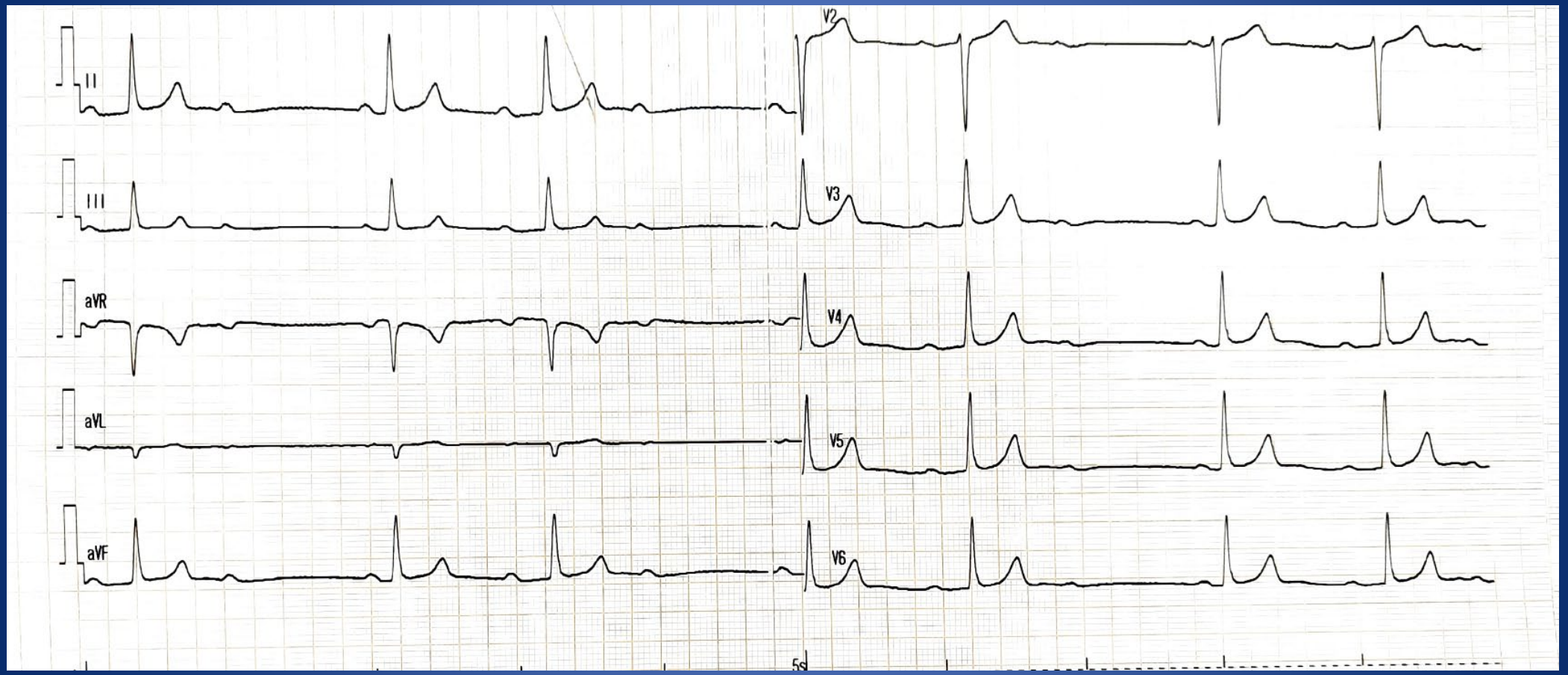
Cardio-neuro-ablation CNA for AVB and perhaps Vagal AF?

