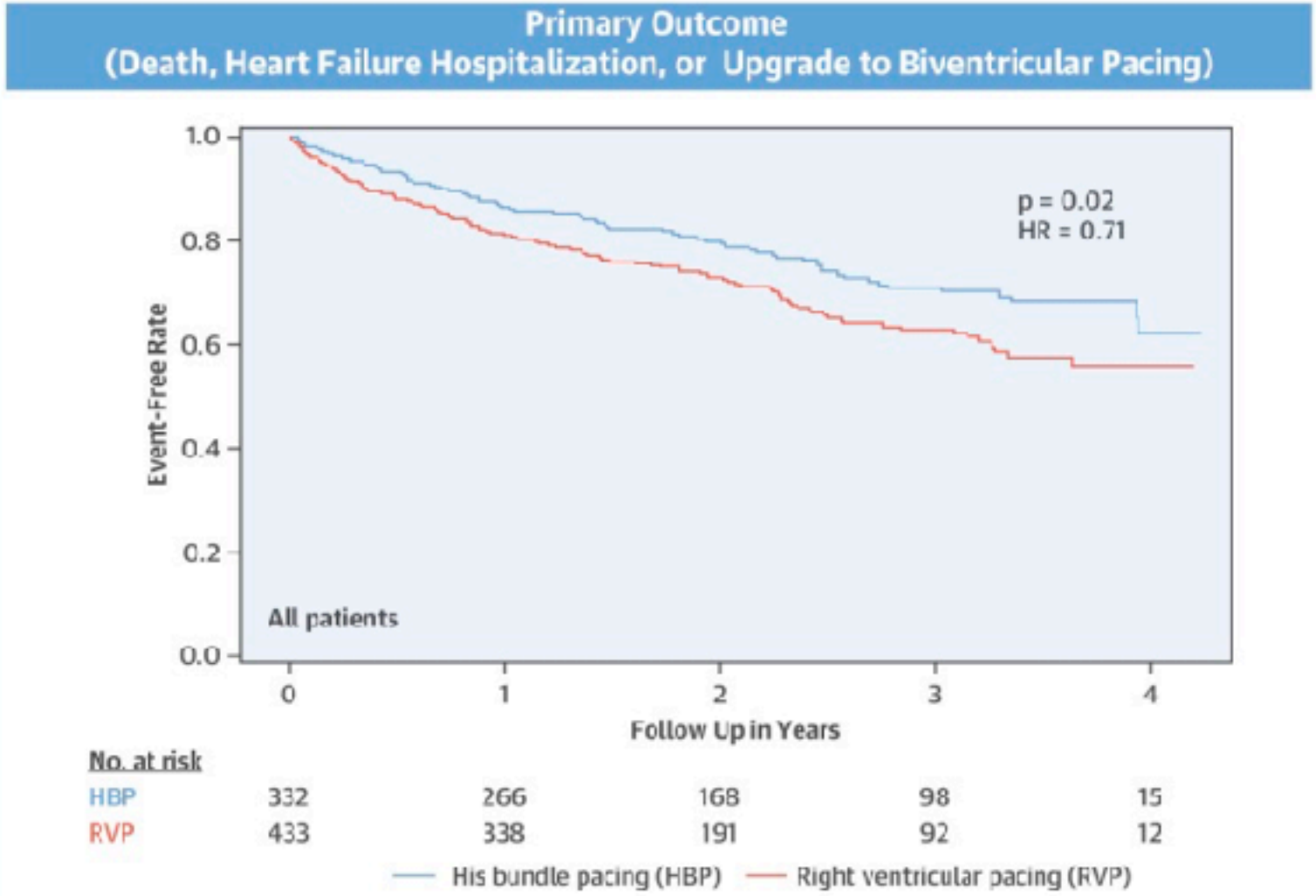
192 patients, HBP vs RVP

Sharma PS, Ellenbogen KA,Vijayaraman P: Permanent His-bundle pacing is feasible, safe, and superior to right ventricular pacing in routine clinical practice. Heart Rhythm 2015;

Clinical Outcomes of His Bundle Pacing Compared to Right Ventricular Pacing.

- 332 HBP (92% succès)
- 443 RVP
- 725 ± 423 days

CENTRAL ILLUSTRATION: His Bundle Pacing and Outcomes: Kaplan-Meier Survival Curves and Analysis of the Primary Endpoint in All Patients

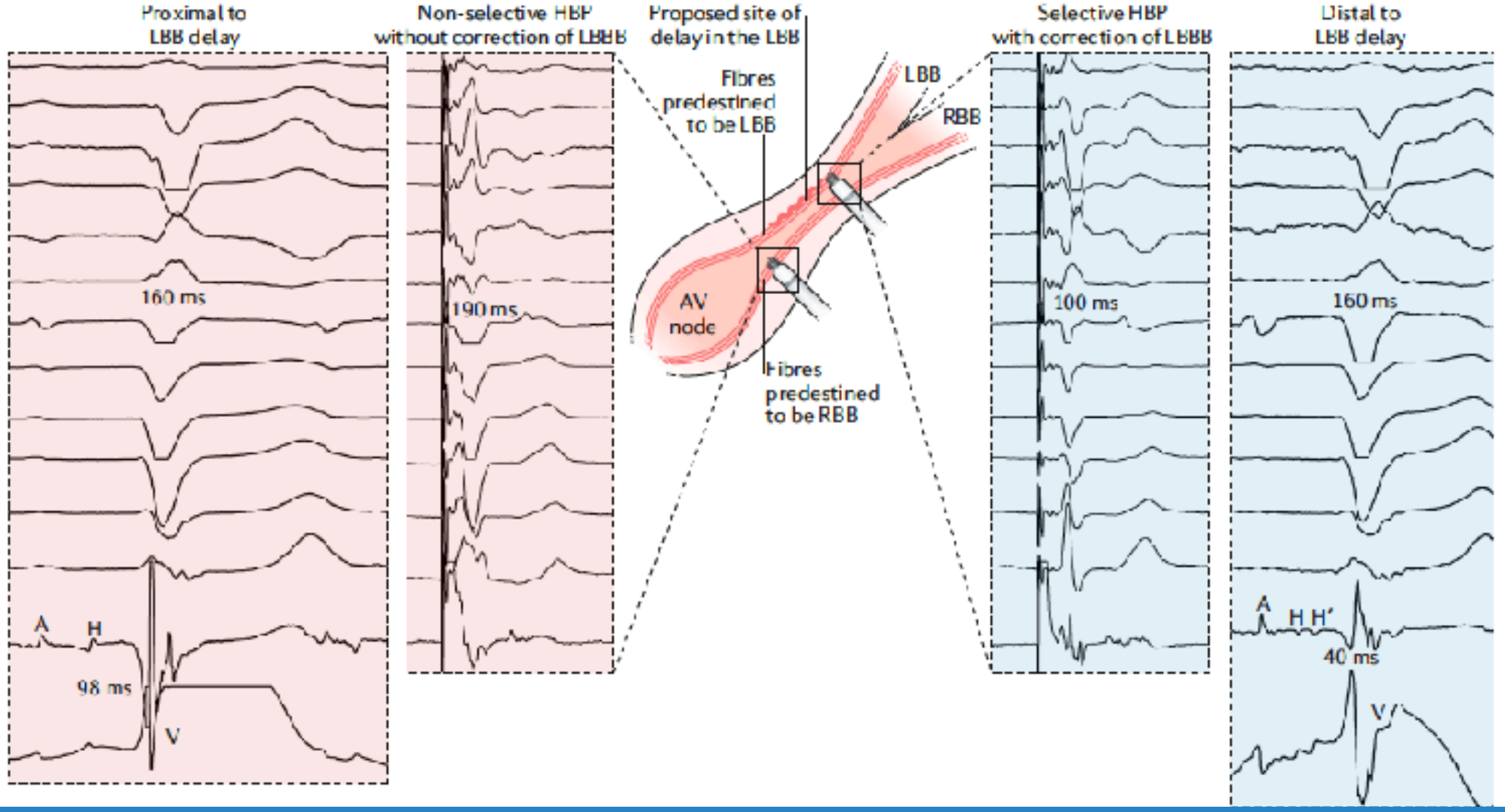


Abdelrahman, M. et al. J Am Coll Cardiol. 2018;71(20):2319-30.

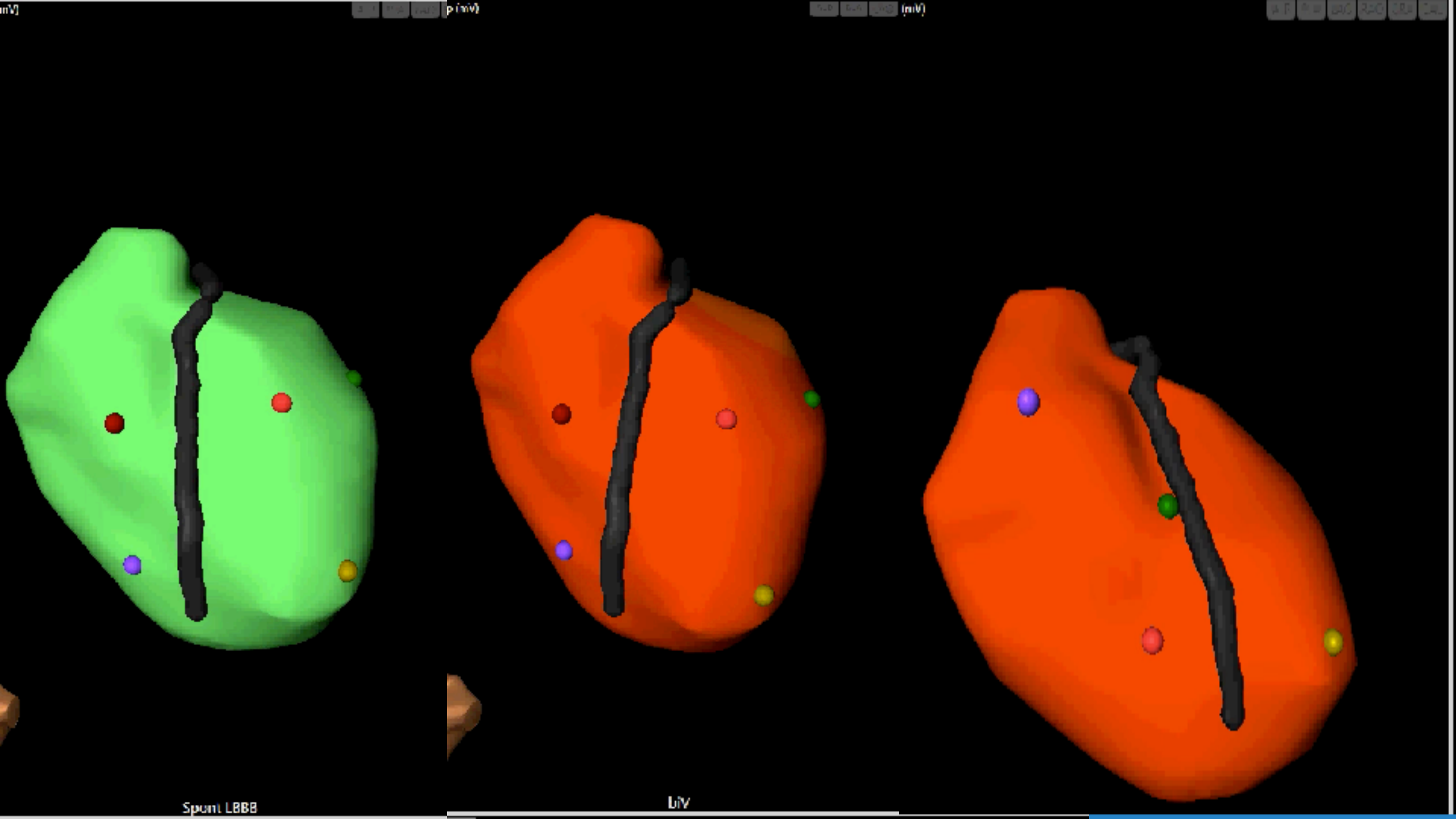
Alternative à la CRT ?

Intérêt si **FEVG altérée et BBG complet**

- Pas toujours techniquement faisable
- Taux de non répondeurs élevé (30%)
- Pas de bénéfice retrouvé pour non-BBG (BBD, blocs aspécifiques,…)



Dissociation longitudinale du faisceau de His

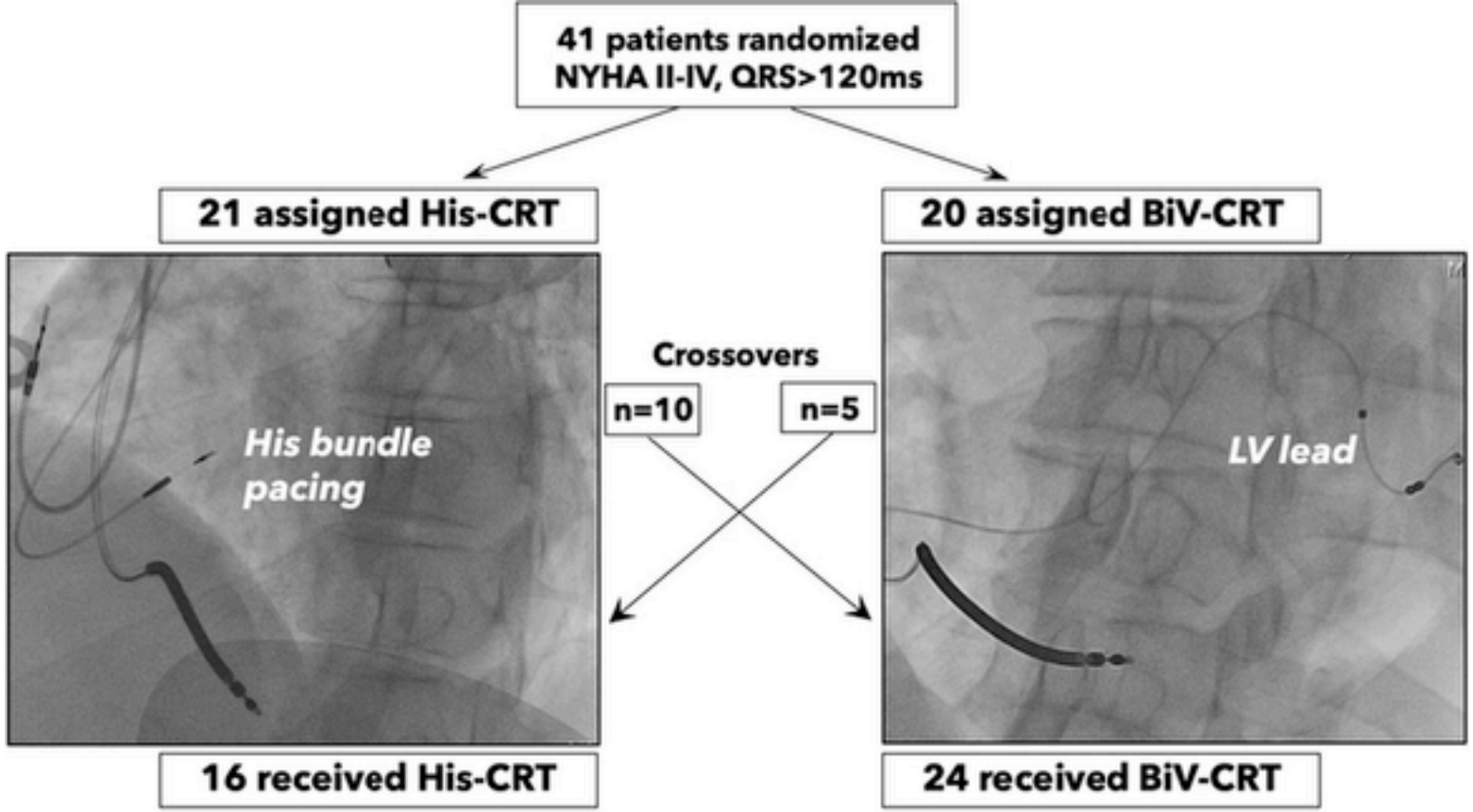

Spont LBBB
LiV

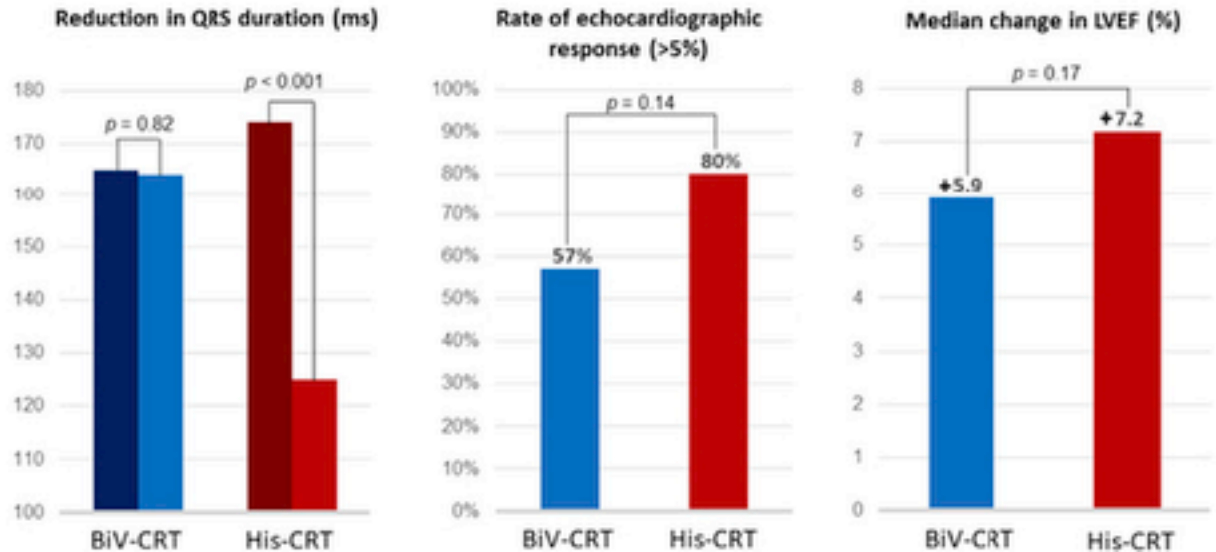
His-SYNC, 2019

HBP superior to CRT ?

10 crossovers

- 2 echecs de mapping
- 3 QRS > 130ms
- 5 IVCD





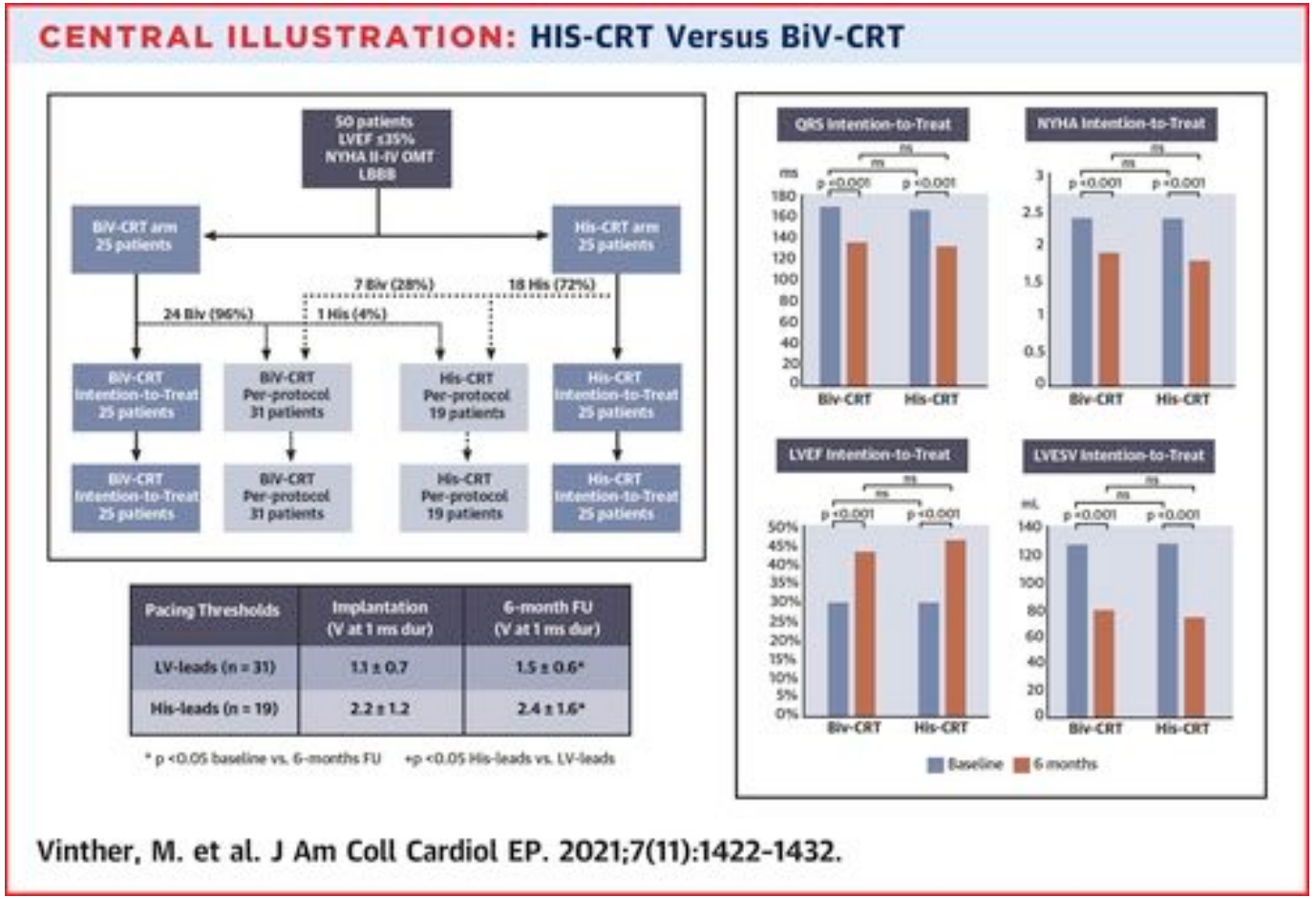
50 patients
FE < 35%
LBBB

Randomisation 1:1

7 crossover

A 6 mois en per-protocol :

- Seuils 2,4V vs 1,4V
- FE 48% vs 42%
- DTSVG 65ml vs 83ml



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

A Randomized Trial of His Pacing Versus Biventricular Pacing in Symptomatic HF Patients With Left Bundle Branch Block (His-Alternative)

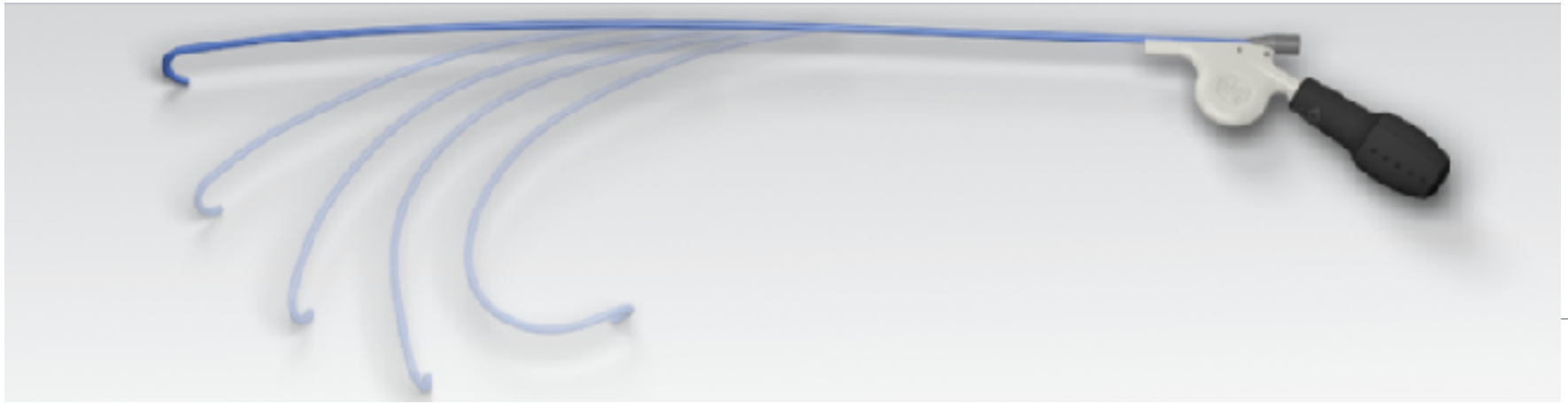
Michael Vinther , and al. J Am Coll Cardiol EP. 2021 Nov, 7 (11) 1422–1432

Indications

Recommendations	Class[a]	Level[b]
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 'backup' for pacing 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 ventricular backup lead 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
HBP may be considered as an alternative to RV pacing in patients with AVB and LVEF >40%, who are anticipated to have >20% ventricular pacing.[42,433]	IIb	C

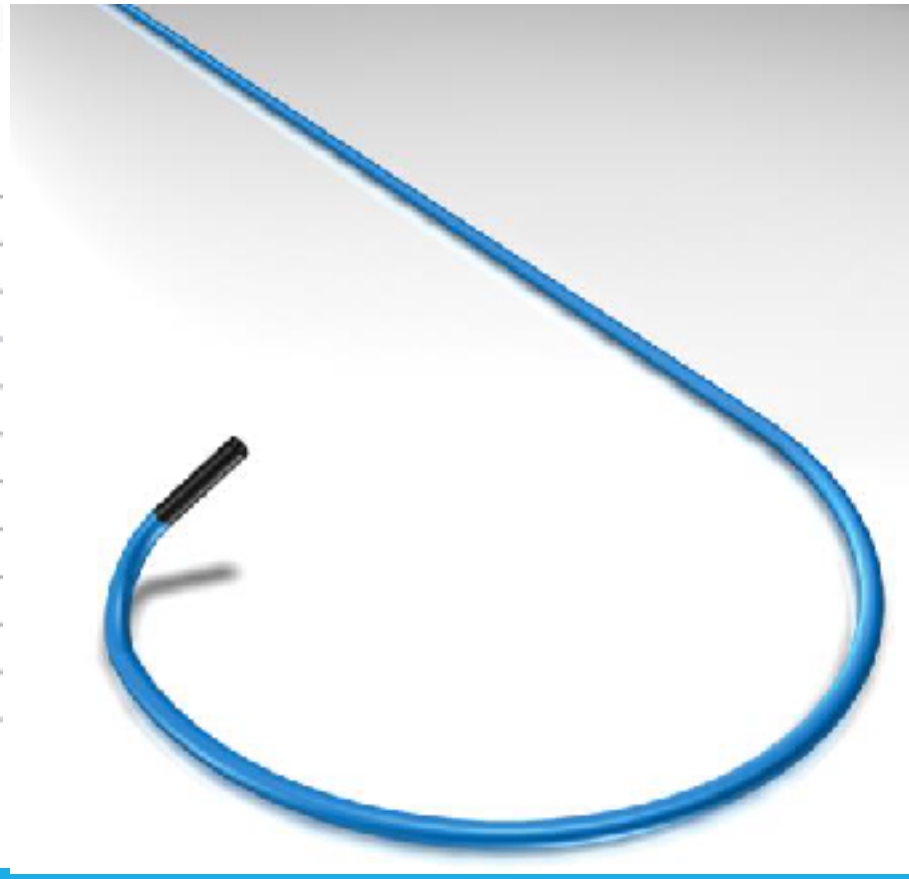
ESC Guidelines on cardiac pacing and cardiac resynchronization therapy 2021

Matériel



This new tool complements the Medtronic portfolio of delivery catheters.

Feature	C304-HIS[1]	C315HIS[2]
Primary Curve Shape	Deflectable + preshaped	Preshaped
Secondary Curve: Out-of-plane, "His" Shape Curve	Yes, preshaped	Yes, preshaped
Introducer	9 Fr	7 Fr
Usable Length	43 cm	43 cm
Inner Diameter	5.7 Fr	5.4 Fr
Outer Diameter	8.4 Fr	7.0 Fr
Integrated Valve	No	Yes
Manipulation	Articulation handle	N/A
Hydrophilic Coating	No	Yes
Shelf Life	2 years	2 years
Marker Band Material	2 gold marker bands	Tungsten Carbide
ETO Sterilization	Yes	Yes



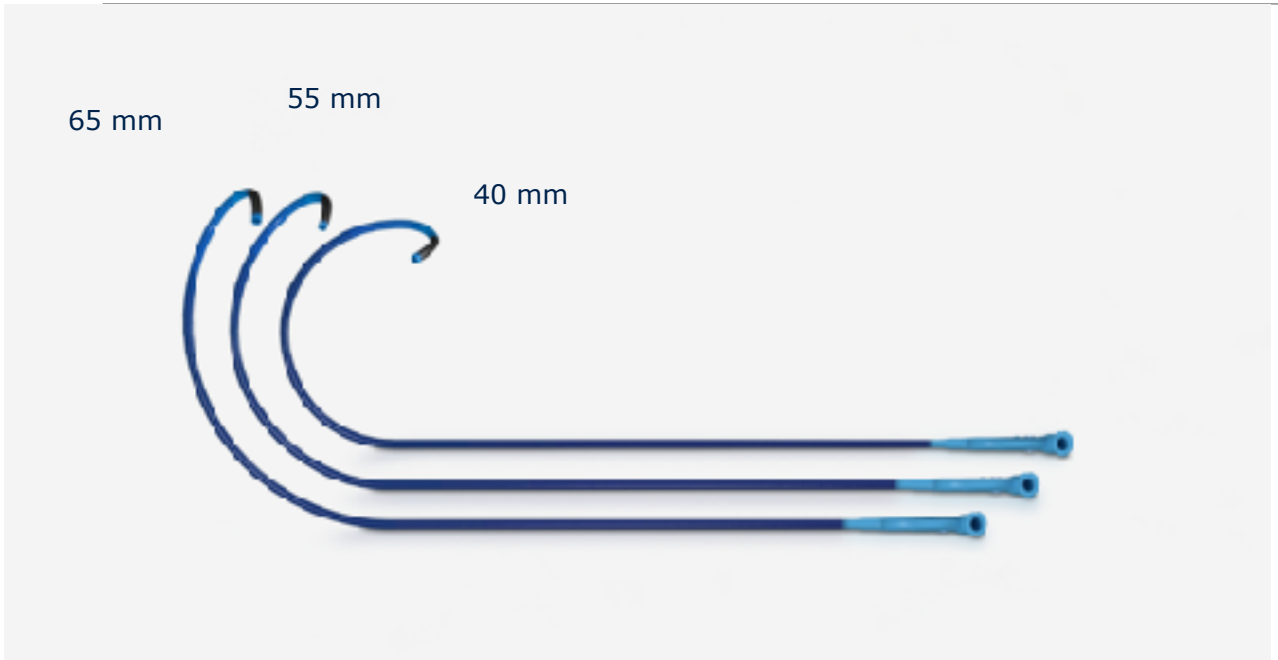
Sonde Medtronic SelectSecure 3830

4,1 Fr

Corps de sonde plein

vis exposée

Biotronik Gaine Selectra 3D

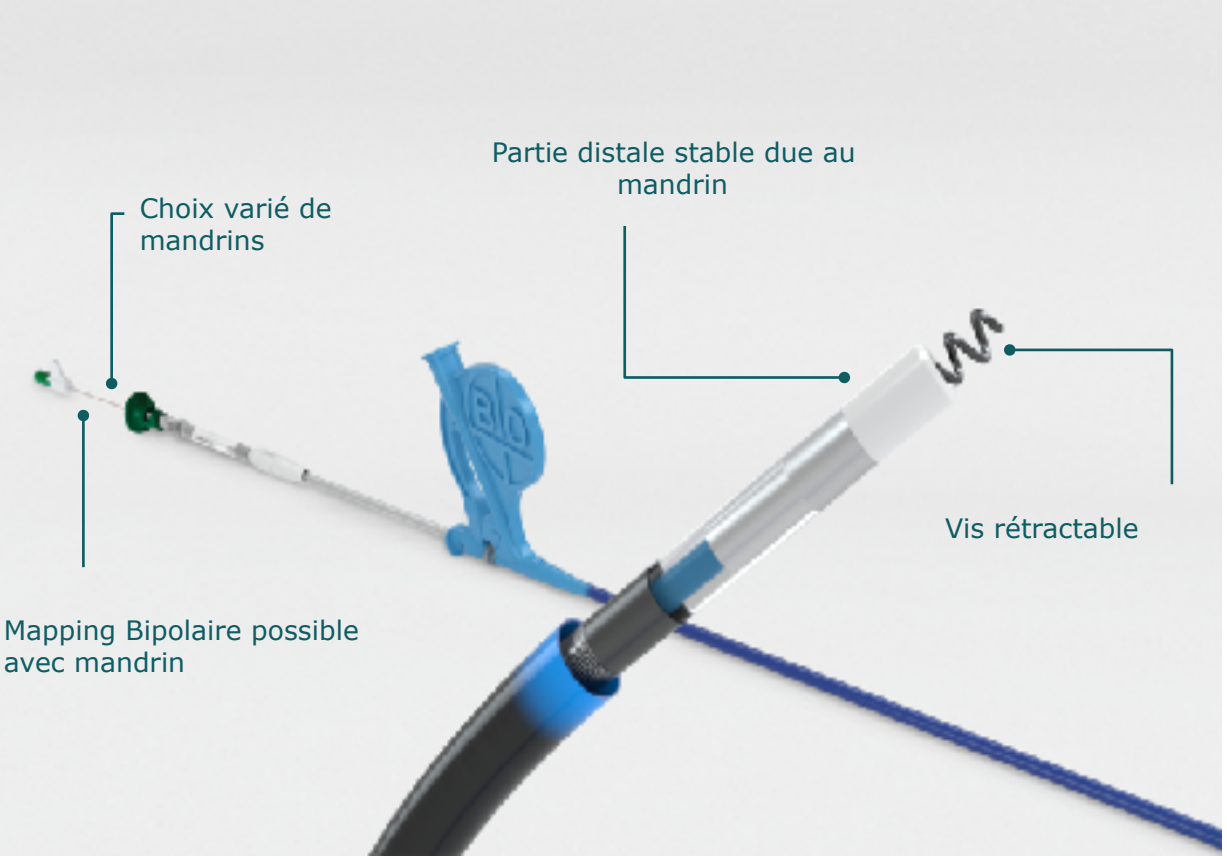


Catheter	Selectra 3D
Diamètre interne	2.4 mm (7.3 F)
Diamètre externe	2.9 mm (8.7 F)
Longueur utile	32, 39, 42 cm
Rayon proximal	40 mm 55 mm 65 mm
Rayon distal	13 mm

Catheters disponibles

Selectra 3D-40-32	Selectra 3D-55-32	Selectra 3D-65-32
Selectra 3D-40-39	Selectra 3D-55-39	Selectra 3D-65-39
Selectra 3D-40-42	Selectra 3D-55-42	Selectra 3D-65-42

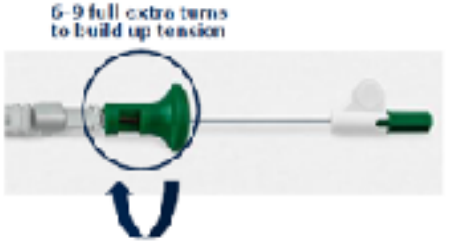
Solia S



Sonde	Solia S
Mandrinable	oui
Stéroïdes	Elution steroides Acetate Dexamethasone
Diamètre corps sonde	1.8 mm (5.6 F)
Fixation	Extensible/Vis retractable
Longueurs	53 cm, 60 cm
Longueur vis	1.8 mm
Compatibilité IRM	1.5 T et 3.0 T FBS
Polarité	Bipolaire
Espace Tip-to-Ring	10 mm
Connecteur	IS-1

Fixation

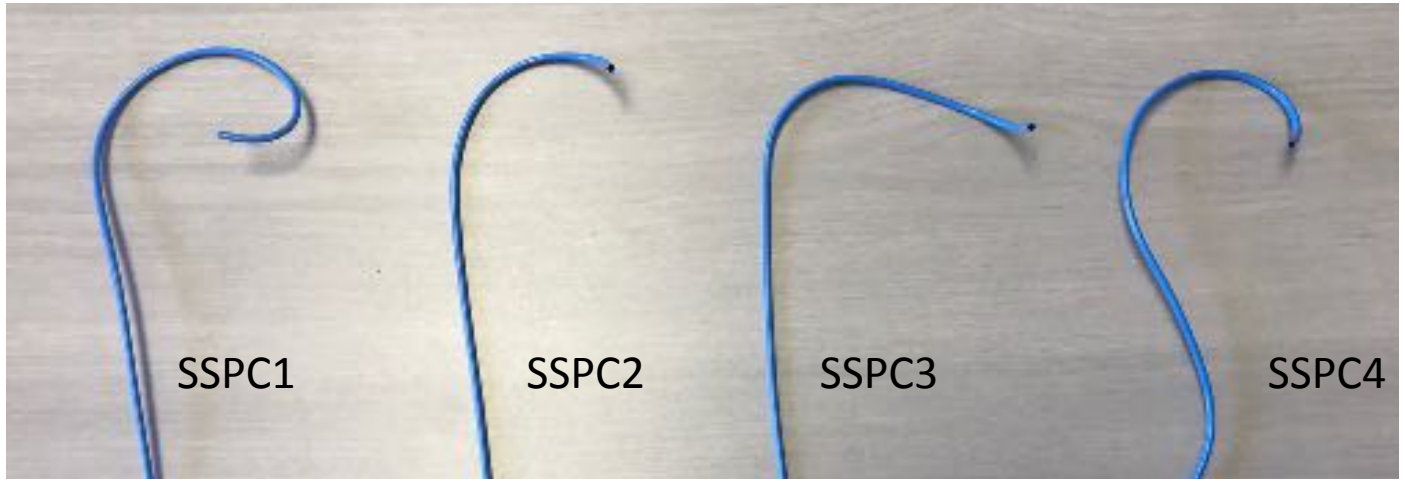
- **Mapping vis sortie** (10-15 tours)
- Bloquer le mécanisme de vissage avec l'entonnoir vert (rajouter 6 tours avec celui-ci)
- Fixer la sonde en tournant le corps de sonde 6 tours dans le sens horaire



Abbott Agilis His Pro

- Deux électrodes distales intégrées
- Double déflexion
- Diamètre externe: 10,5Fr
- Compatible Tendril STS 2088TC

Boston Site Selective Pacing Catheter



9181 (SSPC1) – **“C-shape”**
9182 (SSPC2) – **“Multipurpose”**
9183 (SSPC3) – **“Extended hook”**
9184 (SSPC4) – **“Right sided”**

	Attribute	Description
1.	Working Length	40 cm SSPC1-4
2.	Outer Diameter	8Fr
3.	Inner Diameter	6.5Fr
4.	Tip	Radiopaque
5.	Hub	Hemostatic seal Side flush port

Méthode d’implantation

Préparation pour PM standard

MAIS…

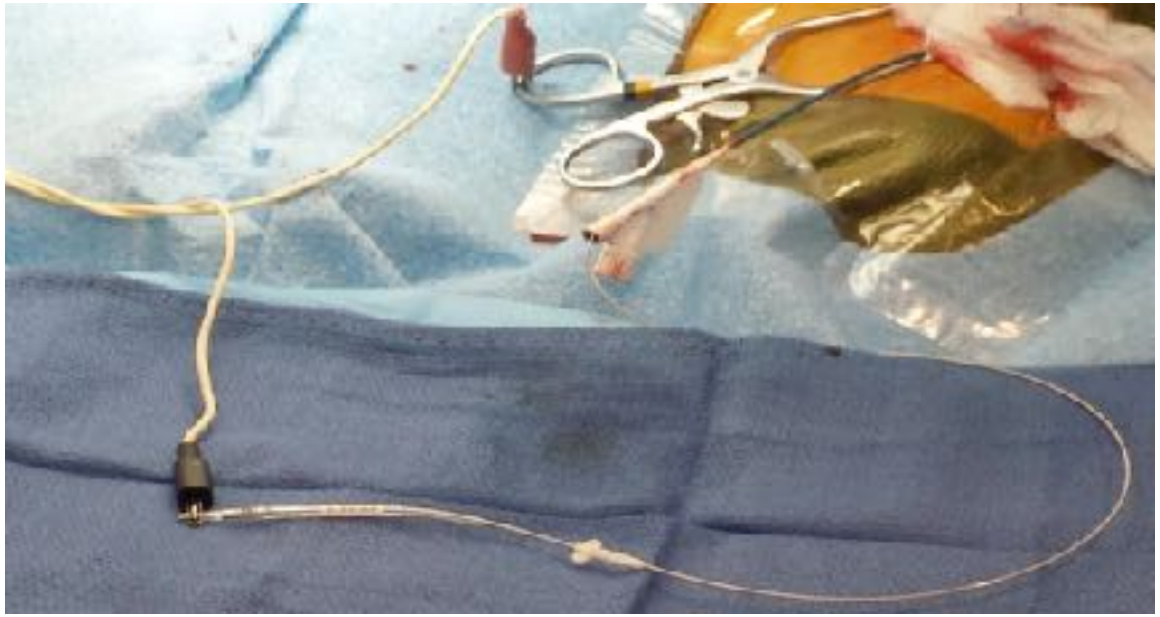
- **ECG 12 dérivations**

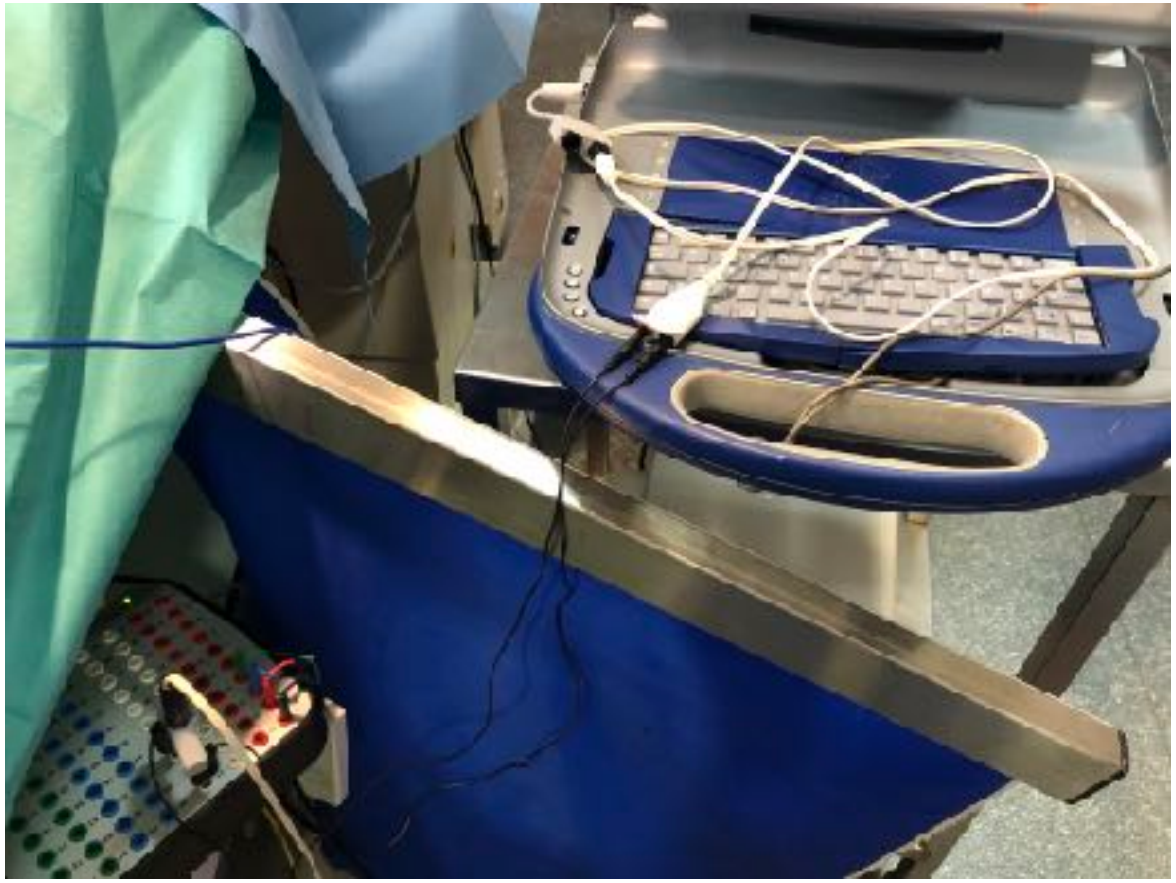
ET

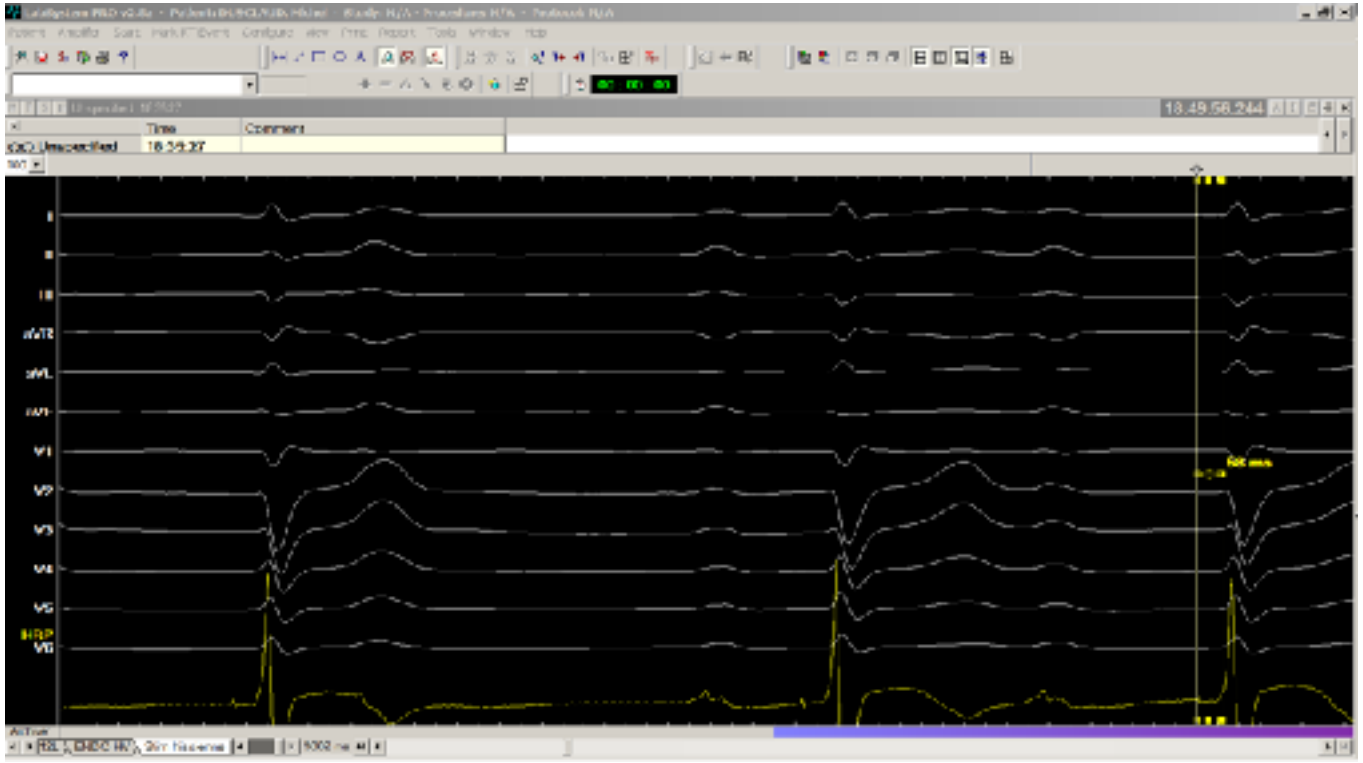
- Si BBG, **sonde d'entrainement**
  - ou sonde atriale temporairement dans le VD

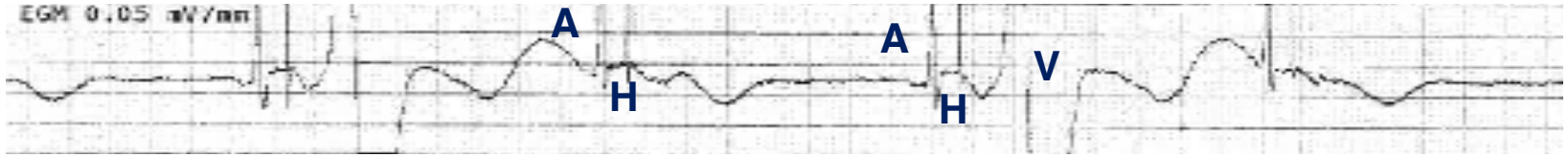
Cartographie du potentiel de His

Directement avec la sonde en unipolaire reliée à l'analyseur ou à la baie d'EP





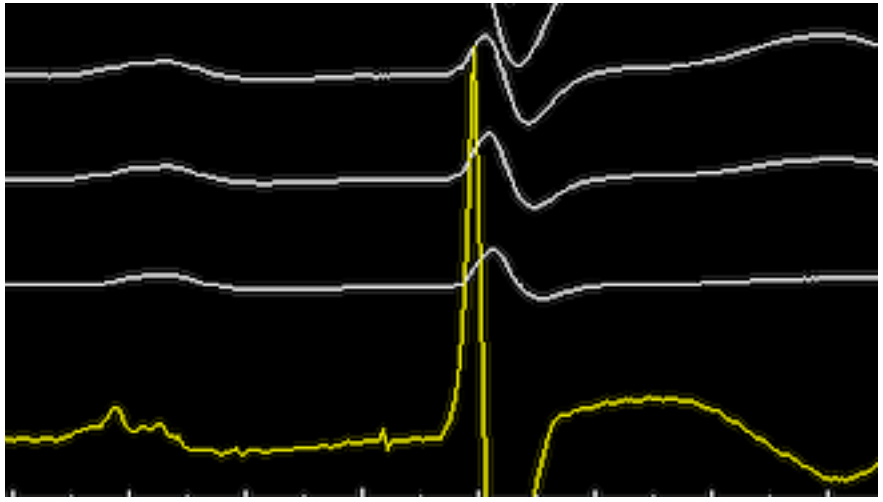


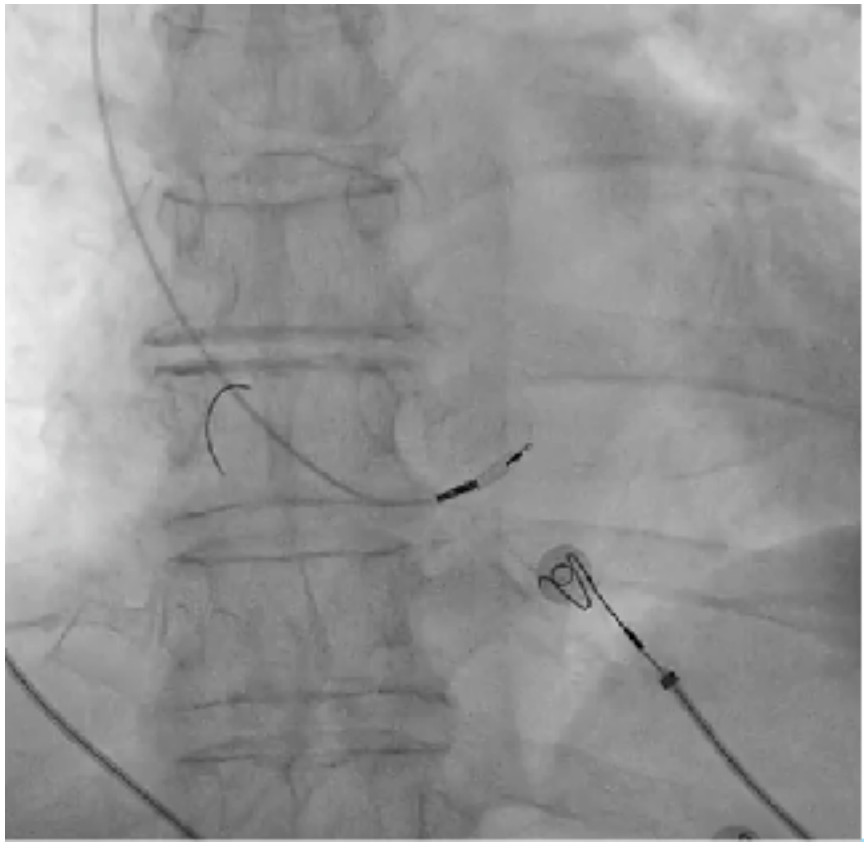


Canal Atrial
Gain 0,05mV / speed 50 mm/s

Choix du site d’implantation

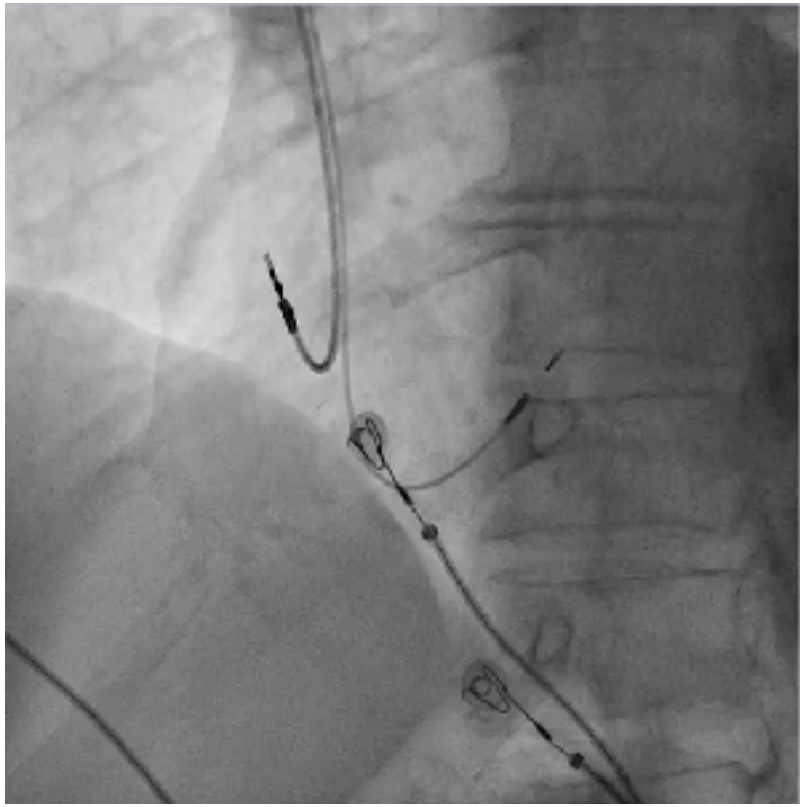
- Scopie en OAD
- Petit A, H aigu, grand V





- Fixation de la sonde par **4 à 5 tours du corps de sonde**, sans la relâcher

  Retour de 1/2 tour si bien fixée



- Tests électriques

- Peler la gaine, en laissant assez de mou.
  - **Courbe en U**

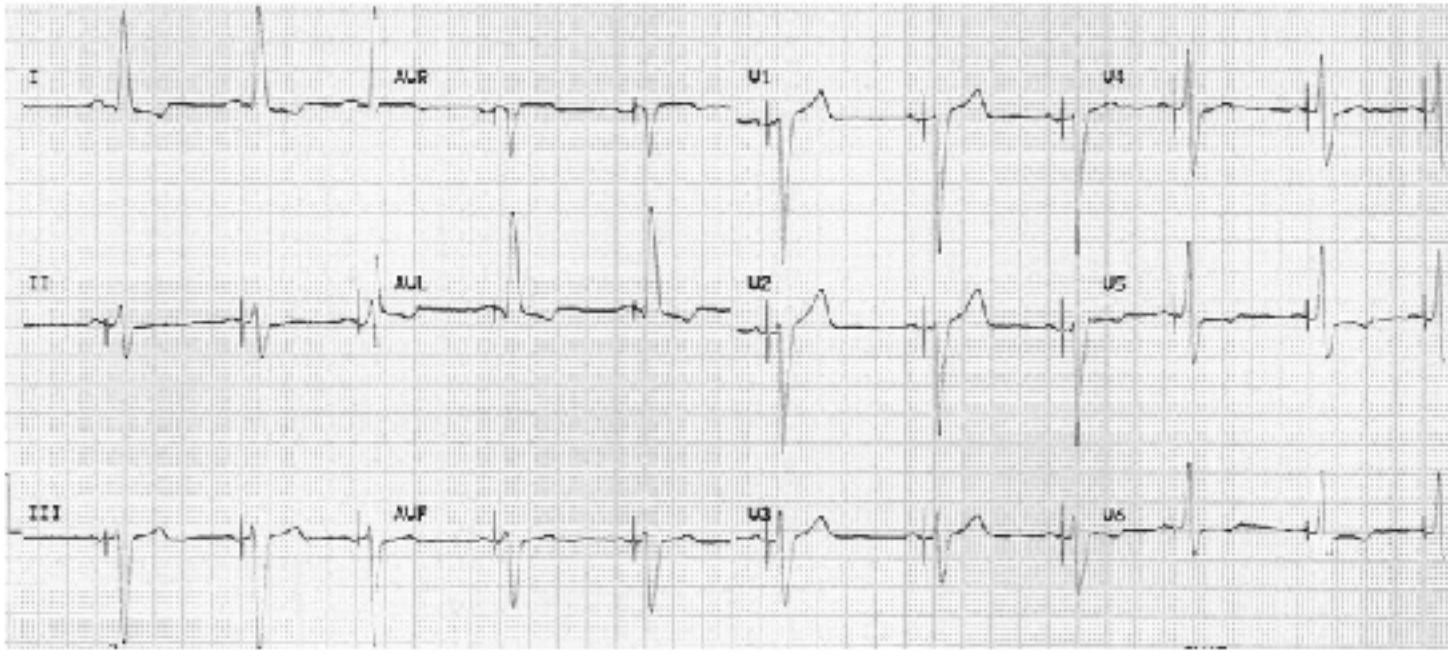
Seuil

ECG 12 Dérivation

Durée d’impulsion 1ms

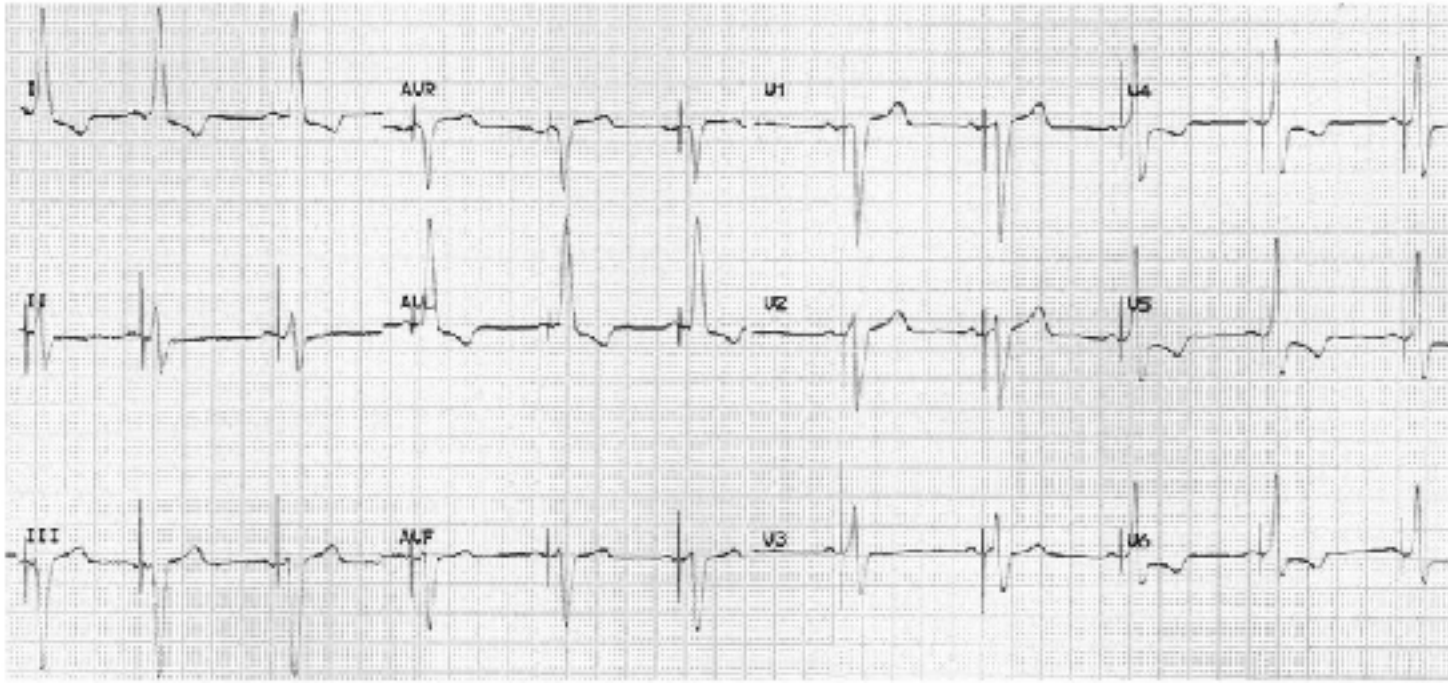
Selective capture
Activation via His-Purkinje system

Paced QRS = native QRS
Clear isoelectric interval
S-QRS = H-QRS



Non-selective capture
Activation via local myocardium
and His-Purkinje system

Paced QRS > native QRS
Pseudodelta wave
Diminished isoelectric interval
S-QRS < H-QRS

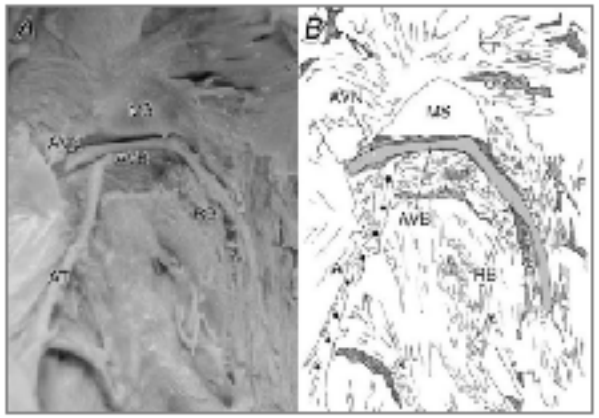


Anatomie du His

Type 1

Normal His bundle: 49 of 105 specimens (46.7%)

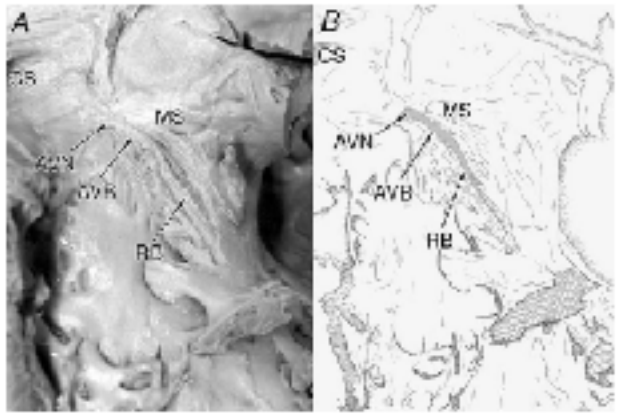
AV bundle runs along the lower border of the membranous septum and is usually covered with a thin layer of myocardial fibers from the muscular part of the septum



Type 2

Deep His bundle: 34 of 105 specimens (32.4%)

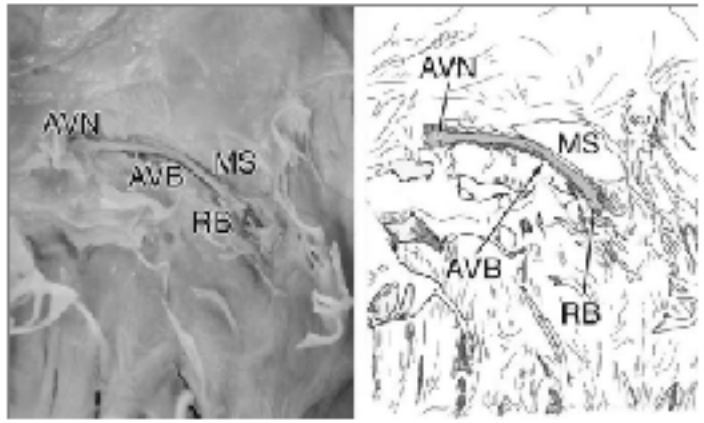
AV bundle is discretely separated from the membranous septum and runs within the interventricular muscle



Type 3

Shallow His bundle: 22 of 105 specimens (21%)

AV bundle runs immediately beneath the endocardium with no insulation from the surrounding myocardial fibers

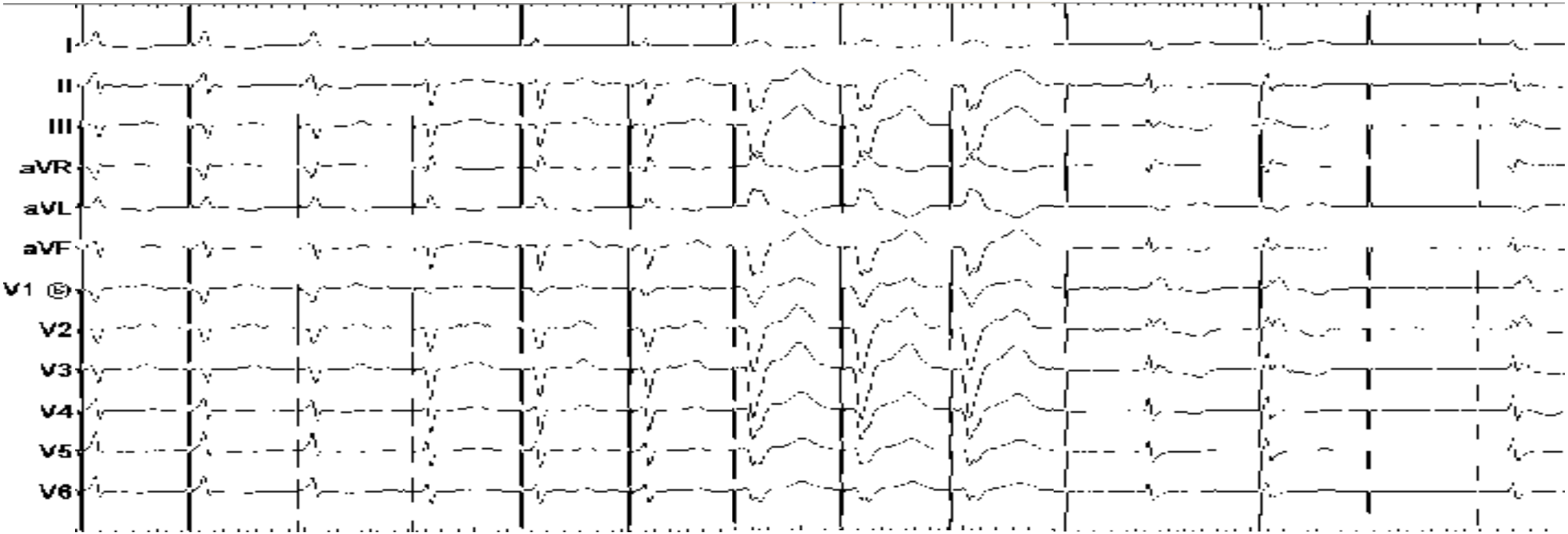


A macroscopic anatomical investigation of atrioventricular bundle locational variation relative to the membranous part of the ventricular septum in elderly human hearts. Kawashima, T. & Sasaki, H. 2005

1.5V @ 1ms

1.25V @ 1ms

1.0V @ 1ms



RV and His capture
NonSelective-HBP

His capture only
Selective HBP

RB capture only
Selective HBP

Baseline RBBB

Suivi post-implantation - paramètres

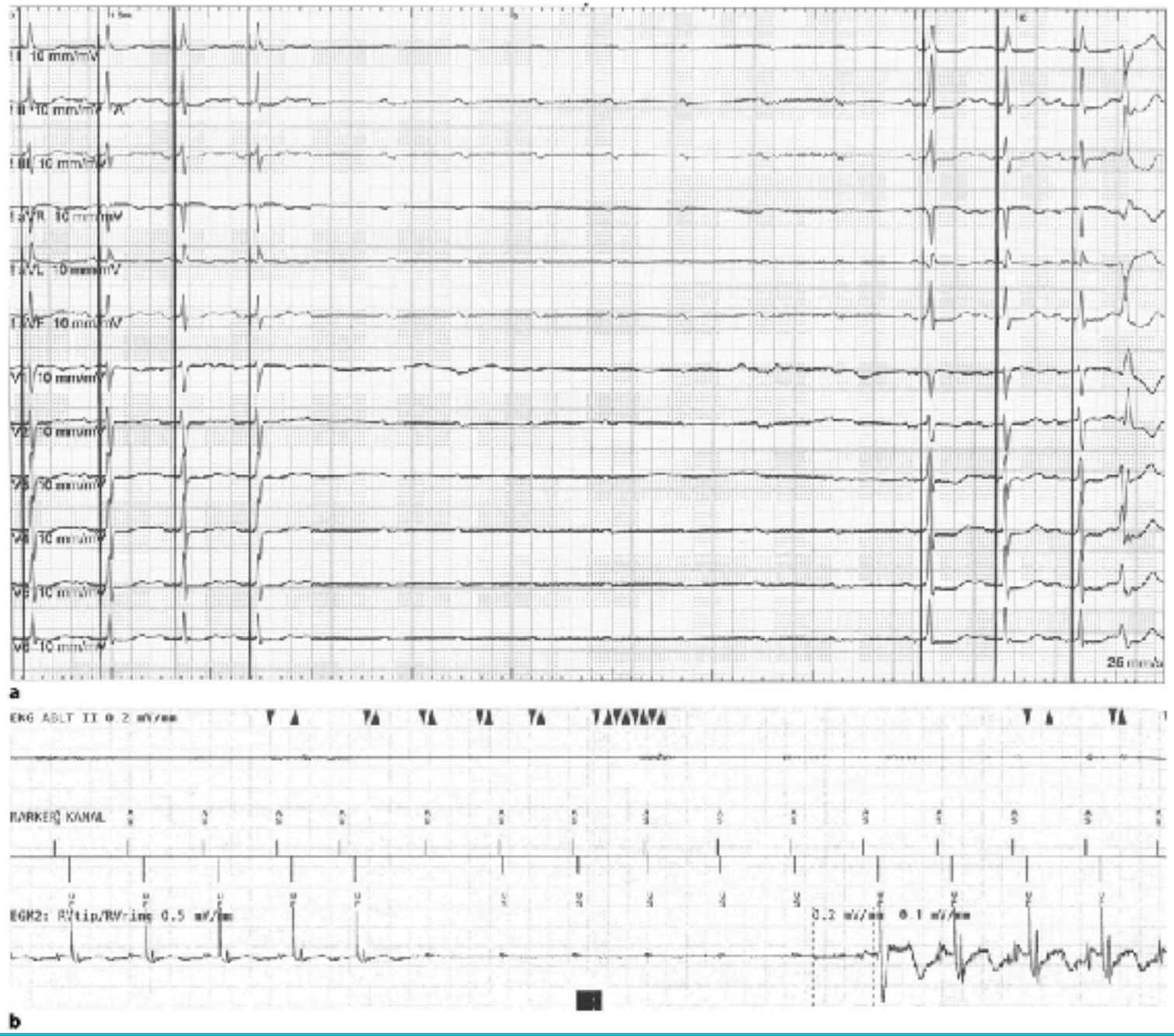
Recommendations	Class[a]	Level[b]
In patients treated with HBP, device programming tailored to specific requirements of HBP is recommended.[430,431]	I	C

Délai AV : tenir compte du délai HV, à raccourcir de 50-60ms

Algorithme d'autocapture/autoseuil

Marge de sécurité pour seuil NS / S ?

Détection V basse / **surdétection A** : sensibilité auto ? détection unipolaire ?


10 mm/mV
26 mm/s
EKG ABLT II @ 2 mV/mm
MARKER KANAL
EGM2: RVtip/RVring 0.5 mV/mm
0.2 mV/mm
0.1 mV/mm

a

b

Cas clinique

M. D, 73 ans

Pas d’antécédents

Pas de traitements

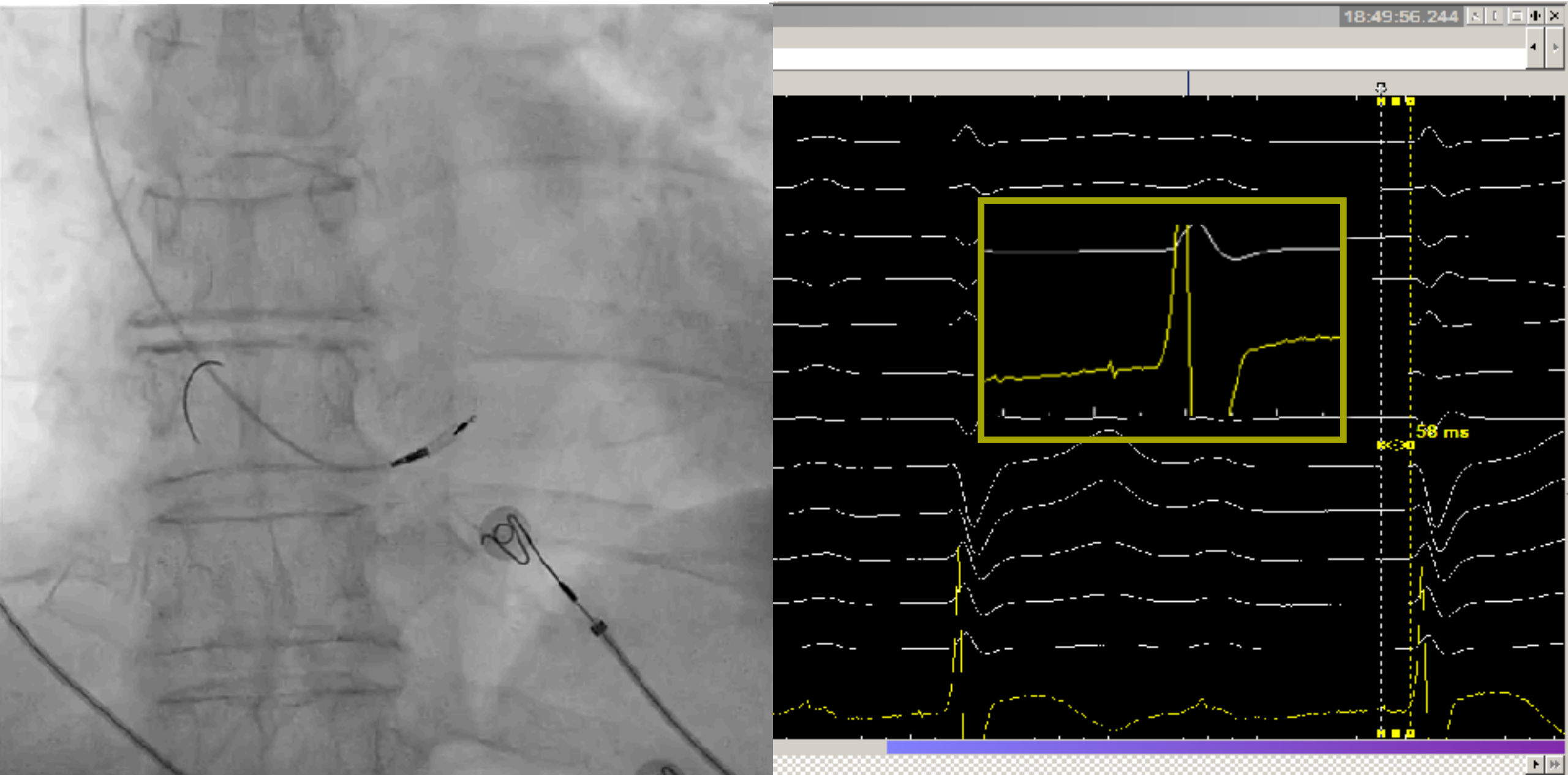
Hospitalisé pour malaises récidivants

Dyspnée NYHA3

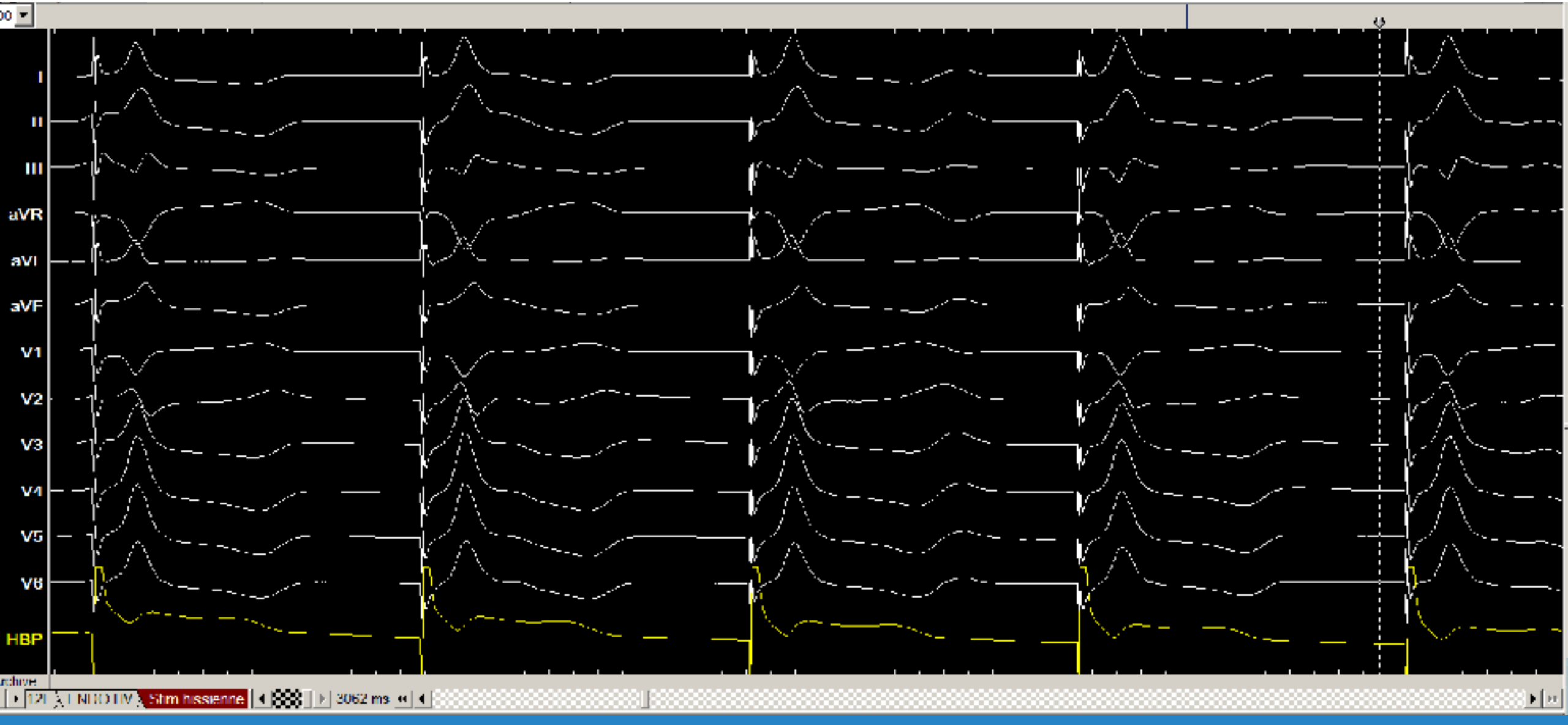
ETT, bio RAS

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

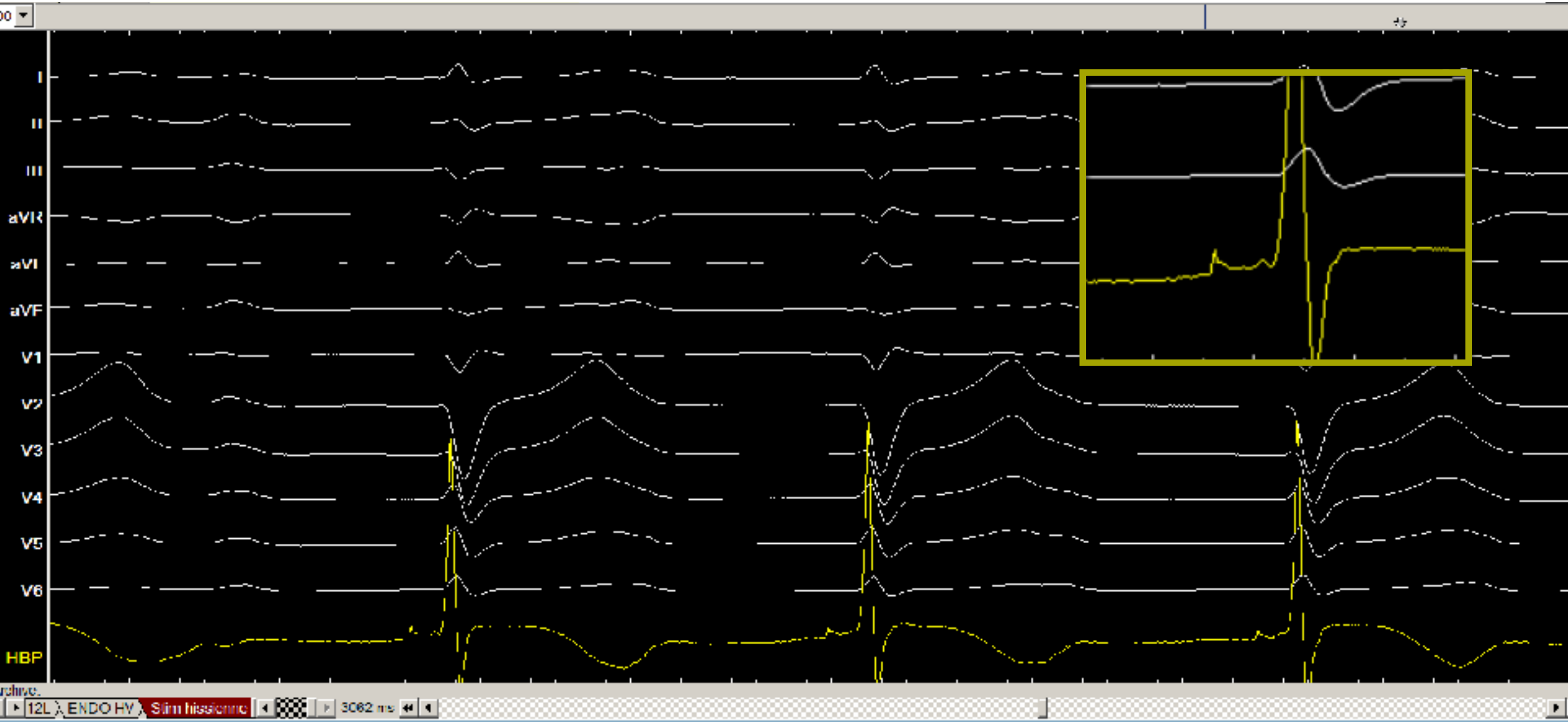
Mapping du potentiel de His



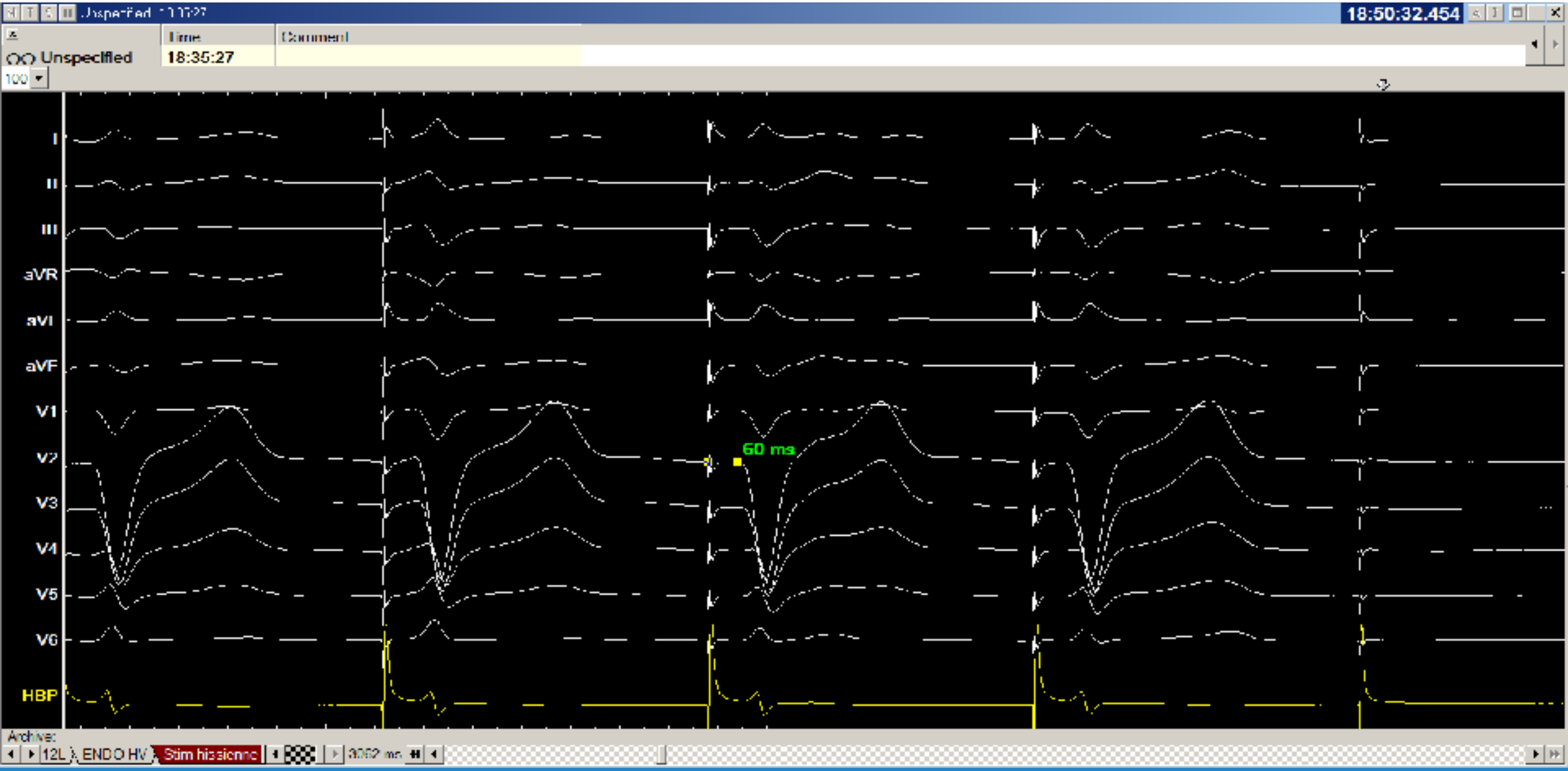
Stimulation avant fixation

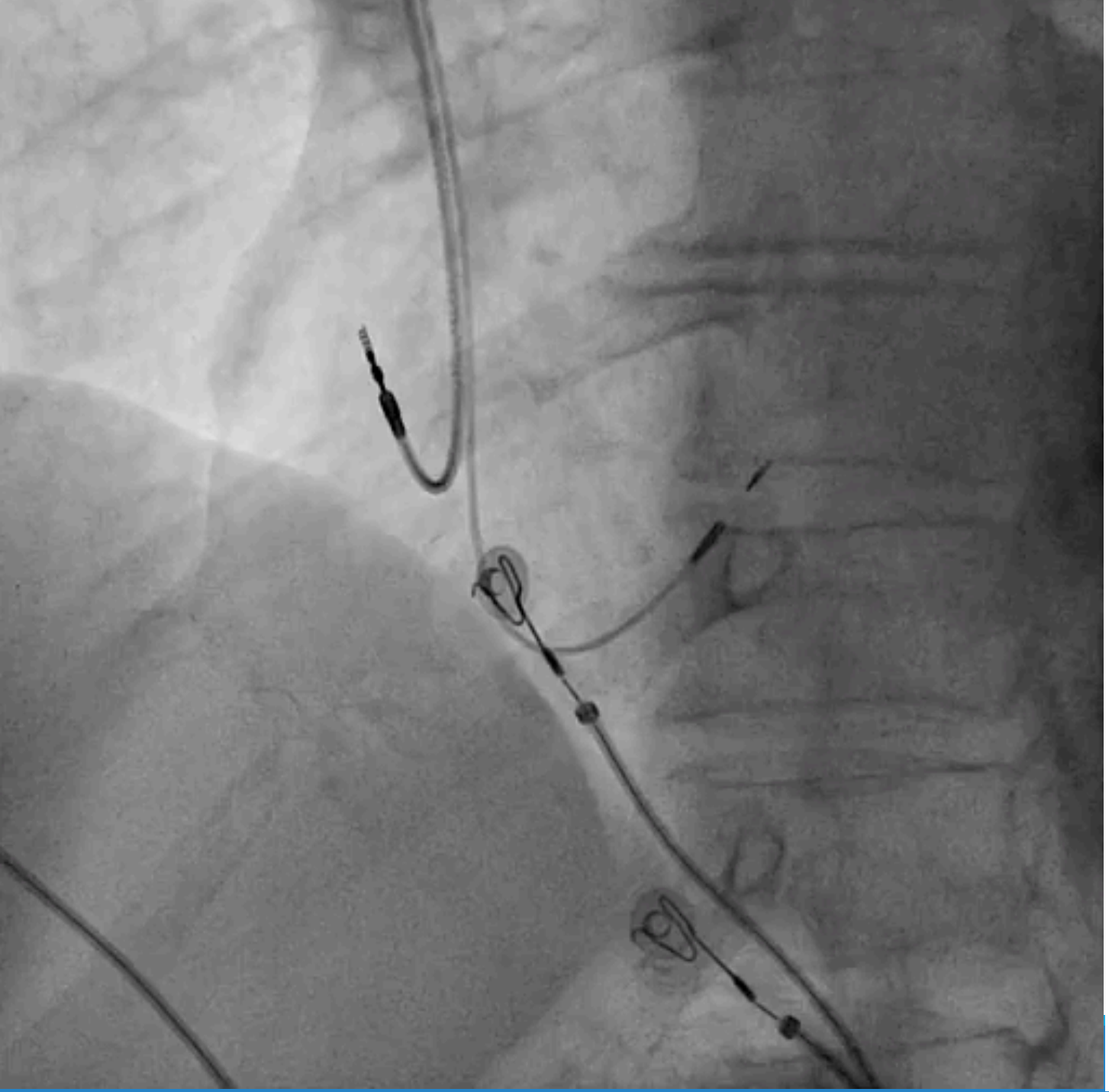


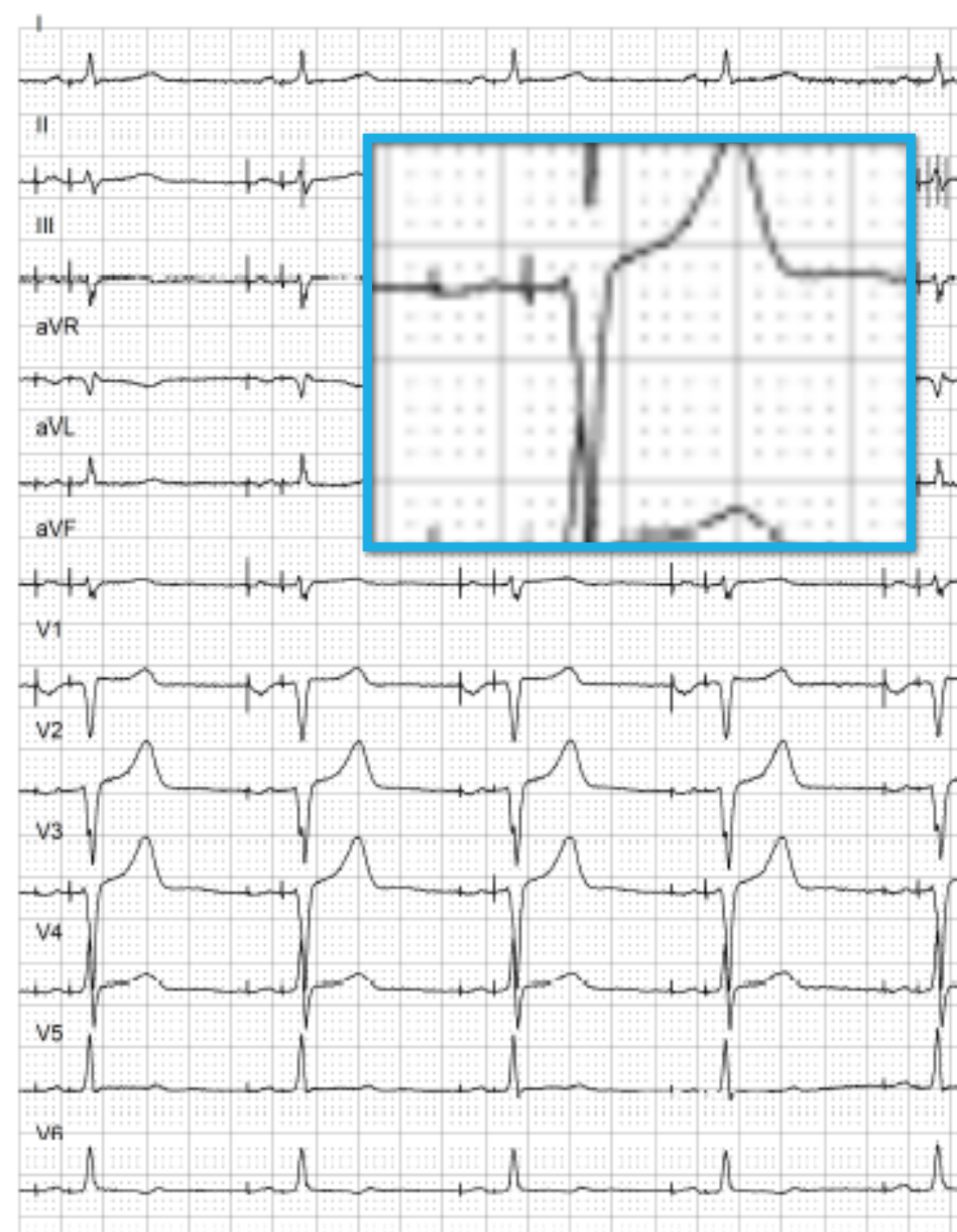
Courant de lésion



Stimulation post fixation - Capture sélective



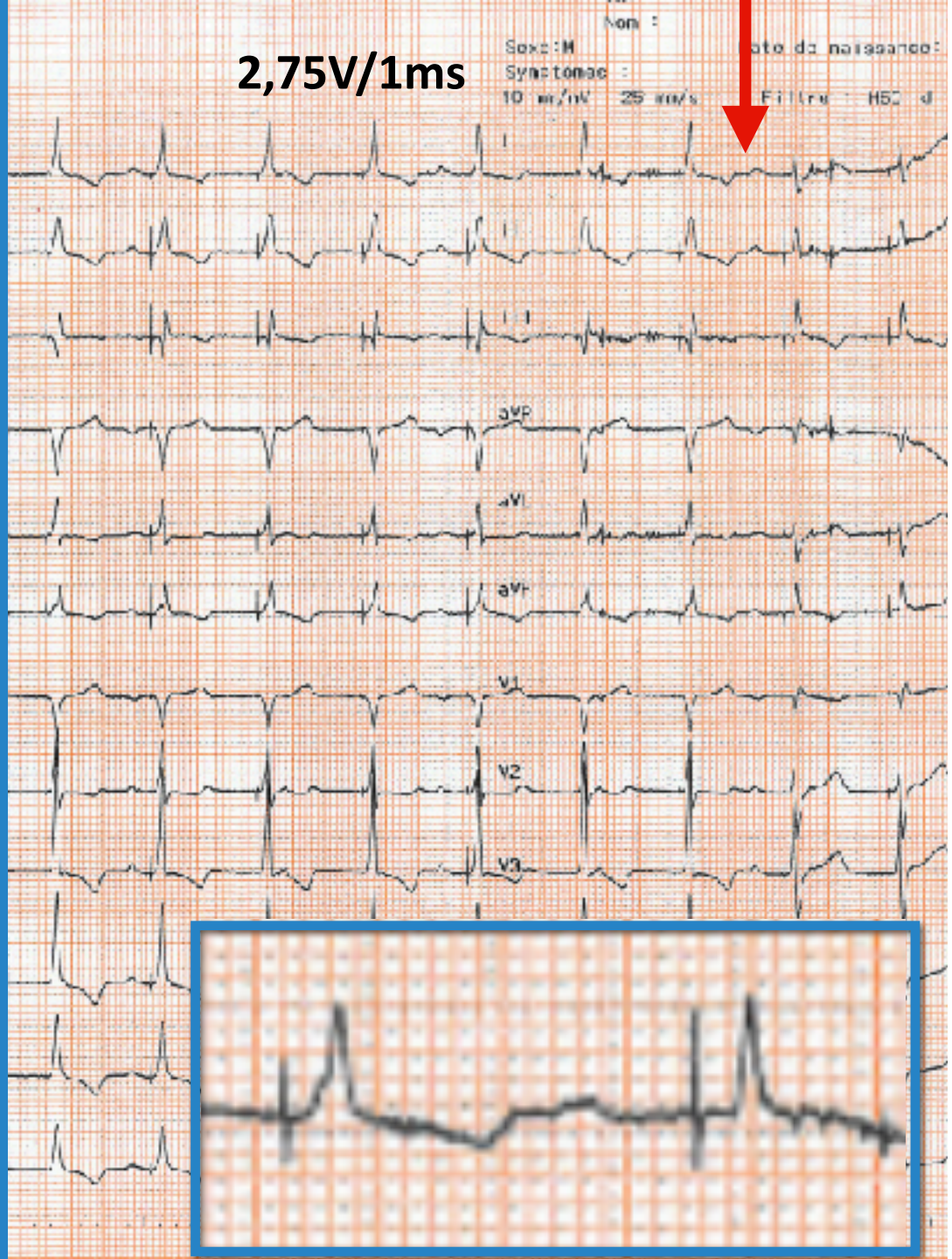


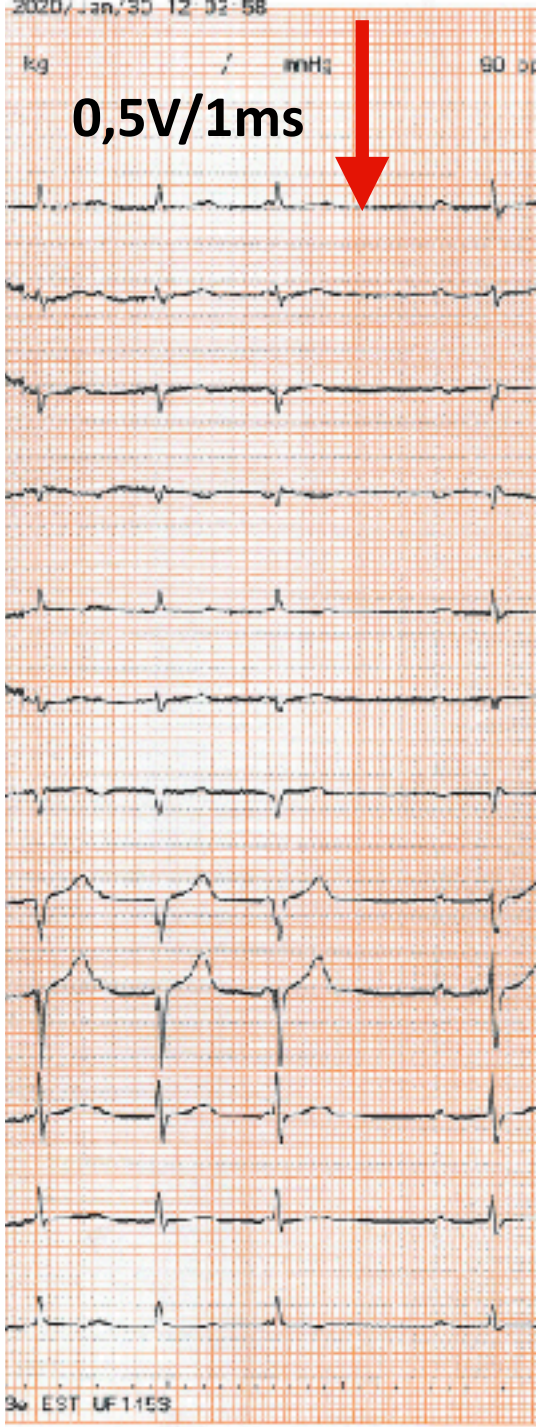

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

Test de seuil

Seuil NS 2,75/1ms

Seuil His 0,5V/1ms





Paramètres

Impédance 399 ohms

Détection **3,5mV**

Seuil NS 3,5V/0,4ms ou 2,75V/1ms

Seuil His 0,75V/0,4ms ou **0,5V/1ms**

Elevation progressive du seuil de stimulation du His à 2V/0,4ms ou **1,25V/1ms** à 6 mois

Limites

Succès 80%

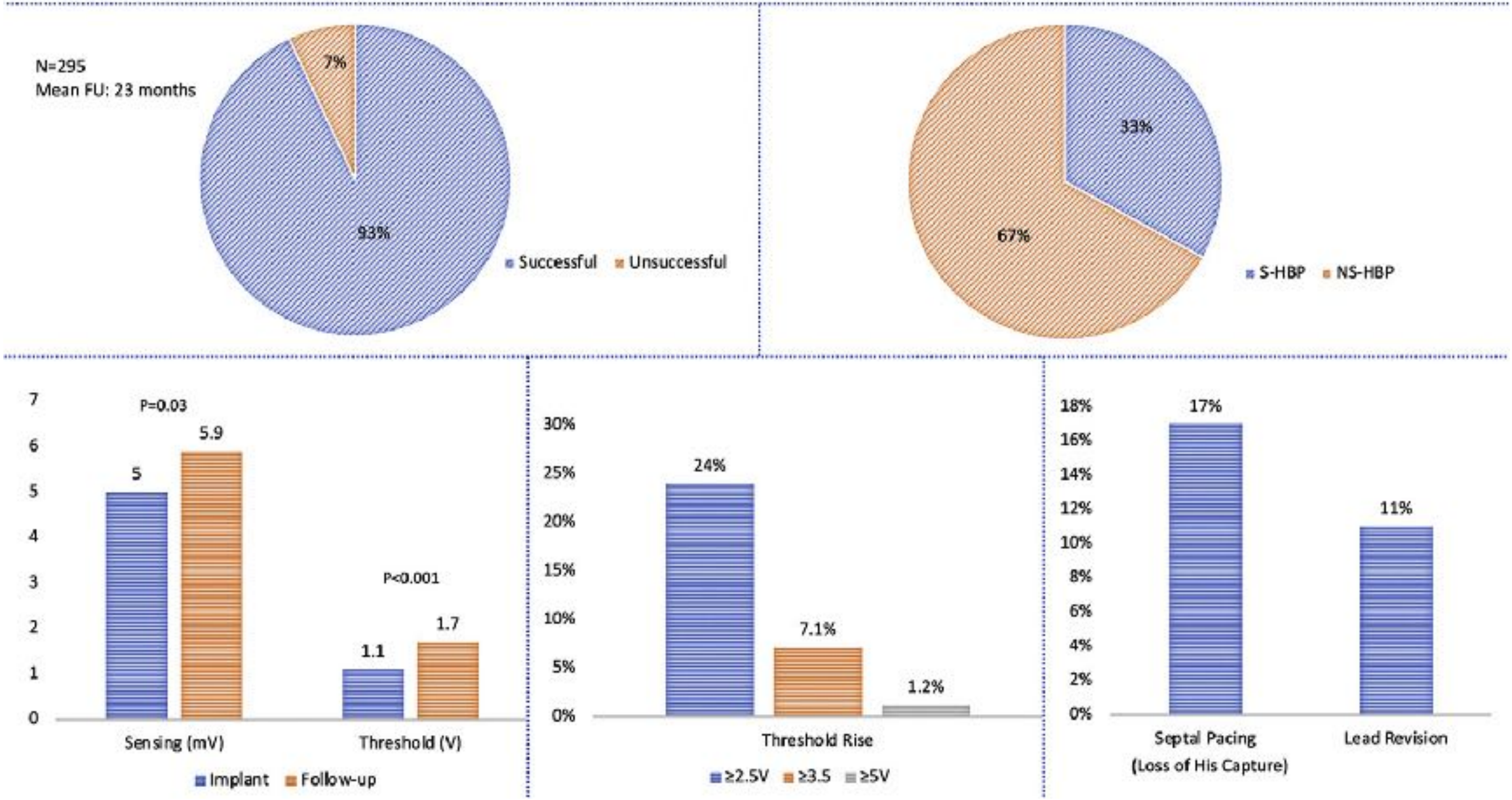
Procédures plus longues (79 +- 25 vs 64 +- 25 min) et plus de scopie (12,7 vs 10 min, p<0,01)

Paramètres de sonde

- Seuil plus élevé (1.35 V @ 0.5 ms vs. 0.6 V @ 0.5 ms, P < 0.001)
- Amplitude de l'onde R plus basse (6.8 mV vs. 13.7 mV, P < 0.05)

Sharma PS, Ellenbogen KA,Vijayaraman P: Permanent His-bundle pacing is feasible, safe, and superior to right ventricular pacing in routine clinical practice. Heart Rhythm 2015;

His Bundle Pacing: Intermediate Term Outcomes



Intermediate-term performance and safety of His-bundle pacing leads: A single-center experience

Todd Teigeler, Jeffrey Kolominsky, Santosh K. Padala, et al. Heart Rhythm 2021

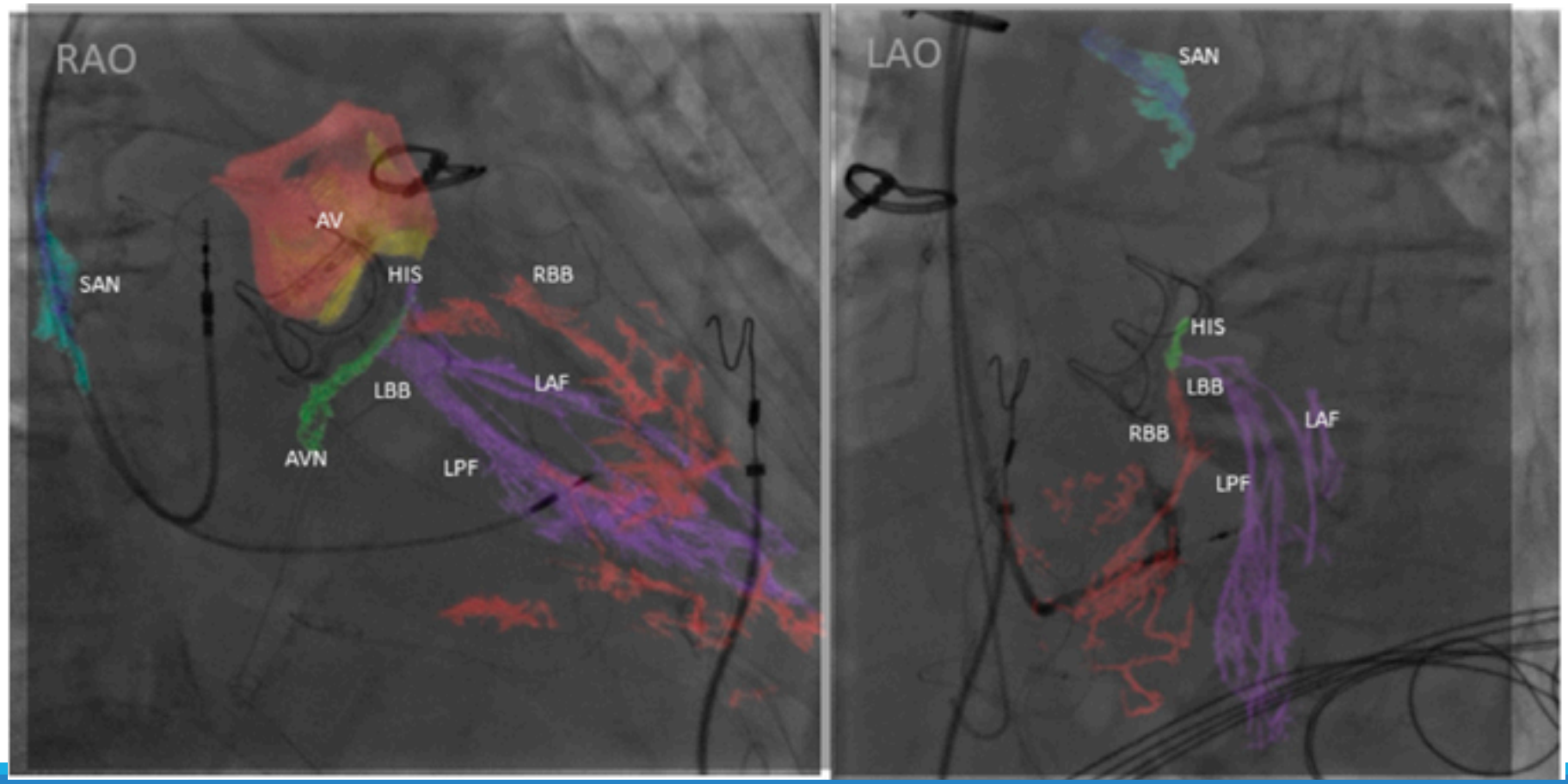
Stimulation de la branche gauche

(LBBAP)

CASE REPORT | VOLUME 33, ISSUE 12, P1736.E1-1738.E3, DECEMBER 01, 2017

A Novel Pacing Strategy With Low and Stable Output: Pacing the Left Bundle Branch Immediately Beyond the Conduction Block

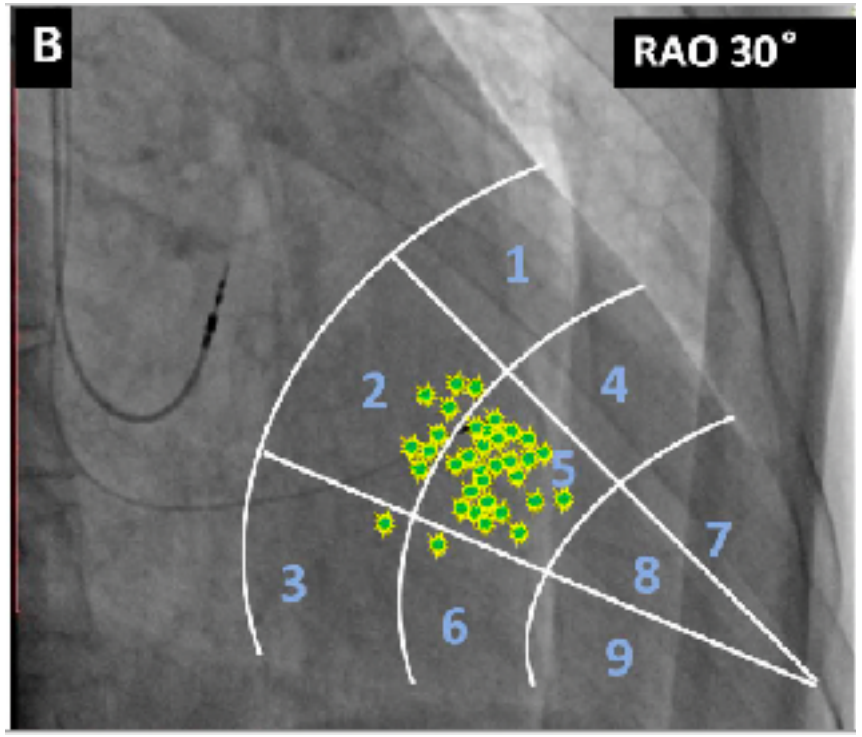
Weijian Huang, MD, FHRS • Lan Su, MD • Shengjie Wu, MD • ... Fangyi Xiao, MD • Xiaohong Zhou, MD • Kenneth A. Ellenbogen, MD, FHRS • Show all authors



Modified from Stephenson RS, Atkinson A, Kottas P, et al. High resolution 3-Dimensional imaging of the human cardiac conduction system from microanatomy to mathematical modeling. Sci Rep. 2017;7(1):7188. Published 2017 Aug 3.

Plus simple que la stim hissienne ?

- Cible plus large
- Taux de succès > 95%
- Complications équivalentes RVP



A novel nine-partition method using fluoroscopic images for guiding left bundle branch pacing. Hai Jiang, et al. Heart Rhythm

Méthode d’implantation

Left bundle branch pacing is the best approach to physiological pacing

Santosh K. Padala, MD, Kenneth A. Ellenbogen, MD, FHRS

From the Department of Cardiac Electrophysiology, Virginia Commonwealth University, Richmond, Virginia.

Site d'implantation

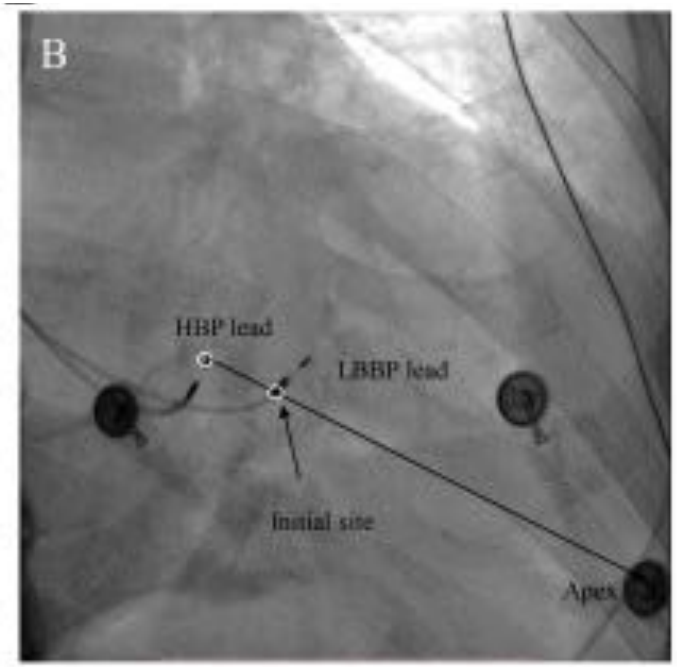
Repère anatomique en OAD 30°

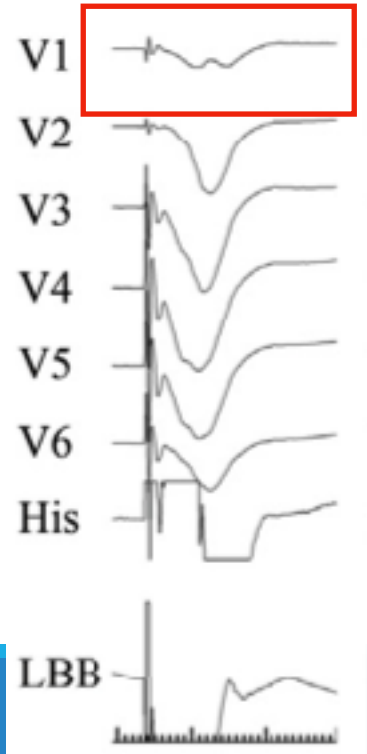
- A 1-2cm du potentiel de His vers l'apex

Et / ou

Pacemap en stimulation unipolaire

- Aspect **« W » en V1**
- Discordance aVR(-)/aVL(+), onde R II > III



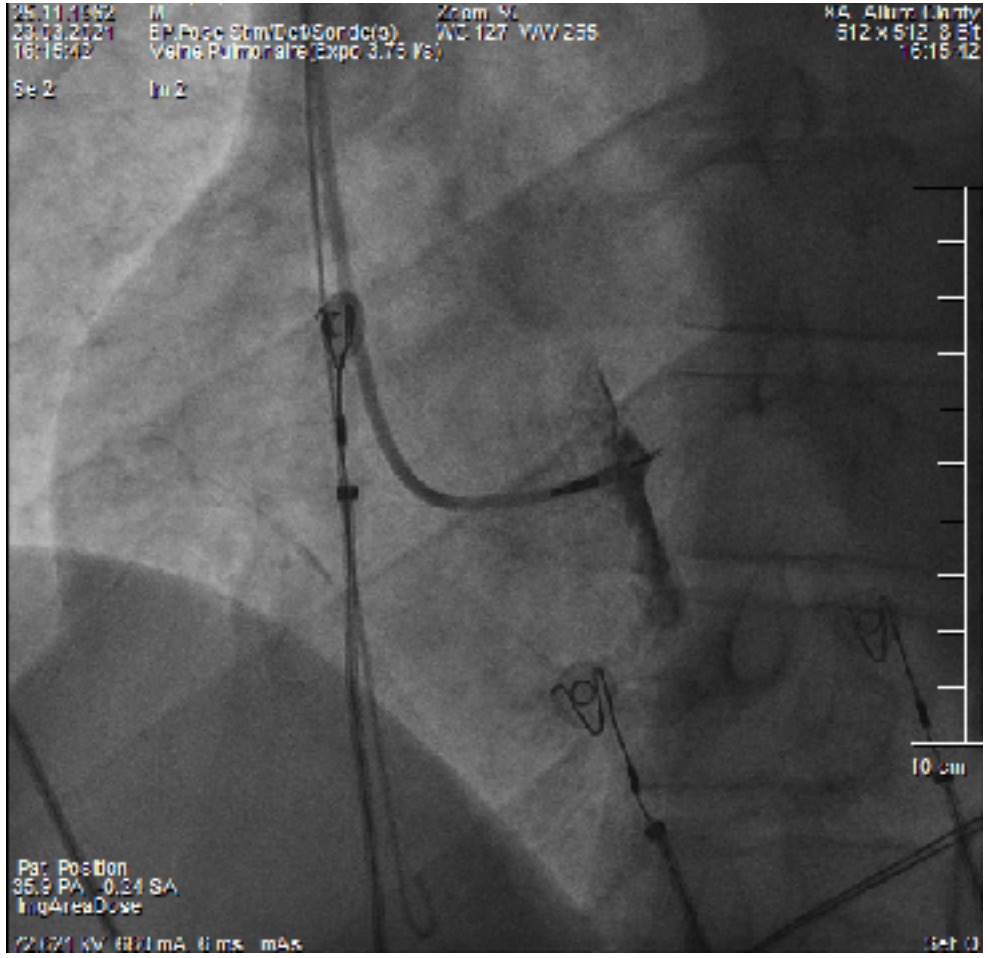


A beginner's guide to permanent left bundle branch pacing
Huang, Weijian et al. Heart Rhythm, 2019, Volume 16, Issue 12, 1791 - 1796

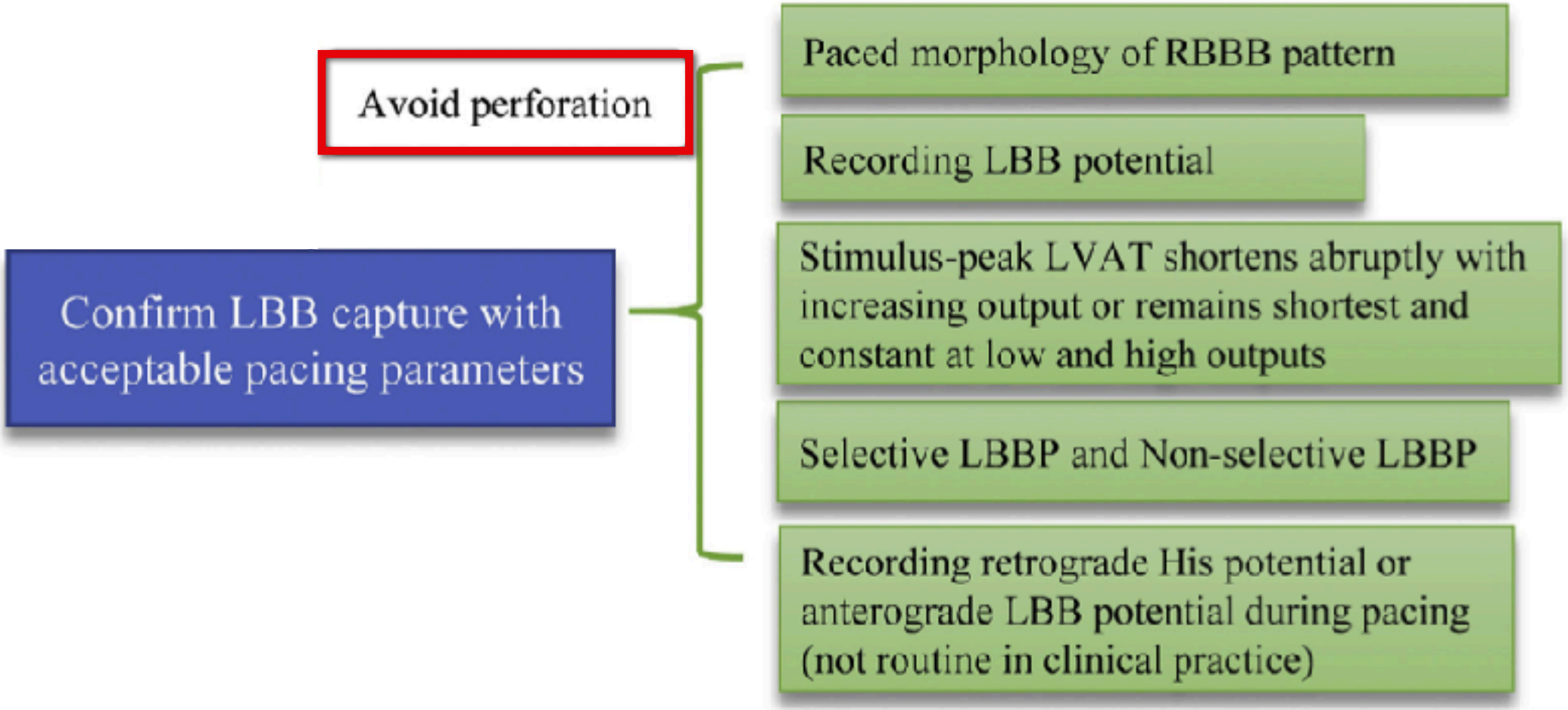
Fixation de la sonde

- OAG 30-45°
- Perpendiculaire au septum

- Monitorage
  - Impédance unipolaire
  - Morphologie du QRS (notch V1)
  - Angiographie via la gaine



Position finale



A beginner's guide to permanent left bundle branch pacing
Huang, Weijian et al. Heart Rhythm, 2019, Volume 16, Issue 12, 1791 - 1796

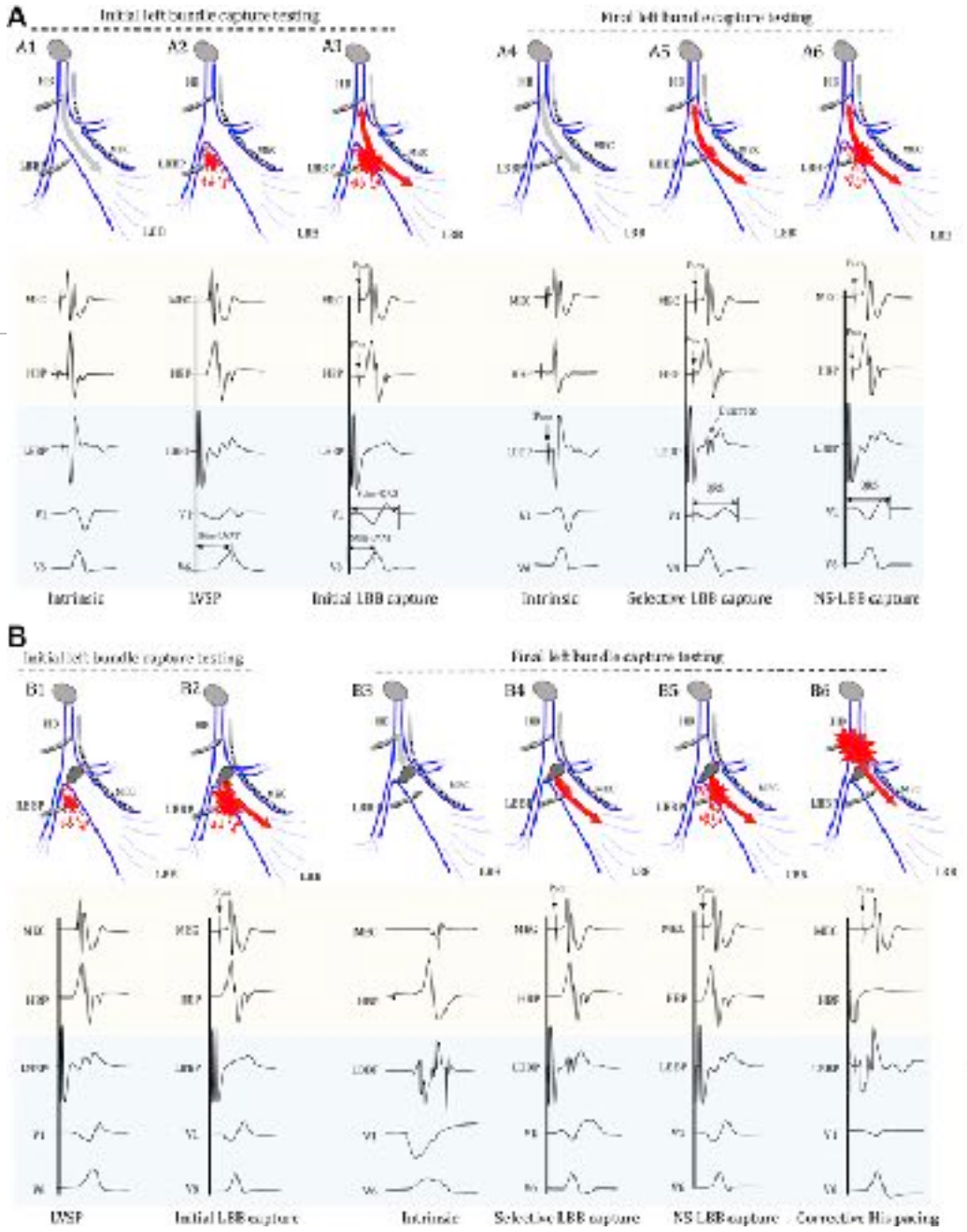
Validation de la capture

TABLE 1 Criteria for LBBAP

1. Paced QRS morphology with RBBB morphology: QR or rSR′.
2. Presence of LBBp.
3. Pacing stim-LVAT.
   - –Stimulus to peak of R-wave in V_5 or V_6.
   - –Short and constant at high (5 V) and low (1 V) output pacing.
4. Determination of S and NS LBBAP
   - –S-LBBAP: Stim-QRS latency seen. Discrete local EGM separate from stimulus artifact seen.
   - –NS-LBBAP: No stim-QRS latency. No discrete local EGM separate from stimulus artifact.
5. Evidence for direct LBB capture.
   - –Stim to retrograde His time from unipolar tip vs. ring pacing.
   - –Retrograde VA time from unipolar tip vs. ring pacing.

LBBAP was considered successful when 2 or more of these criteria were met.

EGM = electrogram; LBBAP = left bundle branch area pacing; LBBp = left bundle branch potential; LVAT = left ventricular activation time; NS = nonselective; RBBB = right bundle branch; S = selective; stim = stimulus; VA = ventriculo-atrial.



Initial Experience, Safety, and Feasibility of Left Bundle Branch Area Pacing A Multicenter Prospective Study. Santosh K. Padala et al. JACC 2020

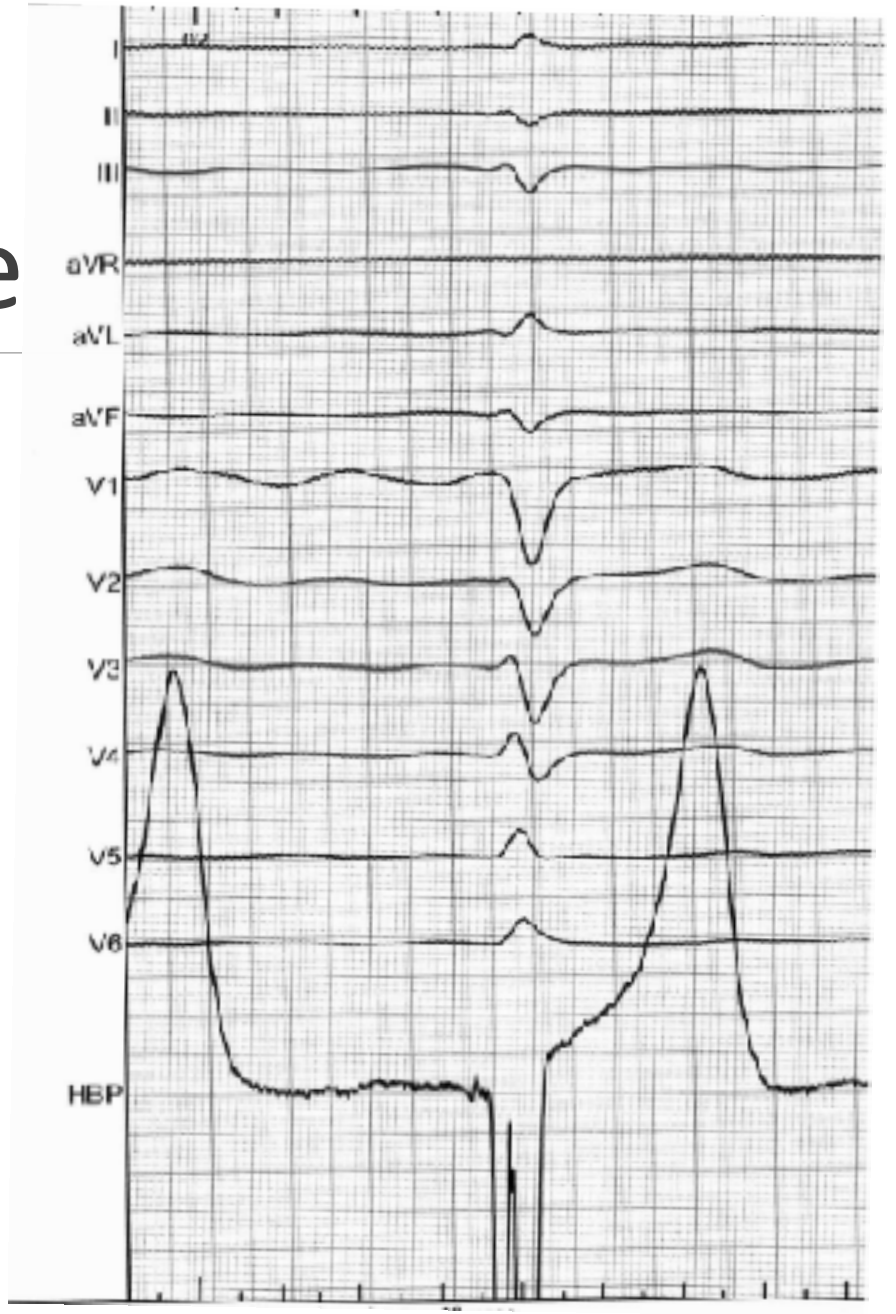
Evaluation of the Criteria to Distinguish Left Bundle Branch Pacing From Left Ventricular Septal Pacing. Shengjie Wu , Weijian Huang et al. J Am Coll Cardiol EP. Apr 28, 2021

Potentiel de branche gauche

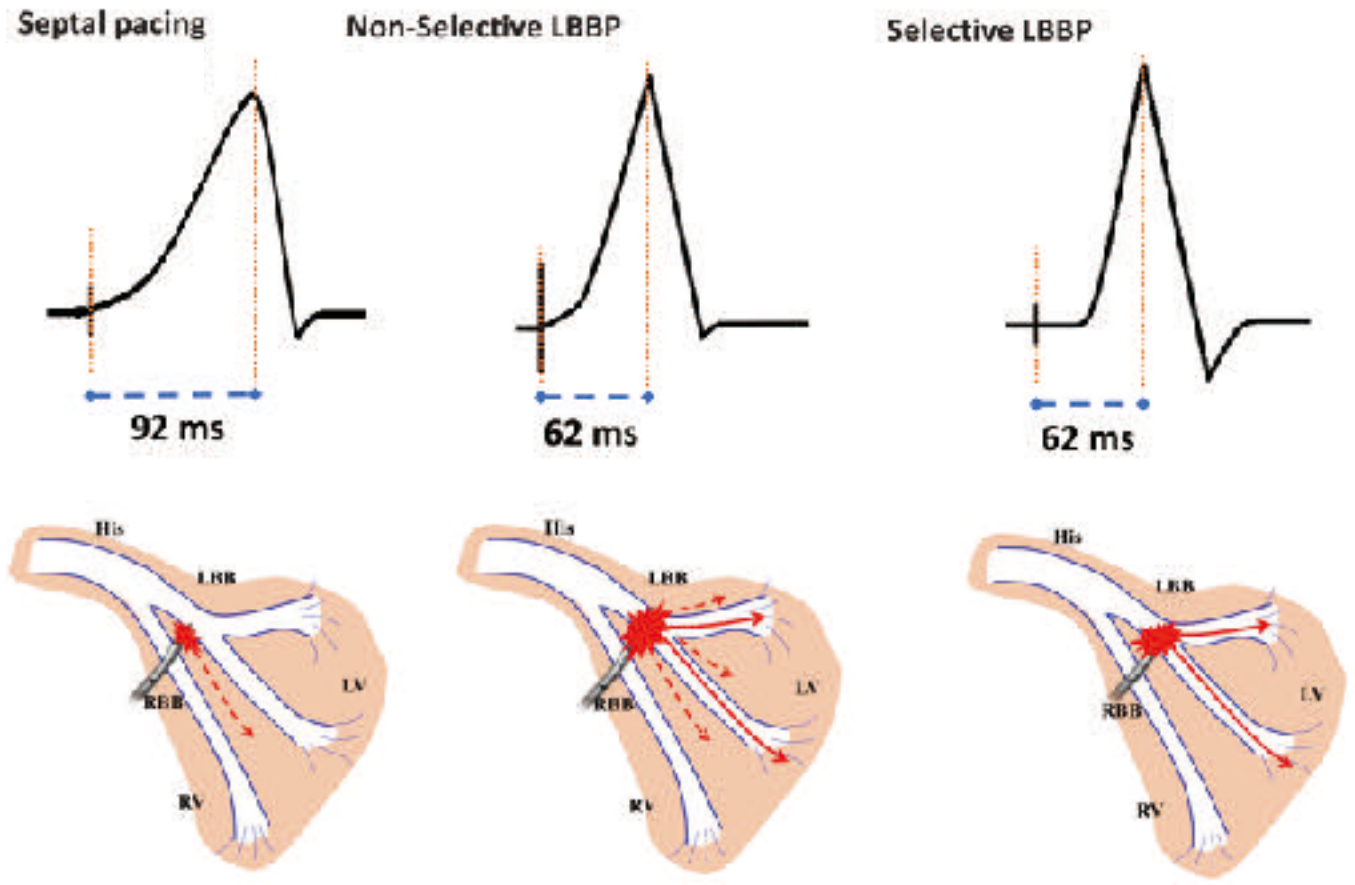
Intervalle potentiel branche gauche-V 20-30ms

Toujours présent si QRS fins / BBD

Possible de le voir en rétrograde si BAV ou BBG



LVAT : Délai Stim - onde R en V5/V6



S / NS-LBBP

SVP depuis la sonde :

Périodes réfractaires myocarde < LBB

Train S1 600ms + ESV

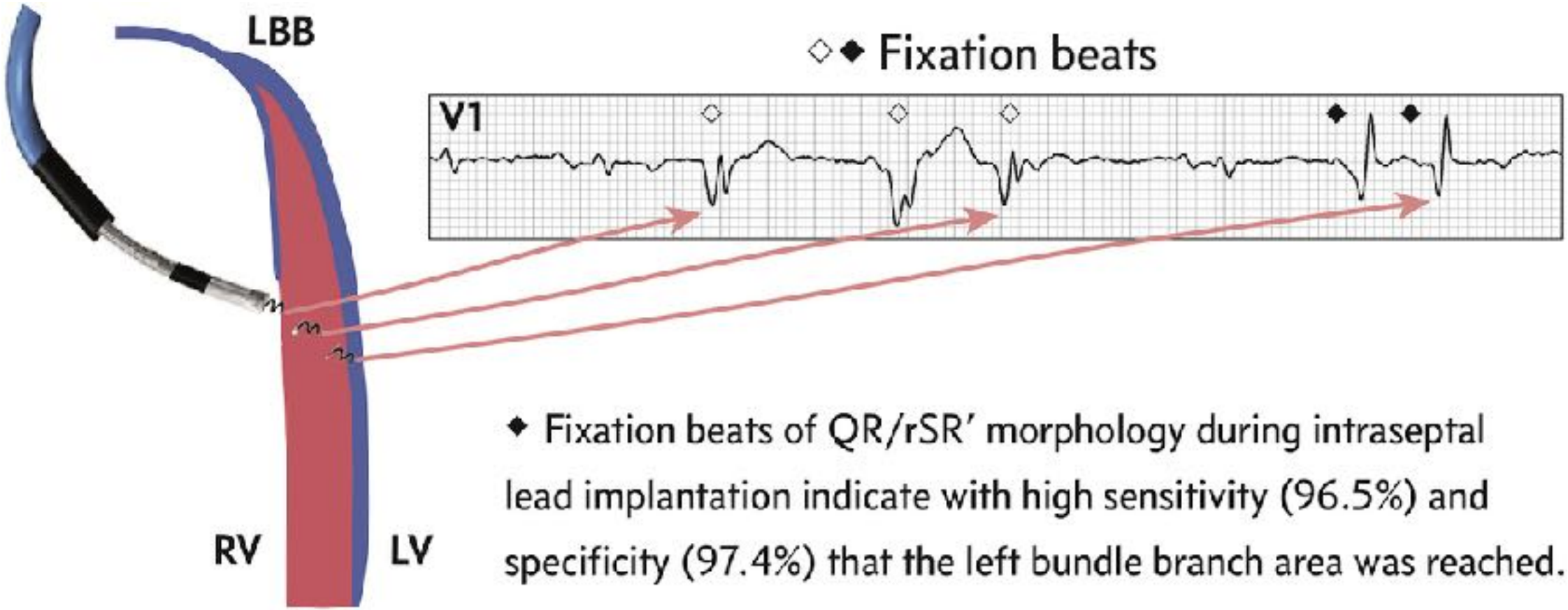
Réponse « Myocarde" ou « Selective »

= capture LBB

79,7% des 143 patients

Jastrzębski M, Moskal P, Bednarek A, Kiełbasa G, Kusiak A, Sondej T, Bednarski A, Vijayaraman P, Czarnecka D. Programmed deep septal stimulation: A novel maneuver for the diagnosis of left bundle branch capture during permanent pacing. J Cardiovasc Electrophysiol. 2020 Feb;31(2):485-493. doi: 10.1111/jce.14352. Epub 2020 Jan 20. PMID: 31930753.

Fixation beats



◆ Fixation beats of QR/rSR' morphology during intraseptal lead implantation indicate with high sensitivity (96.5%) and specificity (97.4%) that the left bundle branch area was reached.

Jastrzębski M, Kiełbasa G, Moskal P, Bednarek A, Kusiak A, Sondej T, Bednarski A, Rajzer M, Vijayaraman P. Fixation beats: A novel marker for reaching the left bundle branch area during deep septal lead implantation. Heart Rhythm. 2021 Apr;18(4):562-569. doi: 10.1016/j.hrthm.2020.12.019. Epub 2020 Dec 25. PMID: 33359876.

V6-V1 interpeak interval

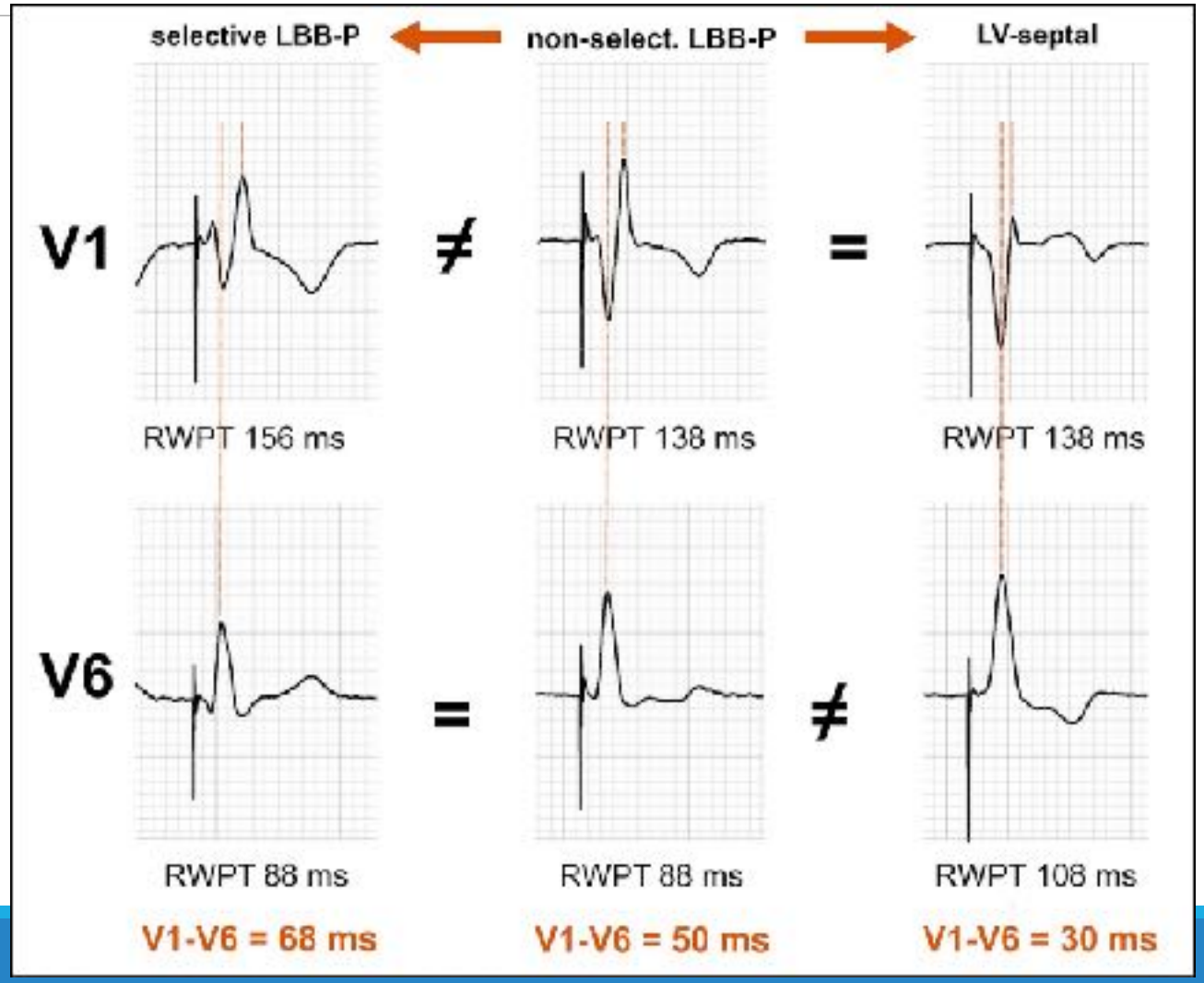
Long si s-LBB

Intermédiaire si ns-LBB

Court si LVS capture

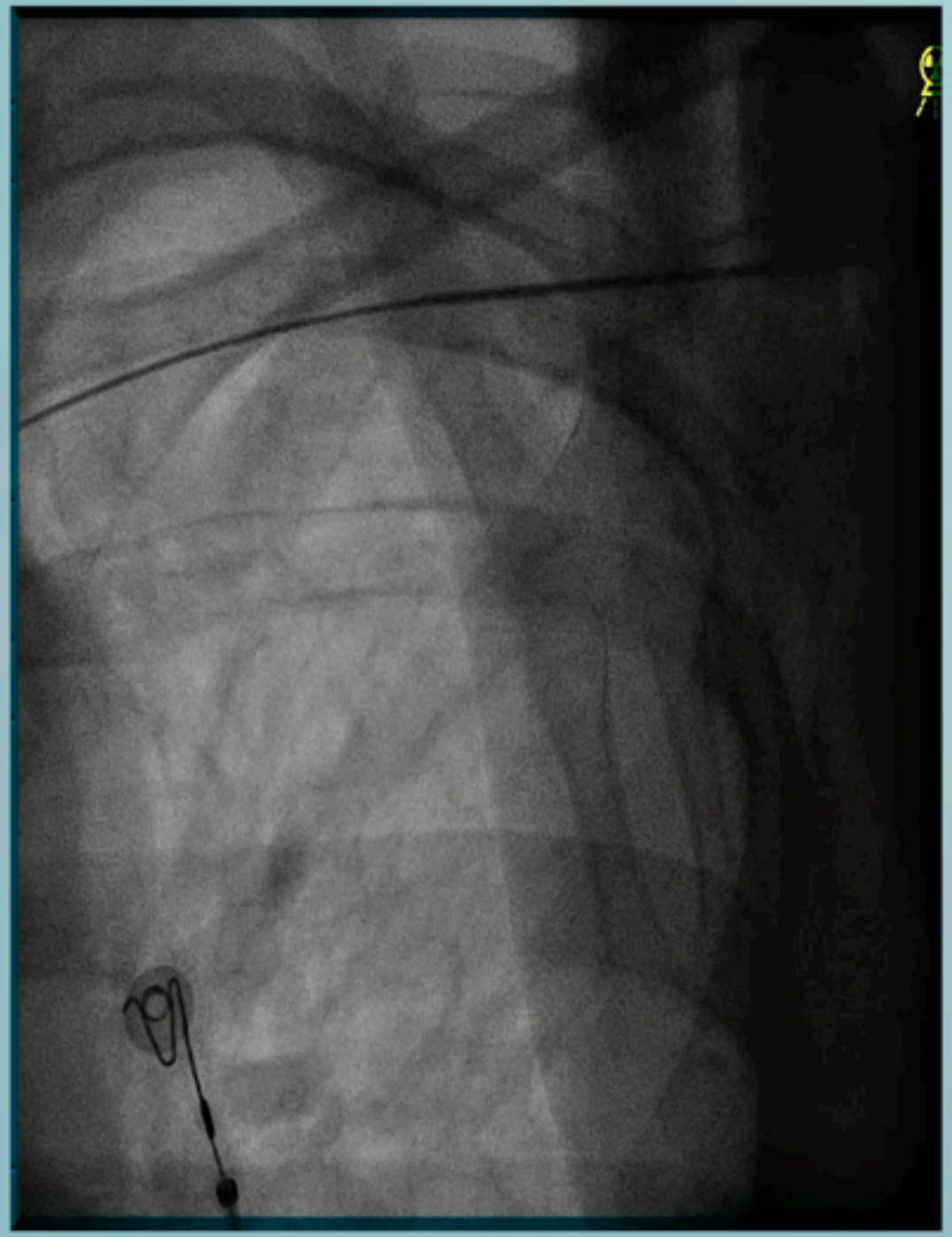
Meilleur cut-off : 33ms

Se 100% pour LBBP si > 44ms

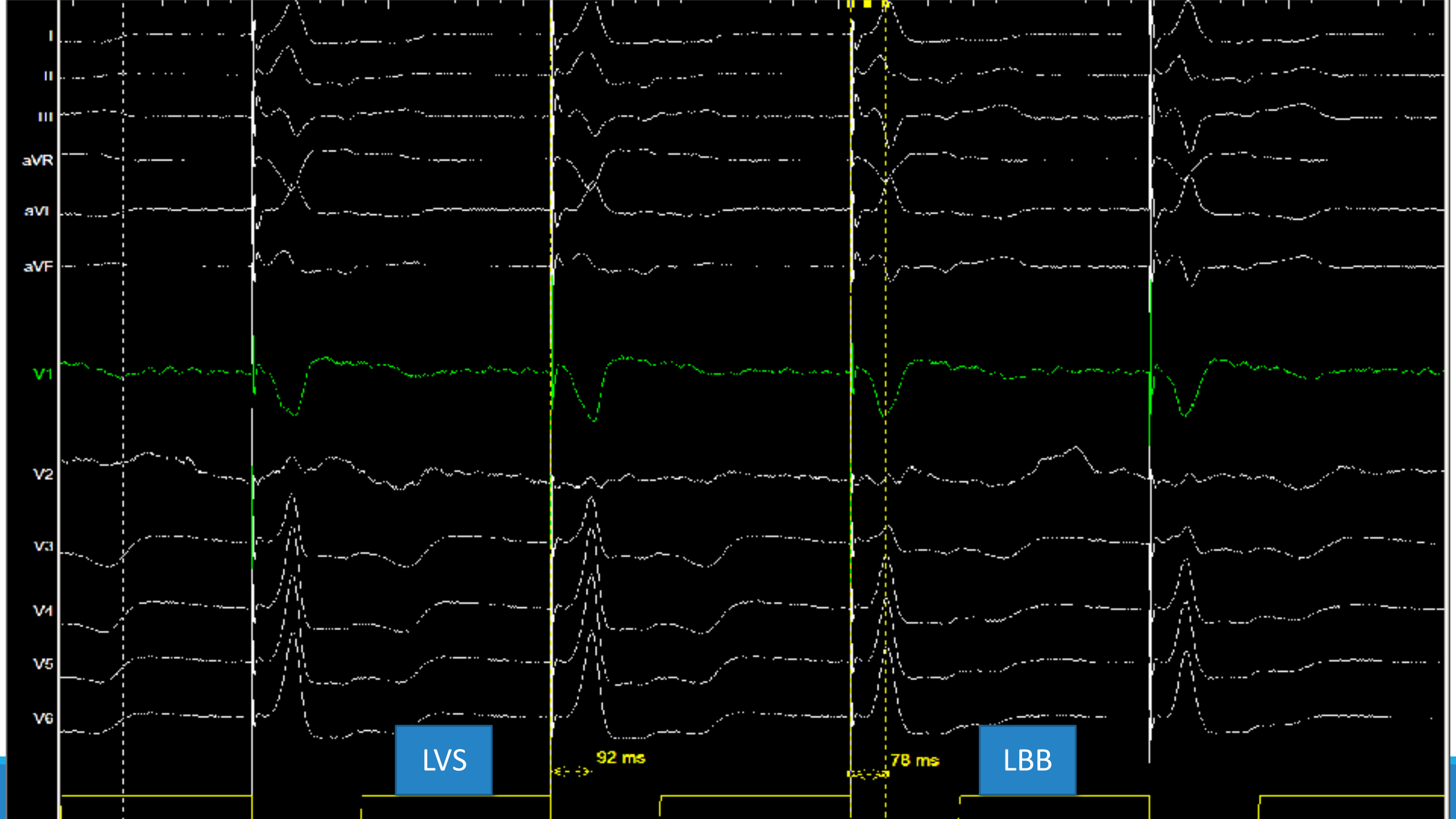


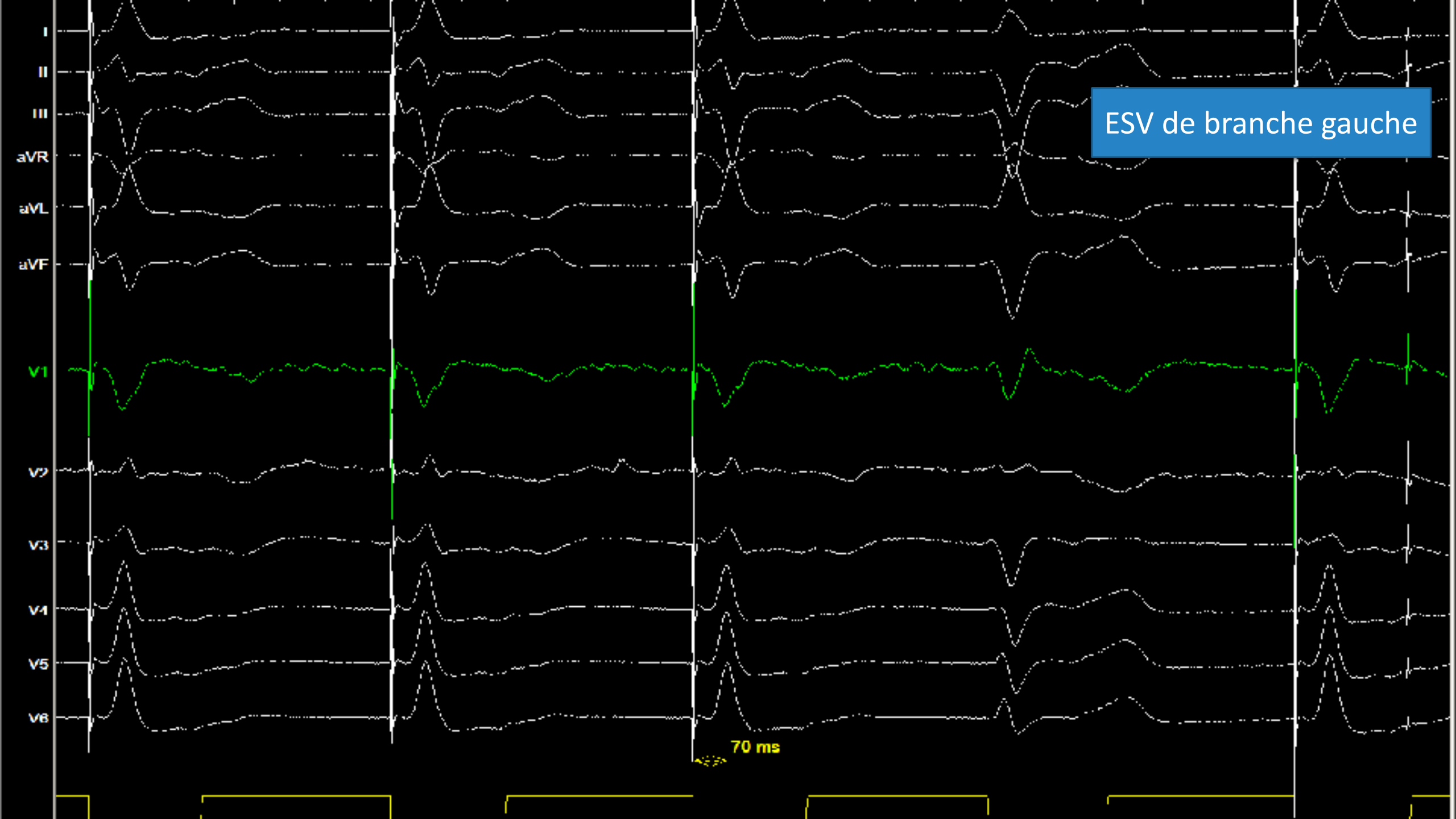
M Jastrzębski, H Burri, P Vijayaraman, The V6-V1 interpeak interval: a novel criterion for the diagnosis of left bundle branch capture, EP Europace, 2021;, euab164,

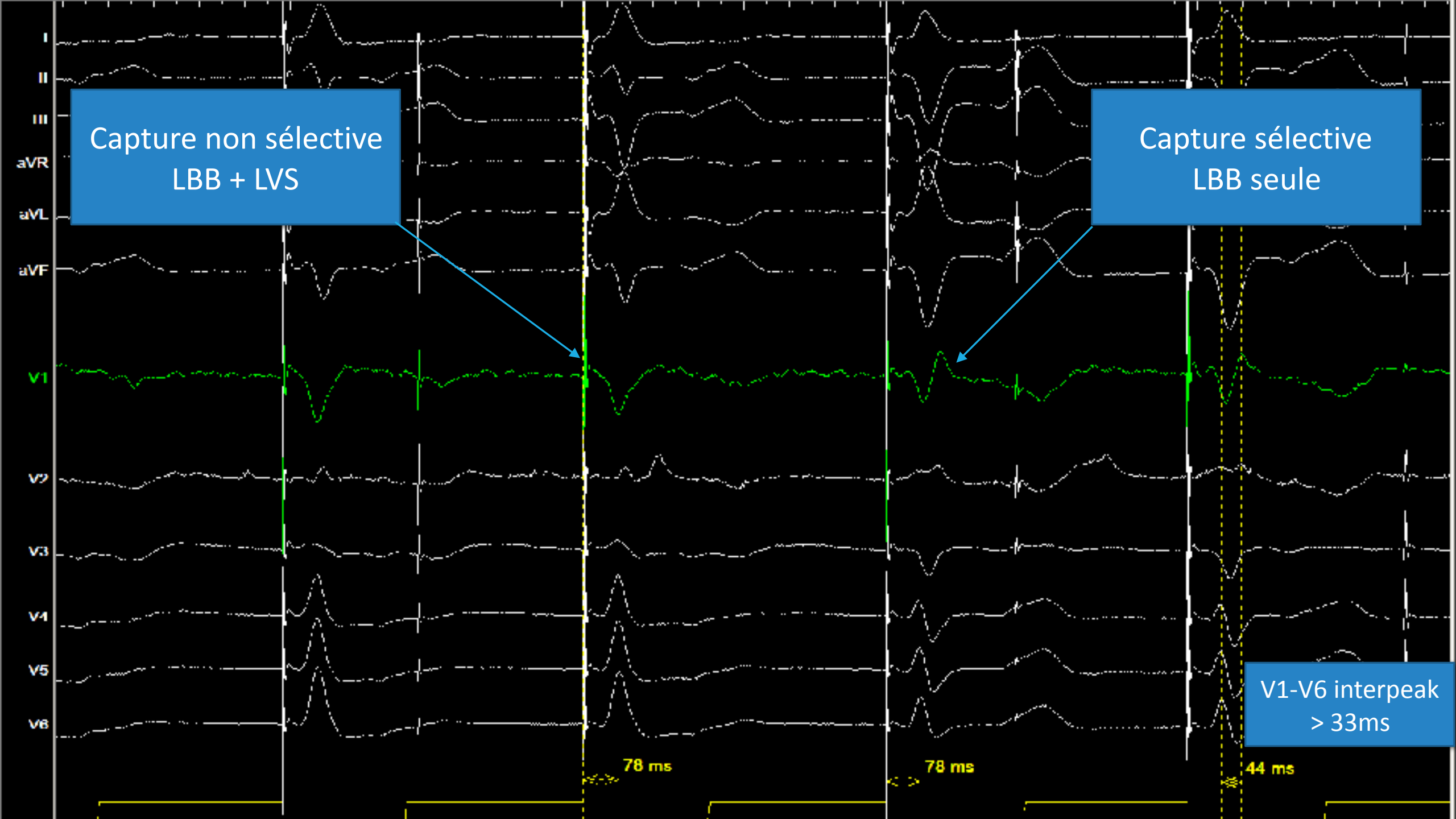
Cas cliniques



I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6


I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
LVS
92 ms
78 ms
LBB


I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
70 ms
ESV de branche gauche


Capture non sélective
LBB + LVS
Capture sélective
LBB seule
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
78 ms
78 ms
44 ms
V1-V6 interpeak
> 33ms

ECG

Capture non sélective

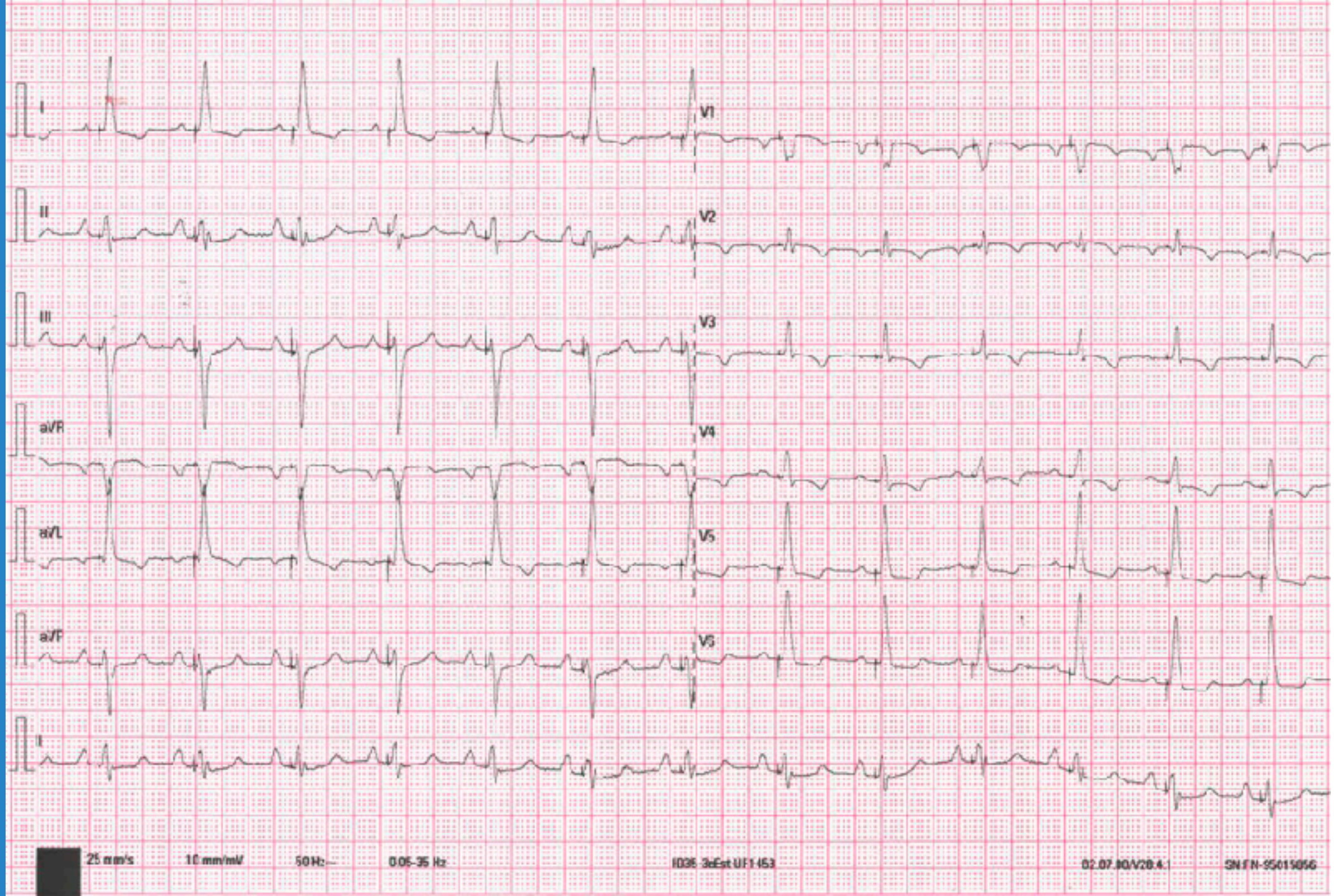
En bipolaire :

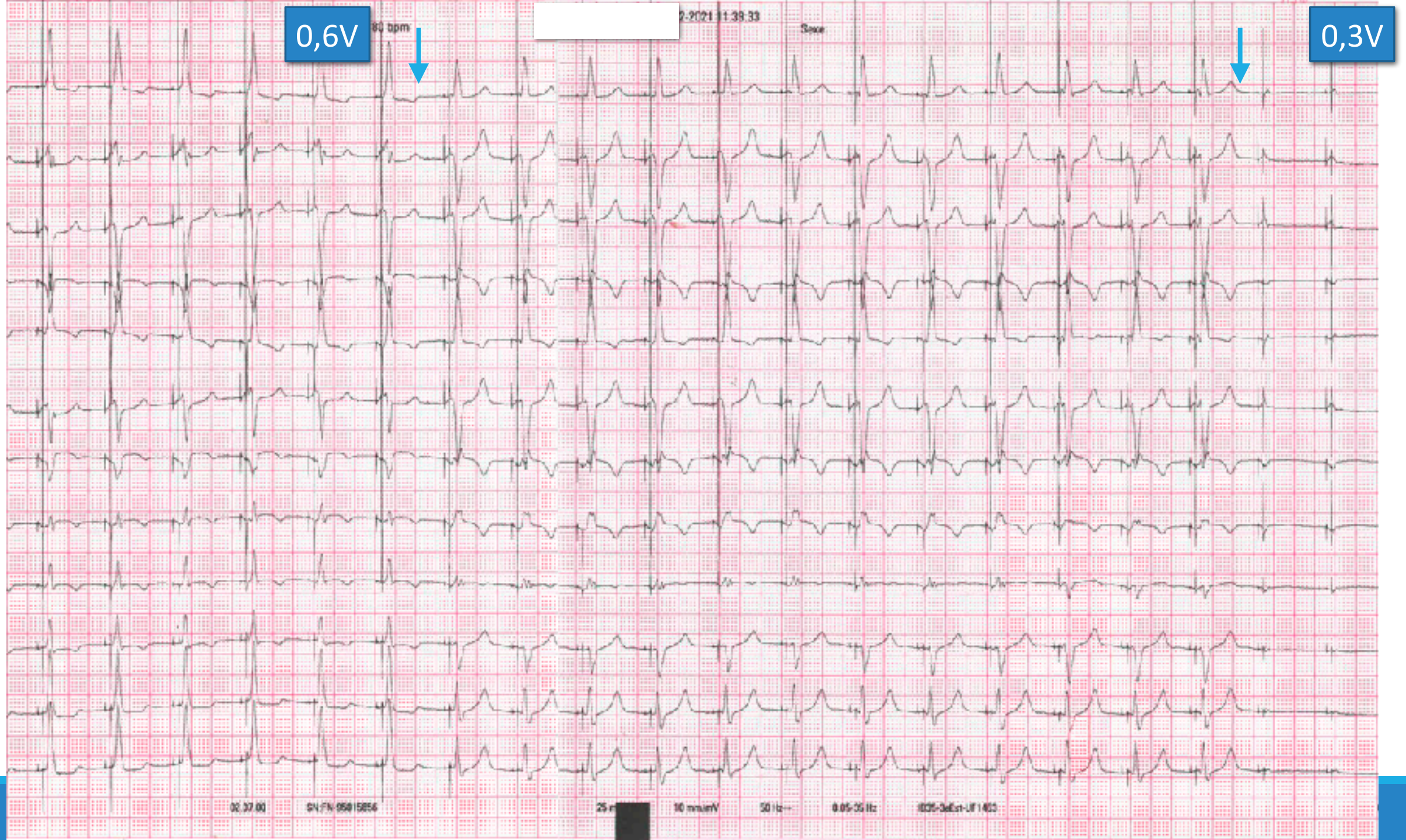
Seuil septal 0,8V

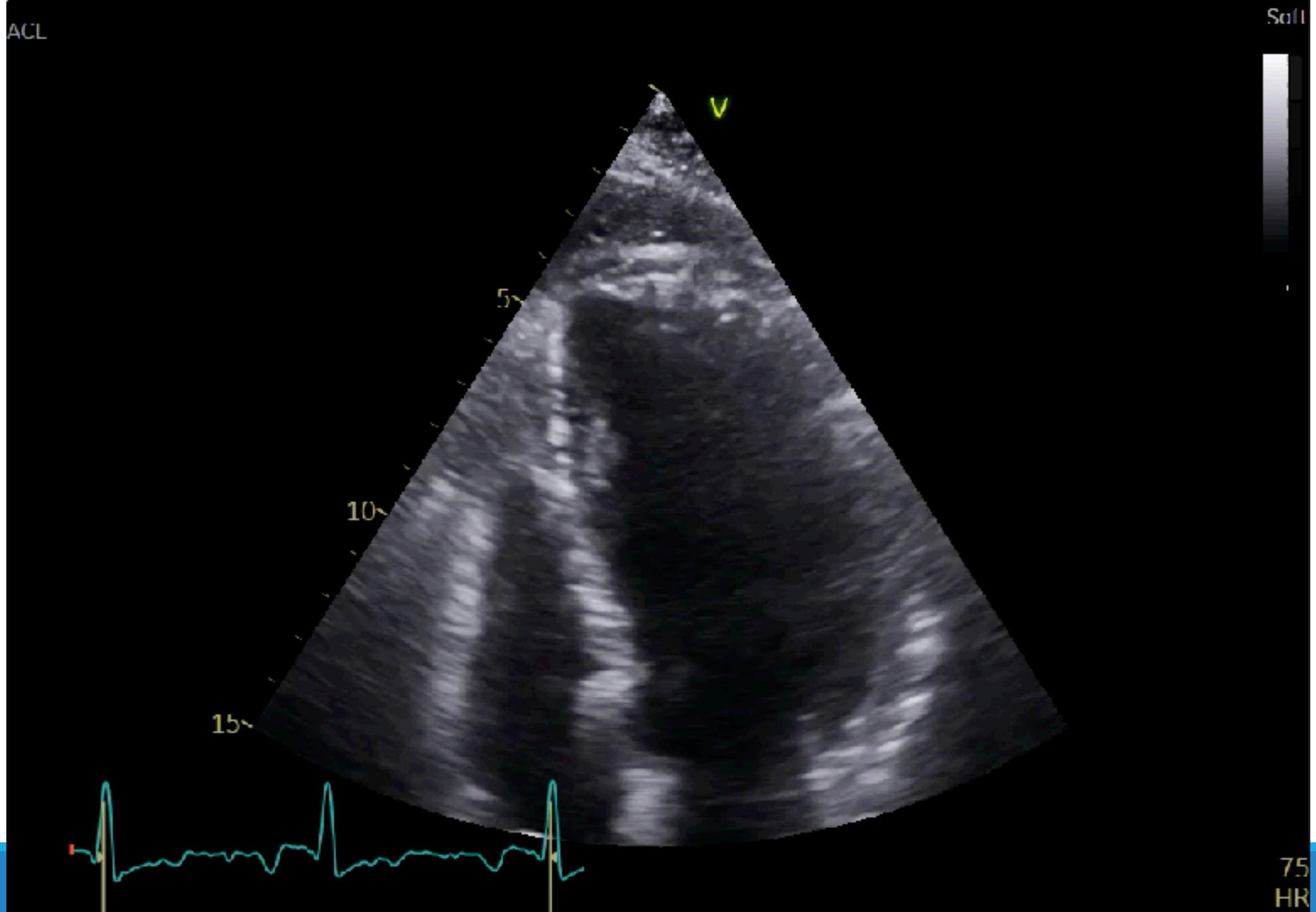
Seuil LBB 0,4V

7mV

585 ohms




0,6V
0,3V


ACL
Soft
V
5
10
15
75
HR

Mme P. 76 ans

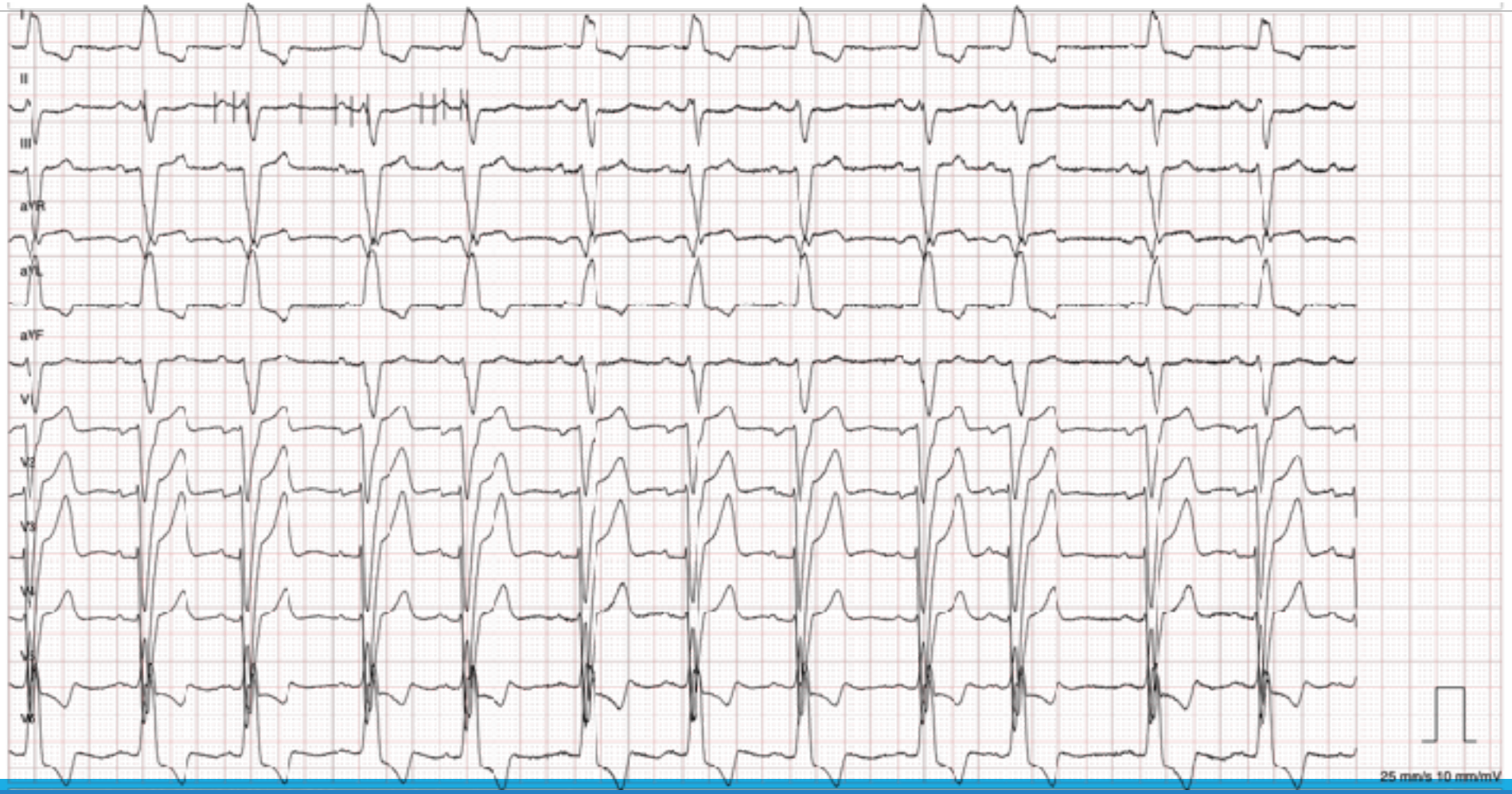
CMD à coronaires saines
FEVG 25% après traitement médical optimal

ECG : sinusal, BBG

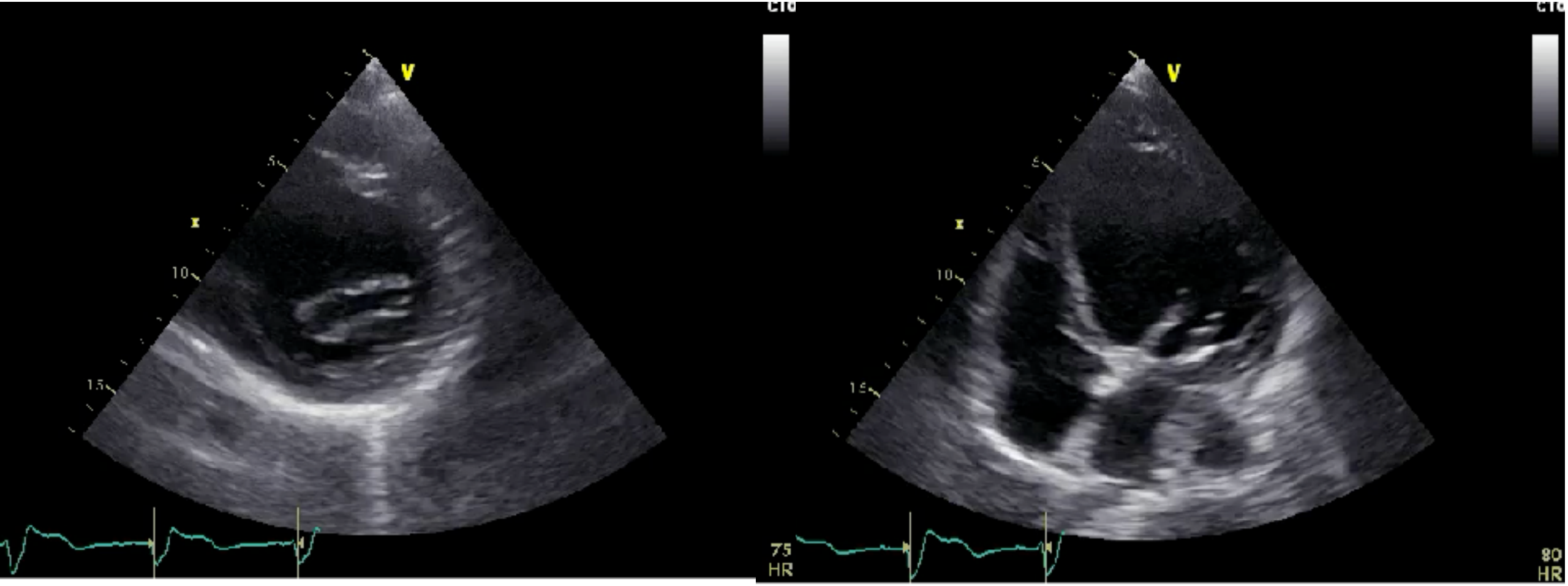
IRM : pas de réhaussement, aspect de cardiopathie conductive

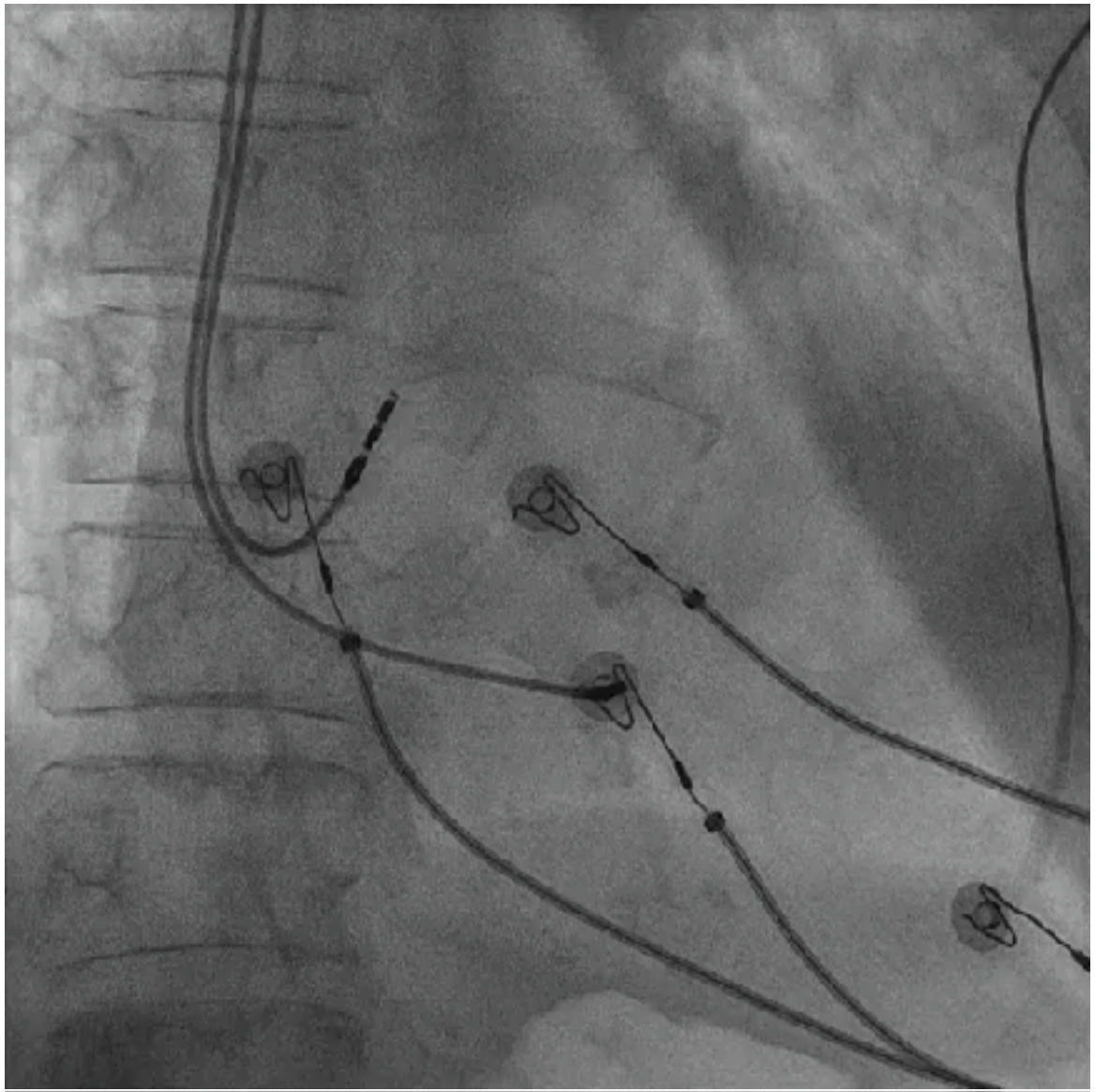
-> Indication PM-CRT

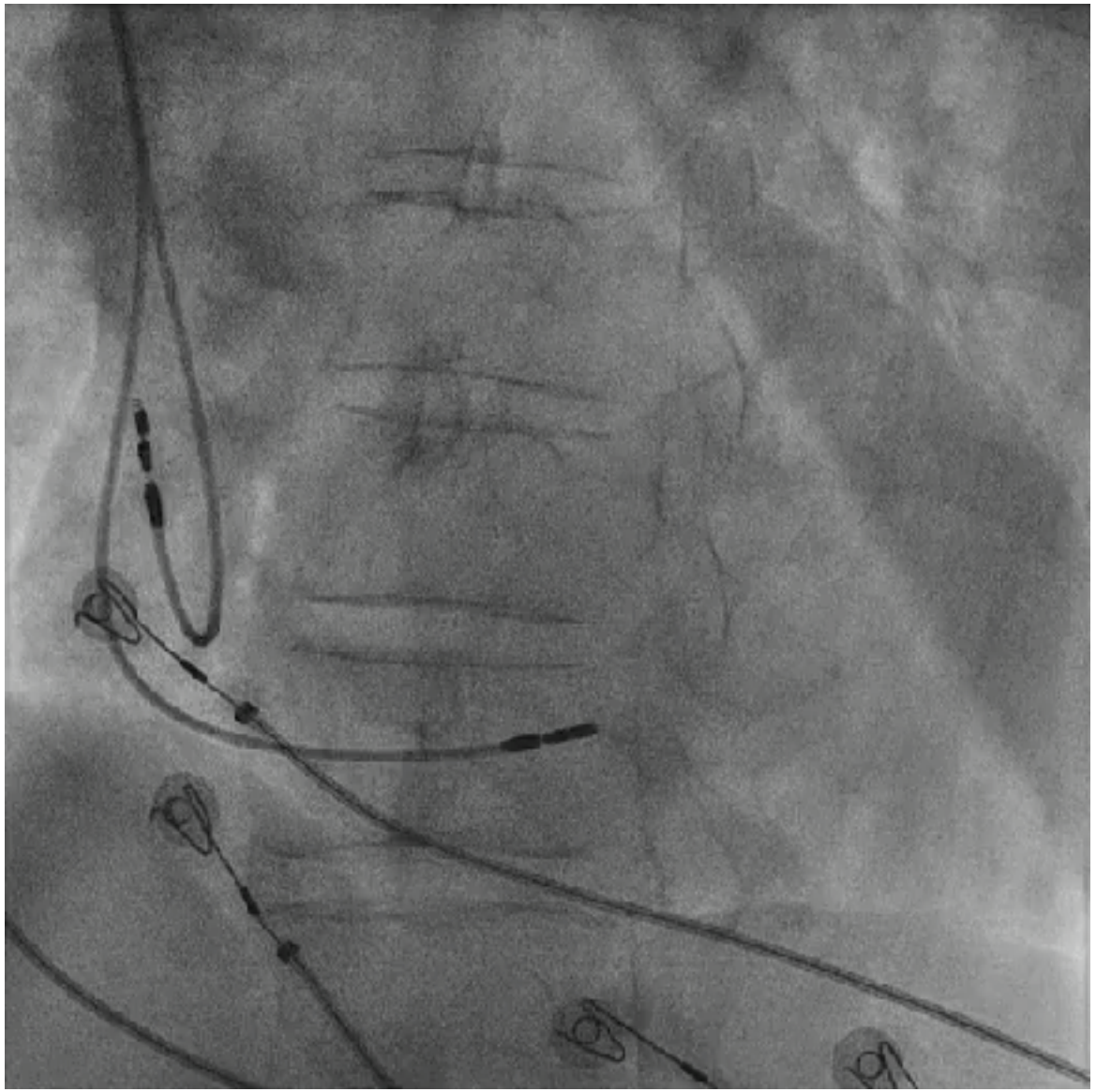
ECG pré implantation



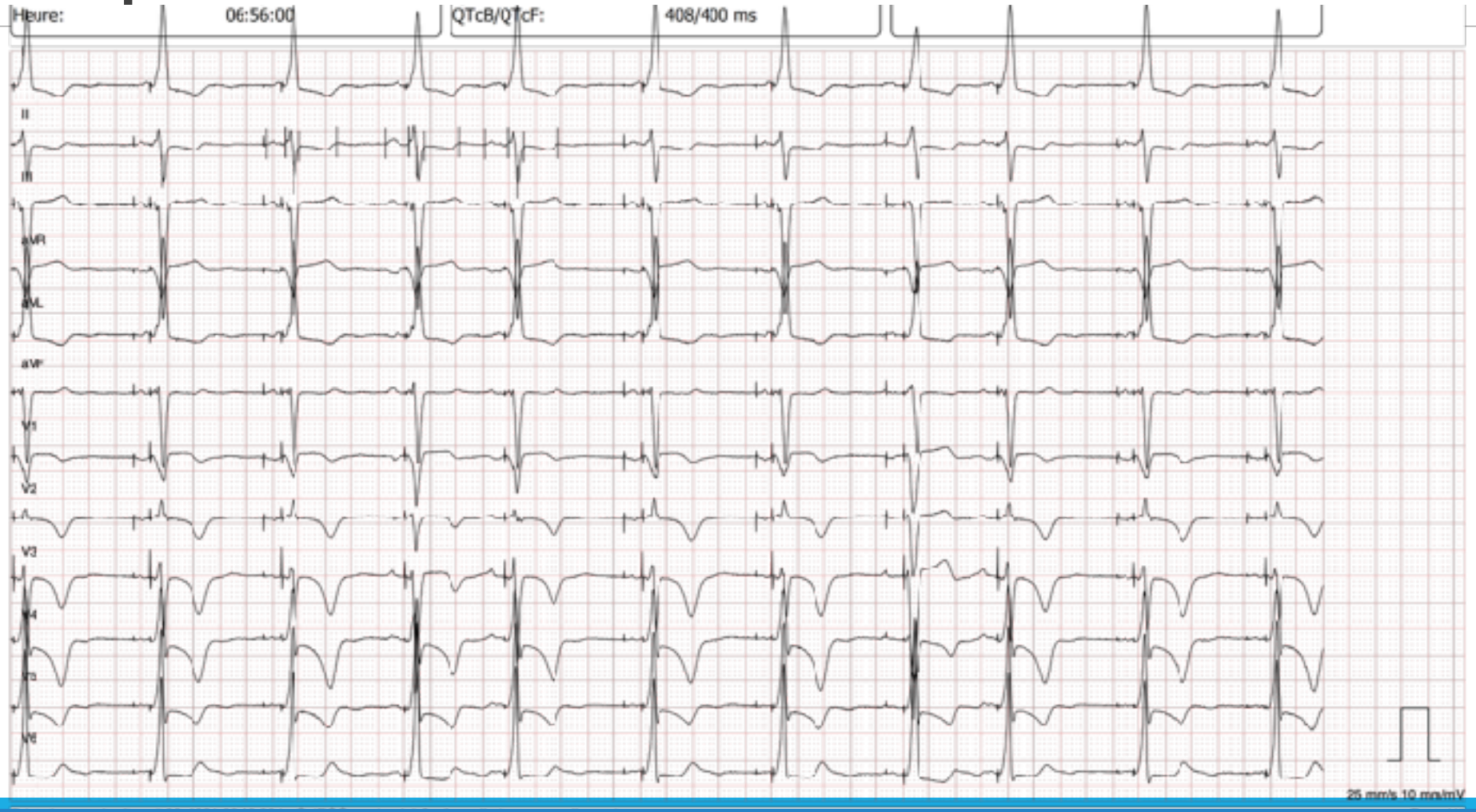
ETT pré-implantation







ECG post-LBBP



Réévaluation à 4 mois

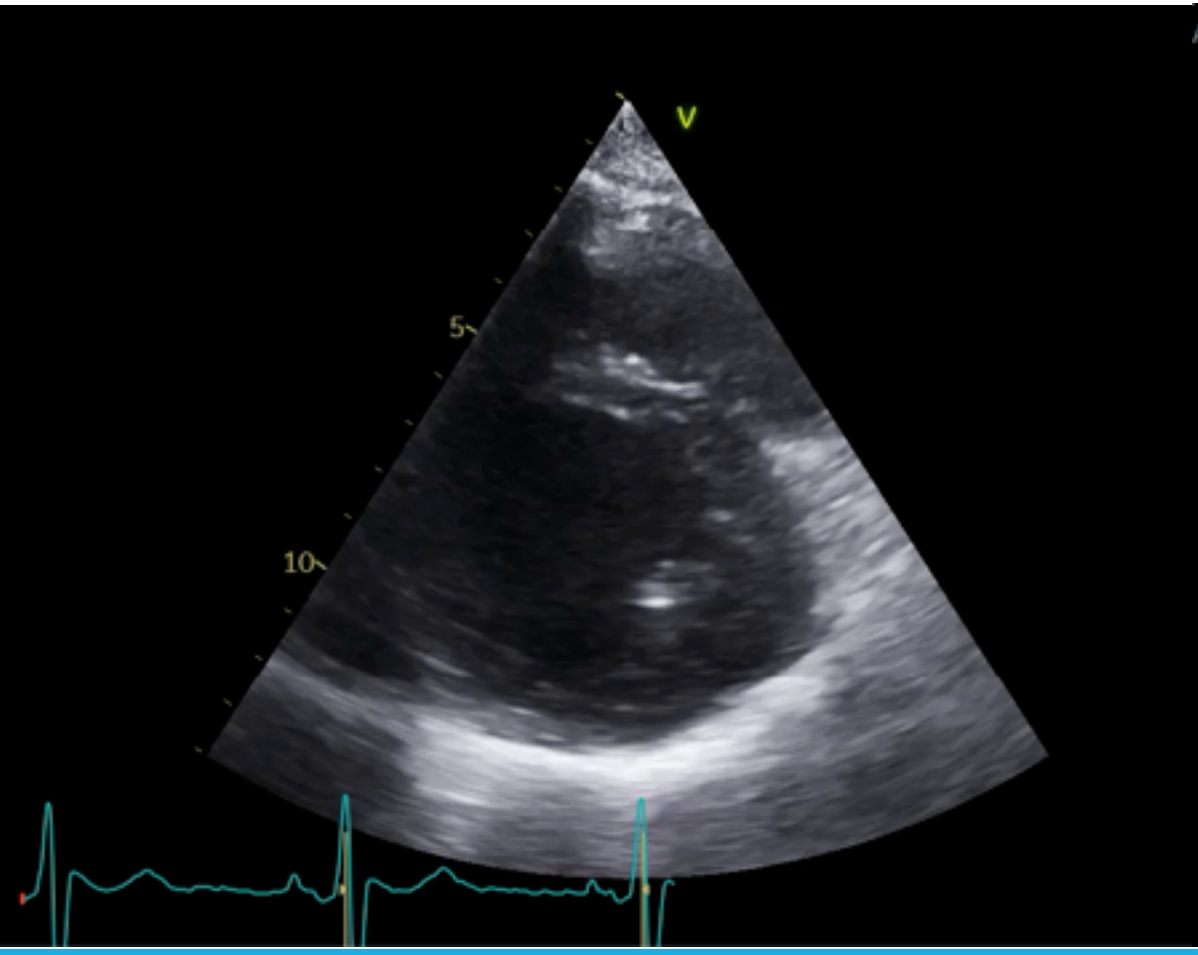
Nette amélioration clinique

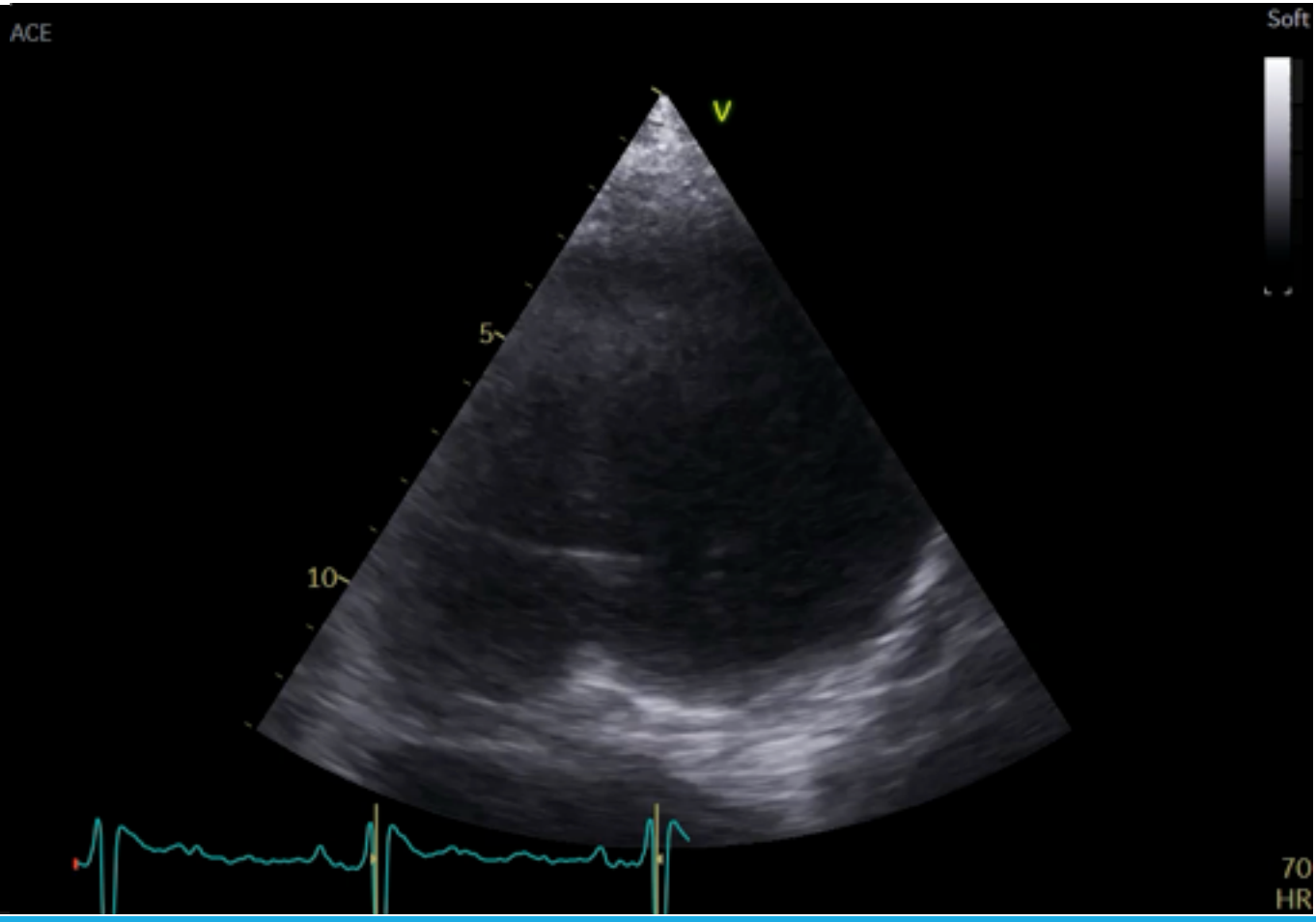
NYHA 1-2

BNP 76 pg/ml

ETT : FEVG 50%

ETT 4 mois post-LBBP





Limites

- **Complications aigues**

  Perforations, déplacement, perte de capture, lésion coronaire septale

- **Performance à long terme**

  Fracture de sonde ? Extraction ?

- **Manque de preuve**, absence de recommandations

  Vs RVP ? Vs CRT ? Vs HBP ?

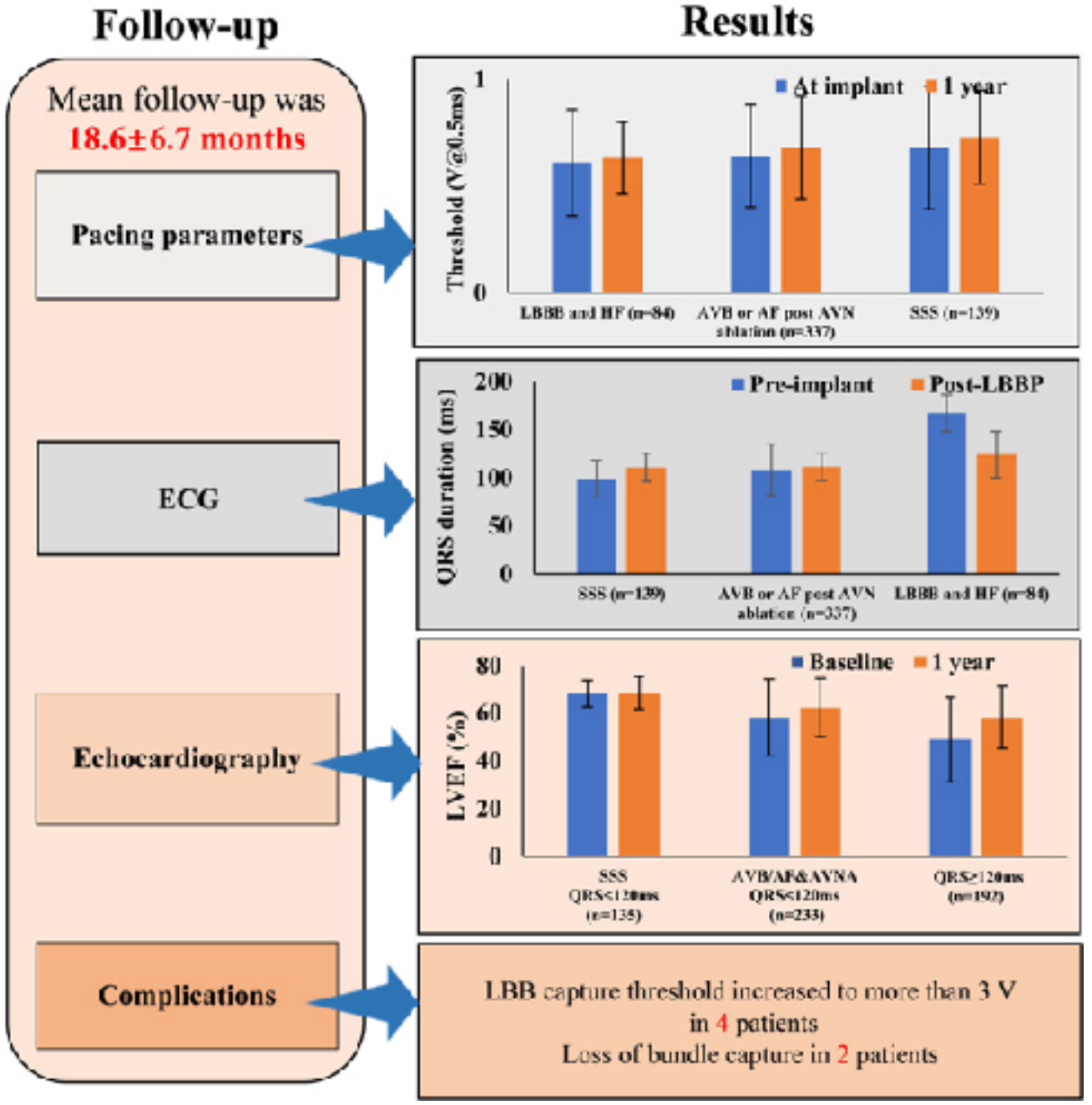
Fiable à 1 an

Stimulation du système de conduction

- Seuils bas
- meilleure détection
- Peu de révision de sonde

Table 3. Complications of Left Bundle Branch Pacing

Complications	Patients (n)
Complications during procedure	
Septal perforation	2
Intravenous puncture-related arterial injury	2
Coronary artery injury	0



Long-Term Safety and Feasibility of Left Bundle Branch Pacing in a Large Single-Center Study
Lan Su, MD, Songjie Wang, Weijian Huang, MD. CIRCEP 2021

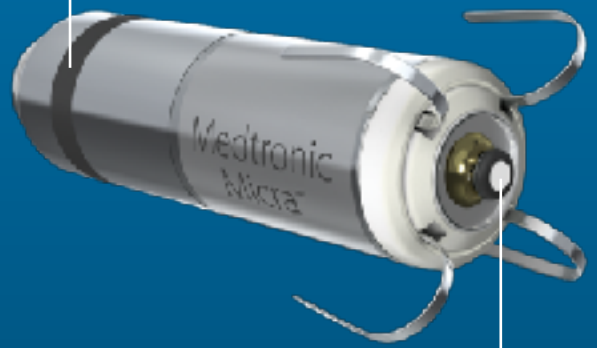
Stimulation sans sonde

MICRA AV

Proximal Retrieval Feature

0,8cc
18mm
1,75g

Anode
- Bipolar pacing



Cathode
- Steroid-eluting electrode
- Separated from FlexFix tines to ensure optimal contact with myocardium

Micra Delivery Catheter

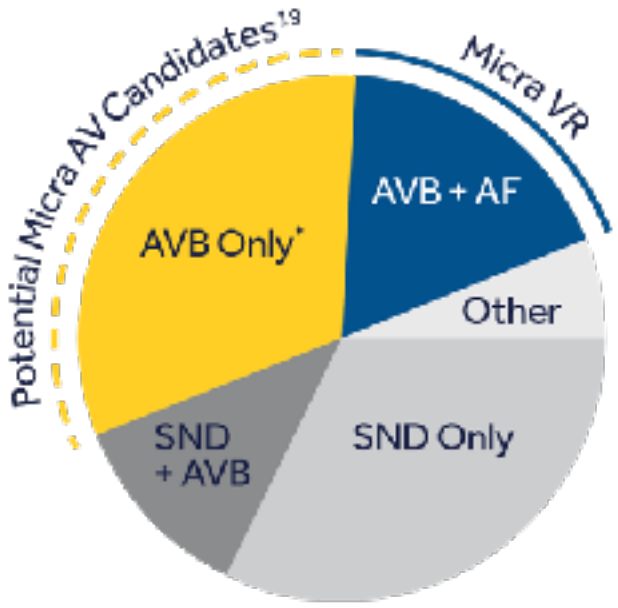
- 105 cm long catheter system with a handle that controls deflection

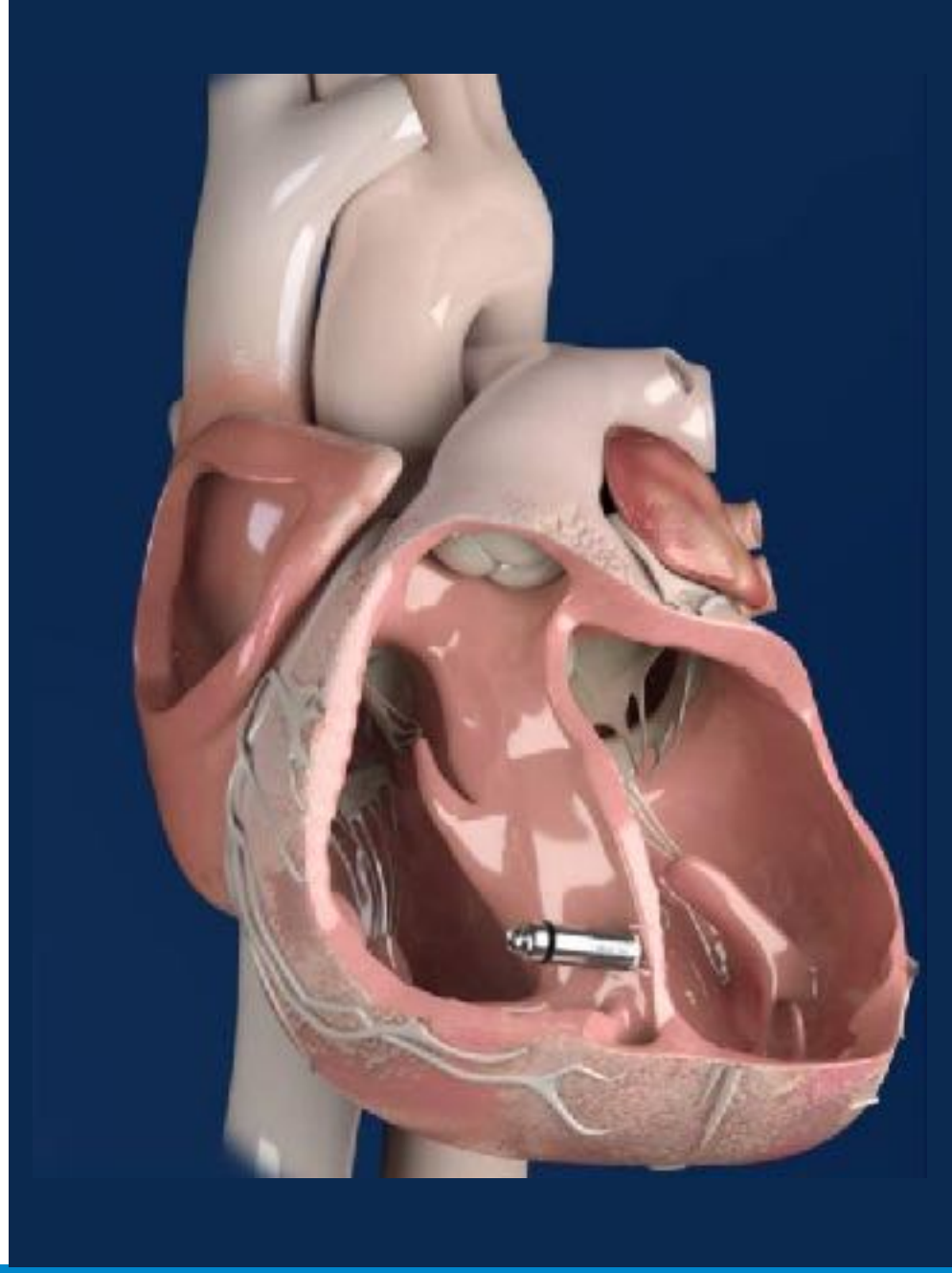
Micra Introducer

- 56 cm
- 23 Fr inner diameter (27 Fr outer diameter)

SYNCHRONISATION AV

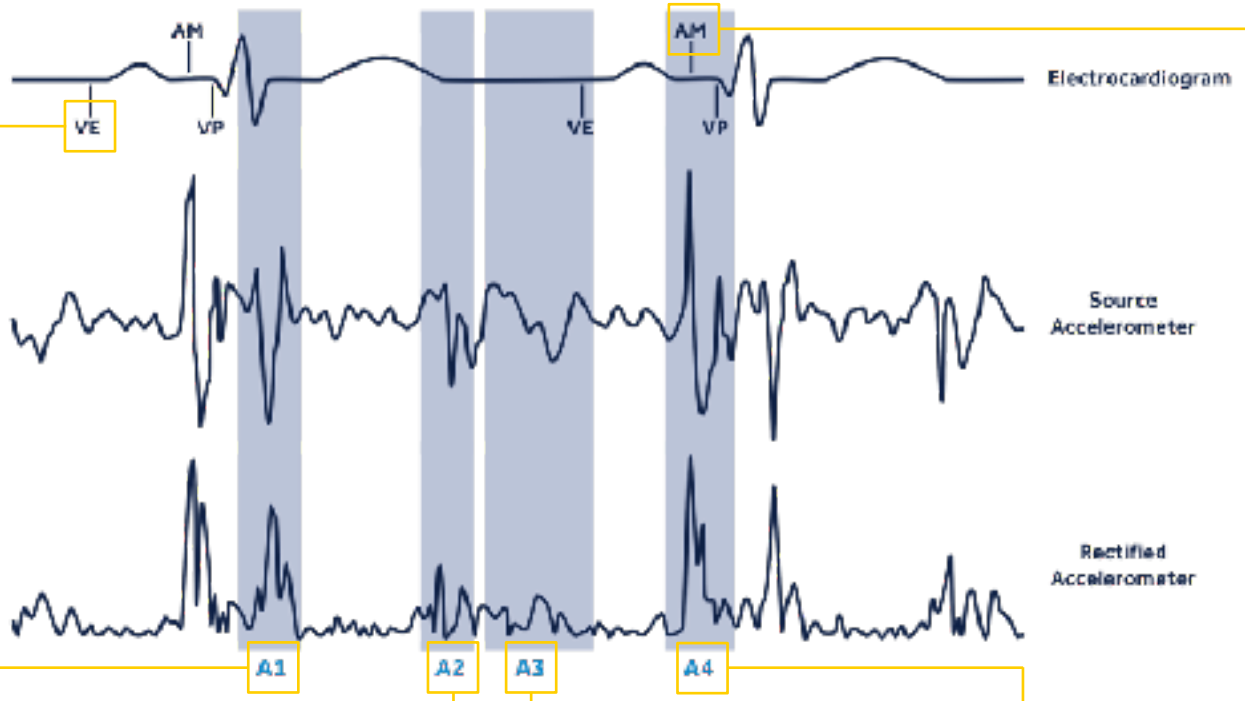
- Fonctionnement en VDD
- Détection de l'activité mécanique atriale par l'accéléromètre du MICRA
- Longévité 8-13 ans





SYNCHRONISATION AV REINVENTEE
SIGNAUX DE L'ACCELEROMETRE DU MICRA™ AV

Marqueur de fin événements ventriculaires (VE)
Fin des signaux ventriculaires A1–A3.



Marqueur de l'activité mécanique atriale (AM)
Marqueur qui indique que le dispositif a détecté l'activité mécanique de l'oreillette (signal A4).

A1
Début de la systole ventriculaire, Fermeture des valves mitrale et tricuspide.

A2
Fin de la systole ventriculaire, Fermeture des valves aortique et pulmonaire.

A3
Diastole, Remplissage passif de l'oreillette vers le ventricule, Ceci correspond à l'onde E visible en écho Doppler

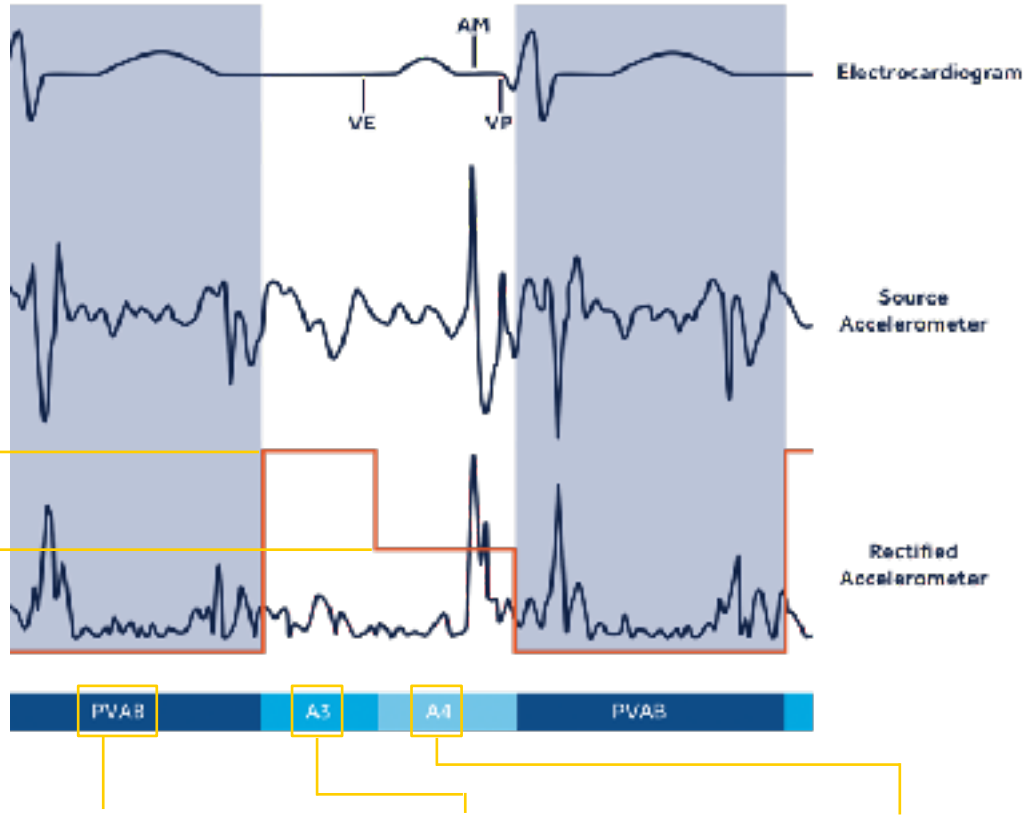
A4
Systole atriale, Délai électromécanique de 100 ms, Ceci correspond à l'onde A en écho Doppler.

Courtesy of Medtronic

SYNCHRONISATION AV REINVENTEE
SIGNAUX DE L'ACCELEROMETRE DU MICRA™ AV

Seuil A3
Doit être réglé à une valeur plus élevée que le signal A3.

Seuil A4
Doit être réglé plus bas que le signal A4 mais à une valeur suffisamment élevée pour s'affranchir du bruit.

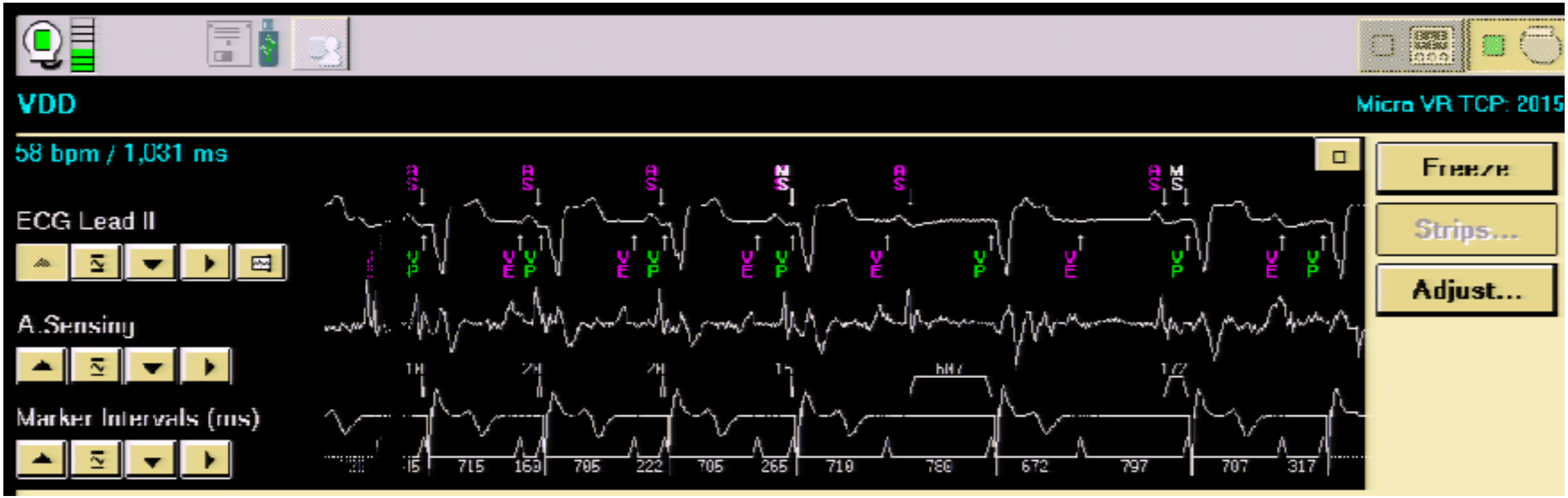


Blanking atrial post-ventriculaire (PVAB)
Les signaux A1 et A2 sont rejetés. Aucune détection atriale n'a lieu pendant cette période .

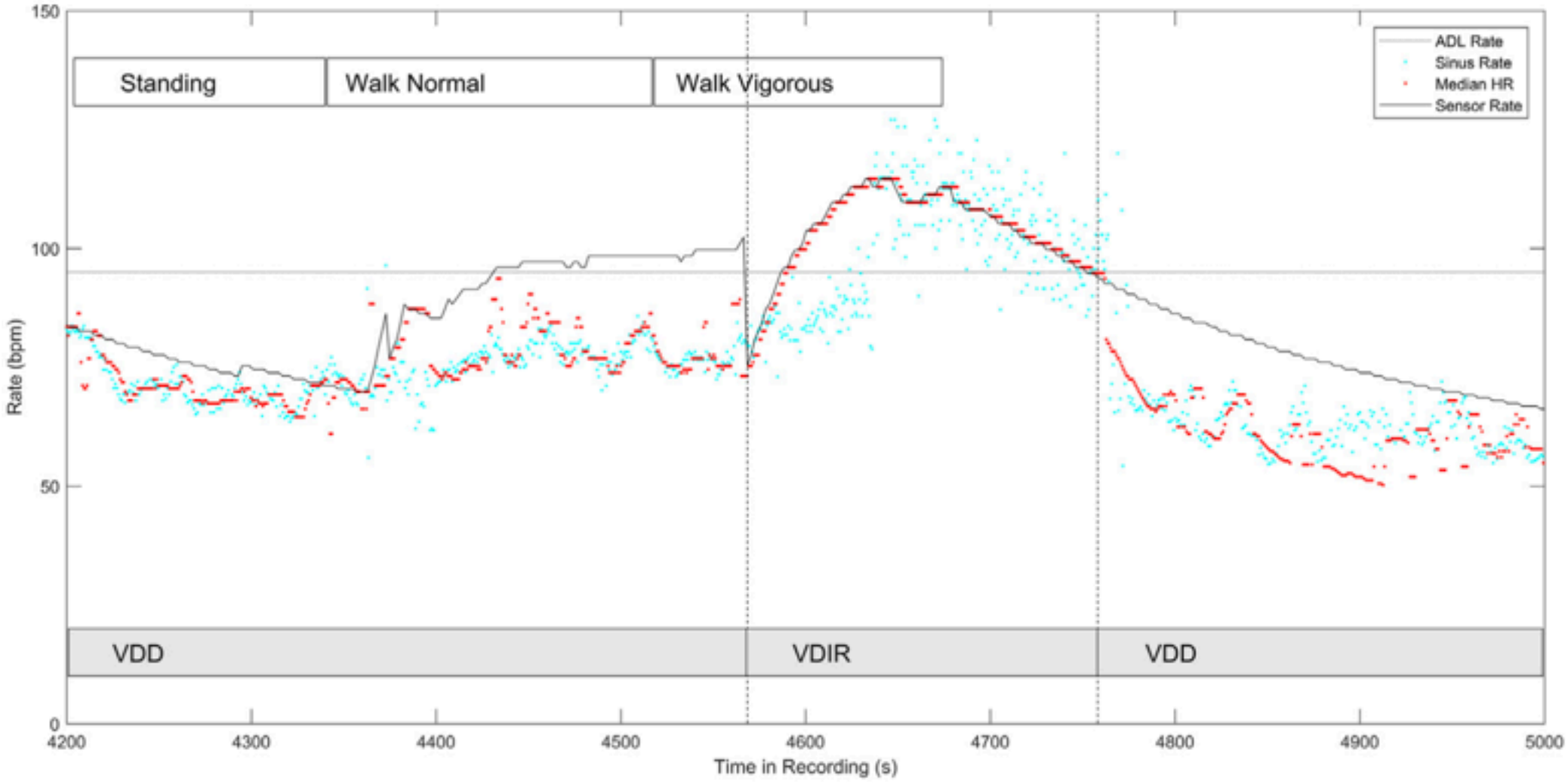
Fenêtre de détection de A3
Le réglage est peu sensible de façon à ce que seul un signal de forte amplitude puisse être détecté. Elle est conçue pour rejeter le signal A3.

Fenêtre de détection de A4
Utilisée pour détecter le signal A4 à l'issue de la diastole ventriculaire.

AV conduction mode switch : VVI 40bpm



Activity Mode Switch : commutation en VVIR à l'effort

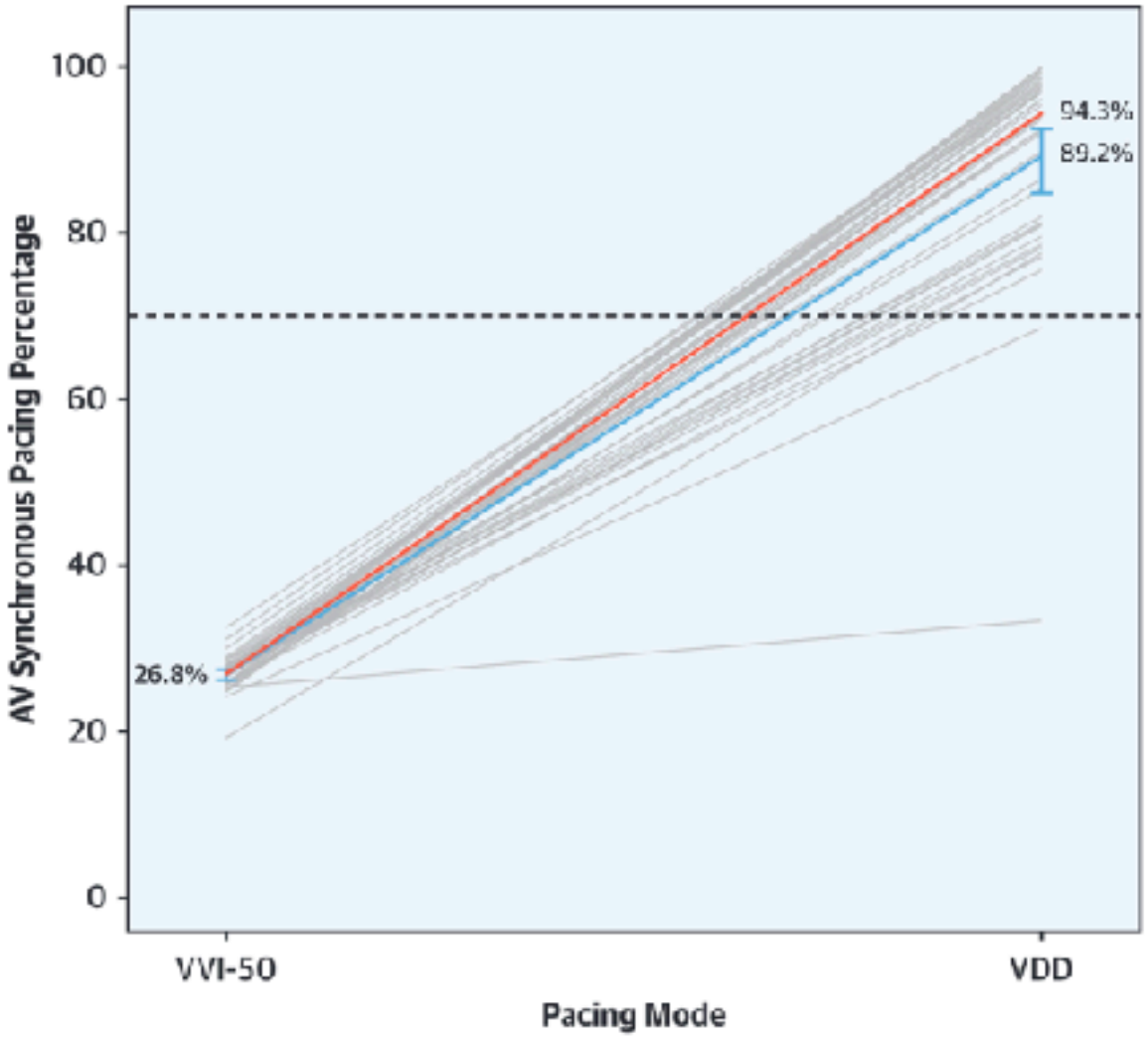


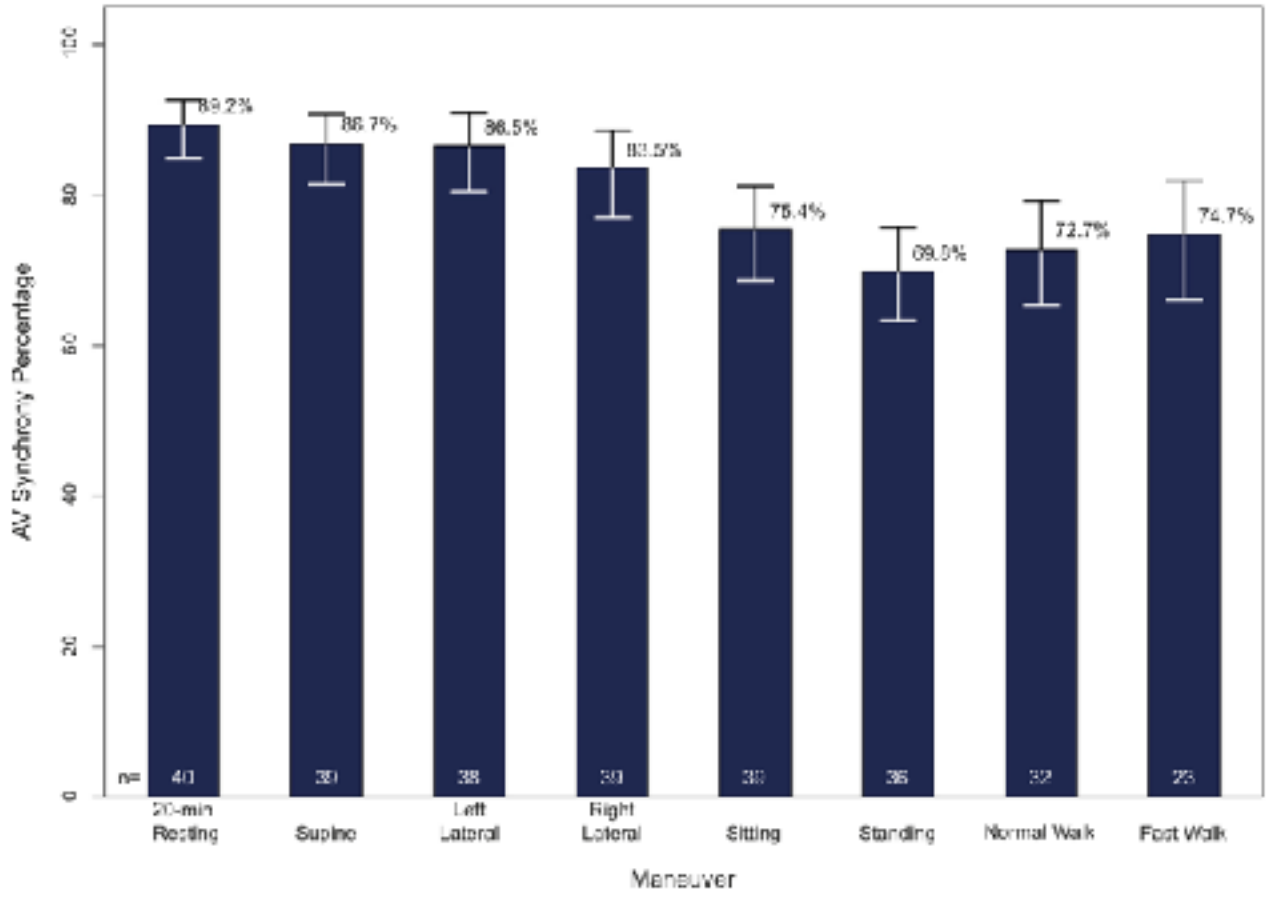
Atrioventricular Synchronous Pacing Using a Leadless Ventricular Pacemaker

Results From the MARVEL 2 Study

Clemens Steinwender, MD,[a,b] Surinder Kaur Khelae, MD,[c] Christophe Garweg, MD,[d] Joseph Yat Sun Chan, MD,[e] Philippe Ritter, MD,[f] Jens Brock Johansen, MD, PhD,[g] Venkata Sagi, MD,[h] Laurence M. Epstein, MD,[i] Jonathan P. Piccini, MD, MHS,[j] Mario Pascual, MD,[k] Lluis Mont, MD,[l] Todd Sheldon, MS,[m] Vincent Splett, MS,[m] Kurt Stromberg, MS,[m] Nicole Wood, BS,[m] Larry Chinitz, MD[n]

Marvel 2 : pourcentage d'association AV



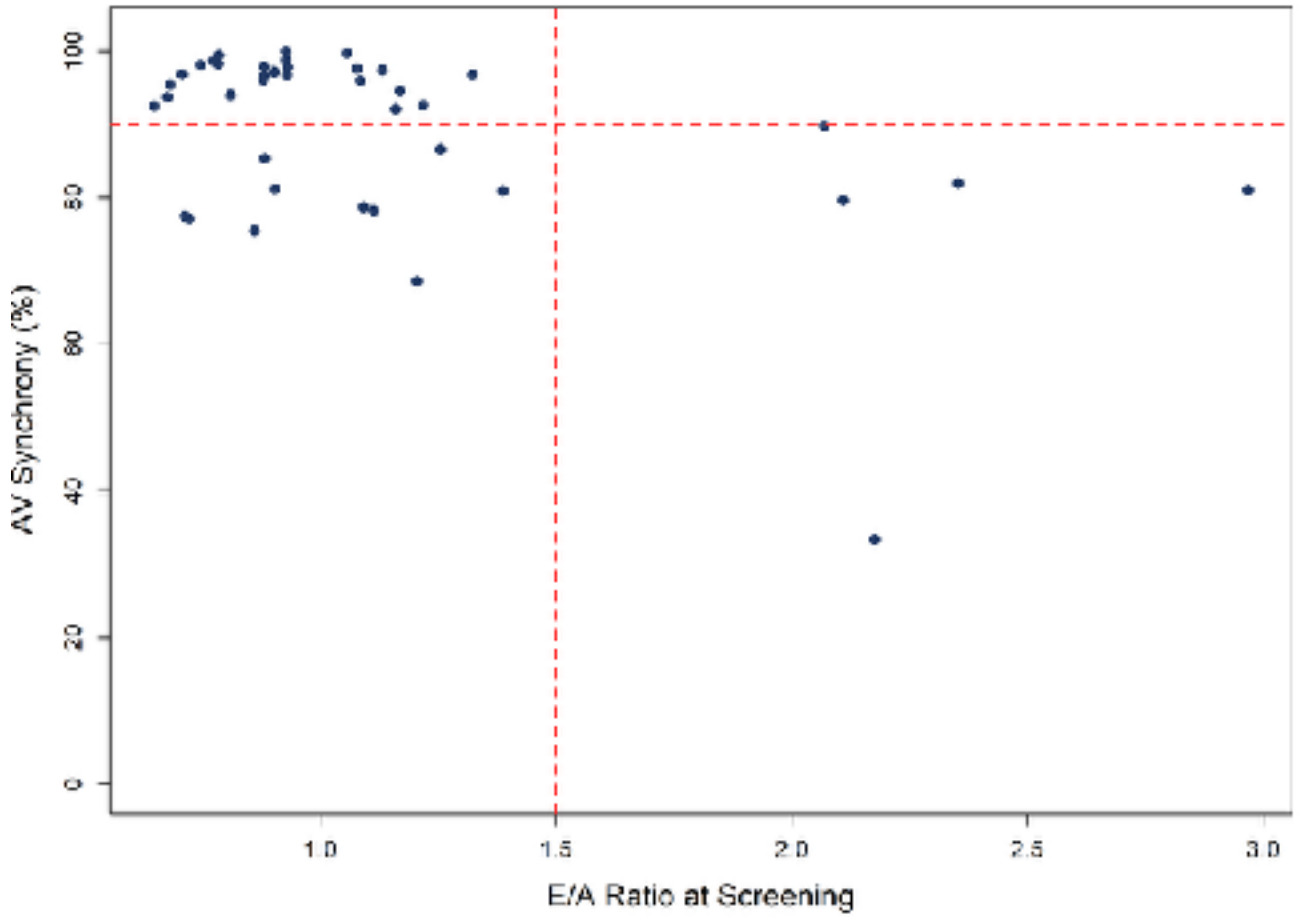


FACTEUR IMPACTANT L'ASSOCIATION AV

Variable Type	Variables	Summary	Univariate Models			Multivariable Model	
			β (95% CI)	P-value	R^2	β (95% CI)	P-value
Baseline and Medical History	Male	54.7%	-0.57 (-1.25–0.10)	0.099	0.04		
	Systolic blood pressure	137 ± 20 [92–176]	0.02 (0.00–0.04)	0.036	0.07		
	History of atrial arrhythmias	15.6%	-0.81 (-1.73–0.11)	0.089	0.05		
	CABG	12.5%	-1.41 (-2.38 to -0.44)	0.006	0.12	-1.01 (-1.8 to -0.13)	0.025
	Prior valve surgery	21.9%	-0.80 (-1.60–0.00)	0.056	0.06		
Echocardiography	4-chamber TR jet area	3 ± 2 [0–12]	-0.15 (-0.32–0.01)	0.077	0.05		
	LV ejection fraction	54 ± 4 [40–61]	0.21 (0.02–0.39)	0.030	0.08		
	LA end-diastolic volume	52 ± 19 [19–92]	-0.12 (-0.25–0.02)	0.088	0.05		
	LA end-systolic volume	25 ± 10 [8–44]	-0.13 (-0.25–0.00)	0.055	0.06		
	LA ejection fraction	53.23 ± 3.99 [46.15–63.04]	0.13 (-0.01–0.28)	0.070	0.05		
	E/A (mitral valve)	1.18 ± 0.62 [0.48–3.43]	-0.25 (-0.39 to -0.10)	0.002	0.15	-0.13 (-0.28–0.02)	0.092
	RV TAPSE	2.4 ± 0.5 [1.4–3.4]	0.23 (0.10–0.37)	0.001	0.15		
	Atrial contraction excursion (ACE)	1.0 ± 0.2 [0.5–1.7]	0.34 (0.18–0.49)	< 0.001	0.23	0.26 (0.11–0.42)	0.001
	E/e'	12.67 ± 6.27 [4.10–31.41]	-0.12 (-0.27–0.02)	0.097	0.05		
	e/a' lateral	1.25 ± 0.85 [0.47–4.57]	-0.19 (-0.34 to -0.03)	0.024	0.08		
	e'/a' septal	1.27 ± 1.01 [0.45–5.00]	-0.16 (-0.31 to -0.01)	0.039	0.07		
	e'/a' average	1.18 ± 0.66 [0.54–3.90]	-0.24 (-0.41 to -0.08)	0.005	0.12		
	Atrial strain Ɛa	8.3 ± 4.4 [1.2–21.6]	0.16 (0.01–0.32)	0.045	0.06	0.11 (-0.03–0.24)	0.117

Garweg C, Khelae SK, Chinitz L. et al Predictors of atrial mechanical sensing and atrioventricular synchrony with a leadless ventricular pacemaker: Results from the MARVEL 2 Study. Heart Rhythm. 2020 Dec;17(12):2037-2045. doi: 10.1016/j.hrthm.2020.07.024. Epub 2020 Jul 24. PMID: 32717315.

RESULTS[30]



No patients with > 90% synchrony had an E/A ratio above 1.5.

- 5 of 15 patients with ≤ 90% synchrony had an E/A ratio > 1.5.

Selection du patient

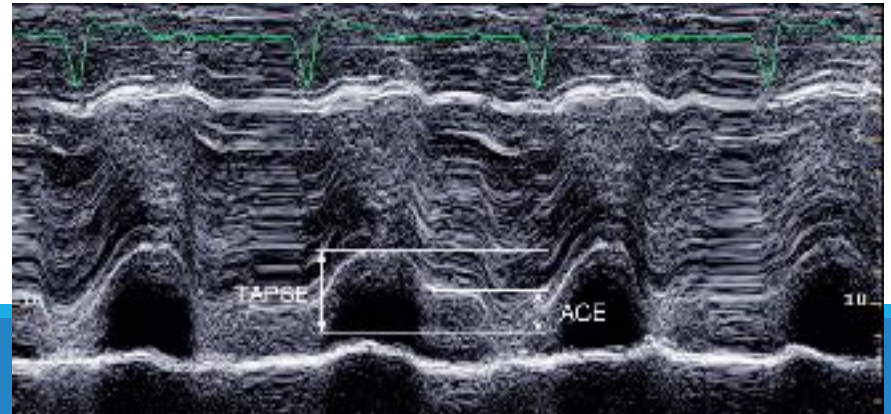
Facteurs de risques d'**échec d'association AV** :

- Faible contraction atriale
- Dysfonction sinusale, Tachycardie sinusale
- ESA et ESV fréquentes

Intérêt d'une **ETT pré-implantation**

E/A ratio

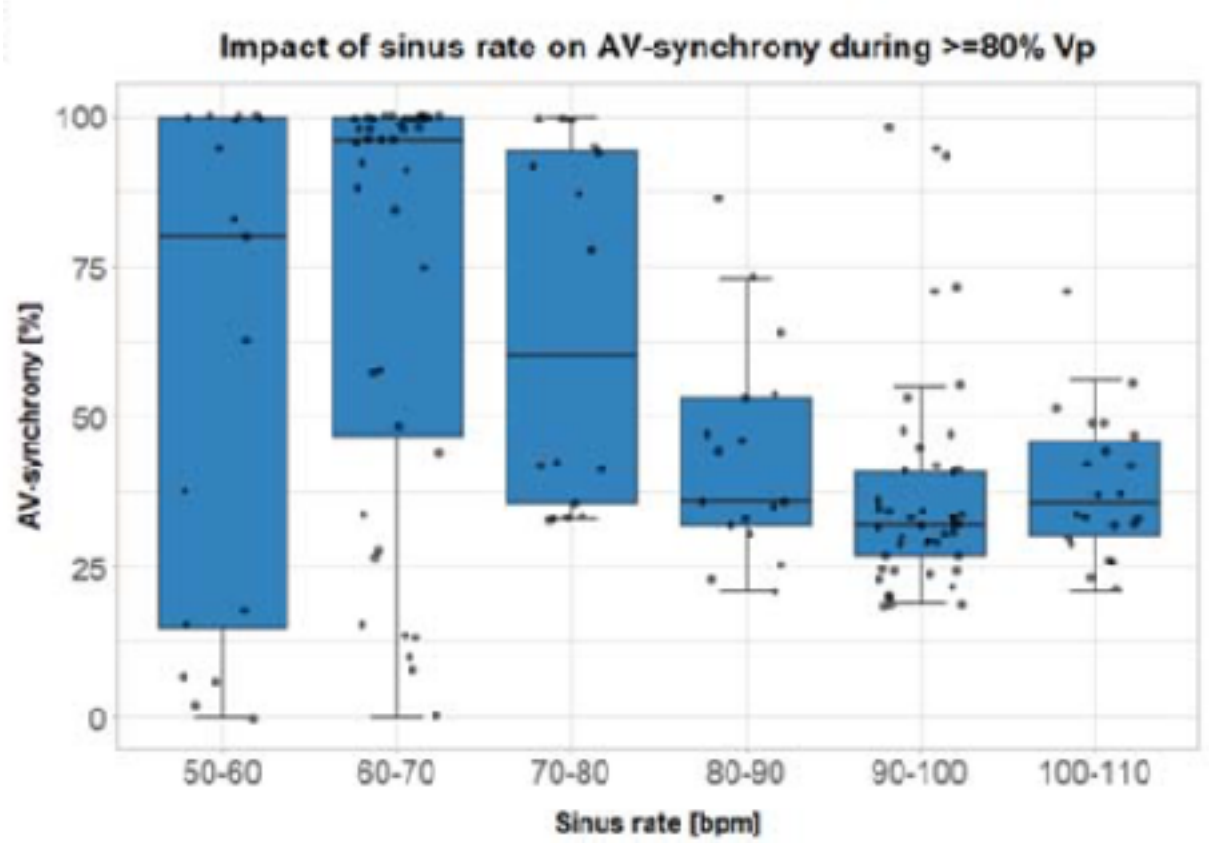
Atrial Contraction Excursion



Programmations ++

- Fenêtre A3 courte
- Seuil A4 bas
- Fréquence basse (VDD 50)

Taux d'association plus bas que dans les études de validation



20 patients ambulatoires
816 heures de Holter ECG

Leadless atrio-ventricular synchronous pacing in an outpatient setting - early lessons learned on factors affecting atrio-ventricular synchrony. Neugebauer F, Noti F, Haeberlin A et al. Heart Rhythm. 2021 Dec 28

Merci de votre attention