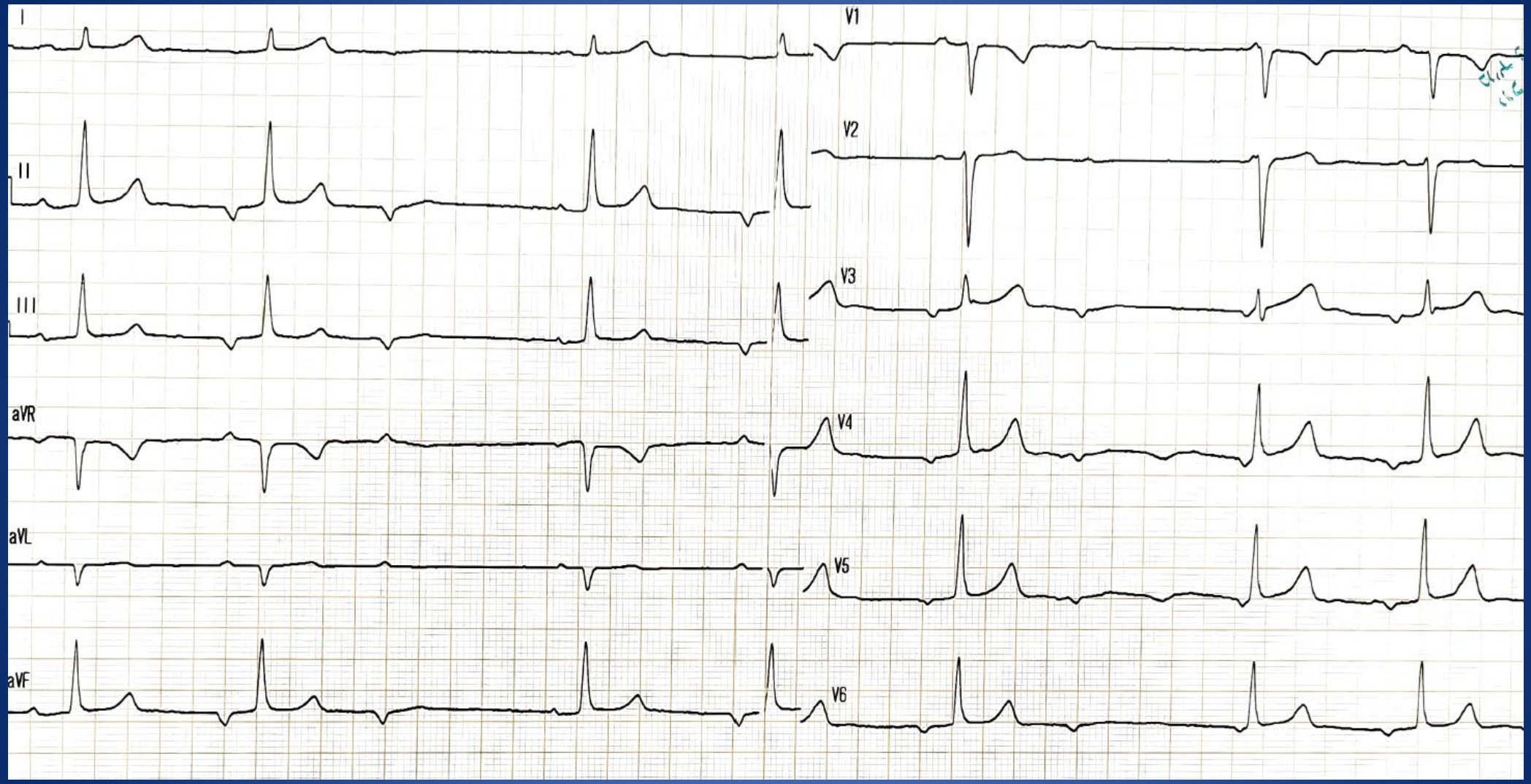
Moti Haim, MD
Cardiac Electrophysiology and Pacing
Cardiology Department
Soroka Medical Center

Patient 1 BT

- 27 years old woman
- Healthy, Does not take any medications, occasional cannabis use
- Presented due to recurrent Syncopal episodes

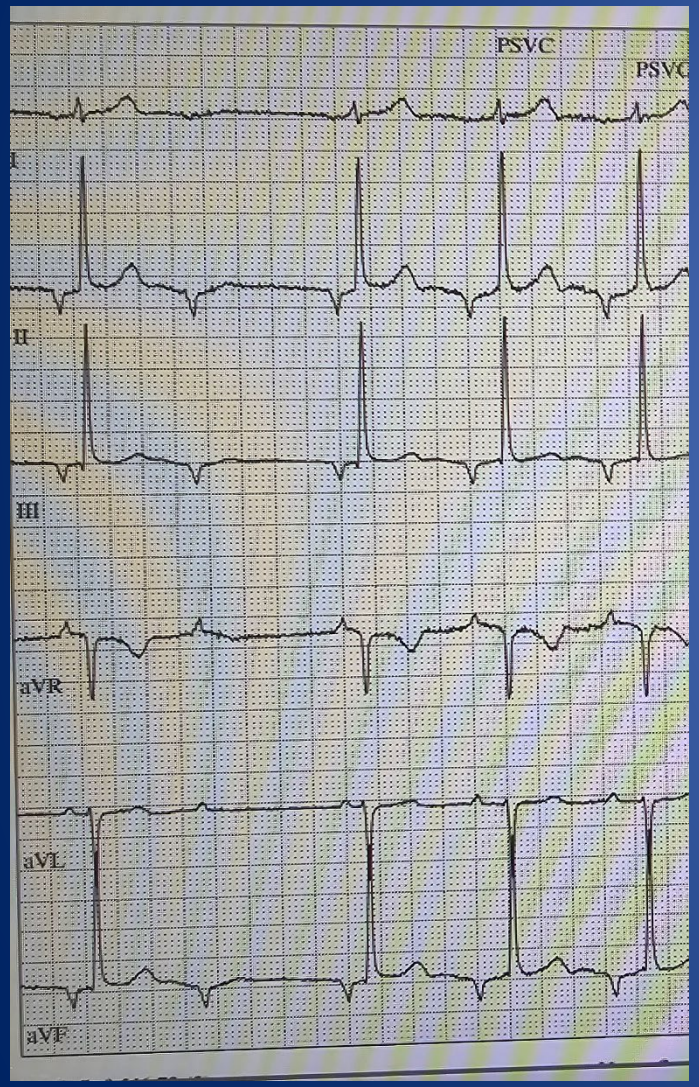
ECGs

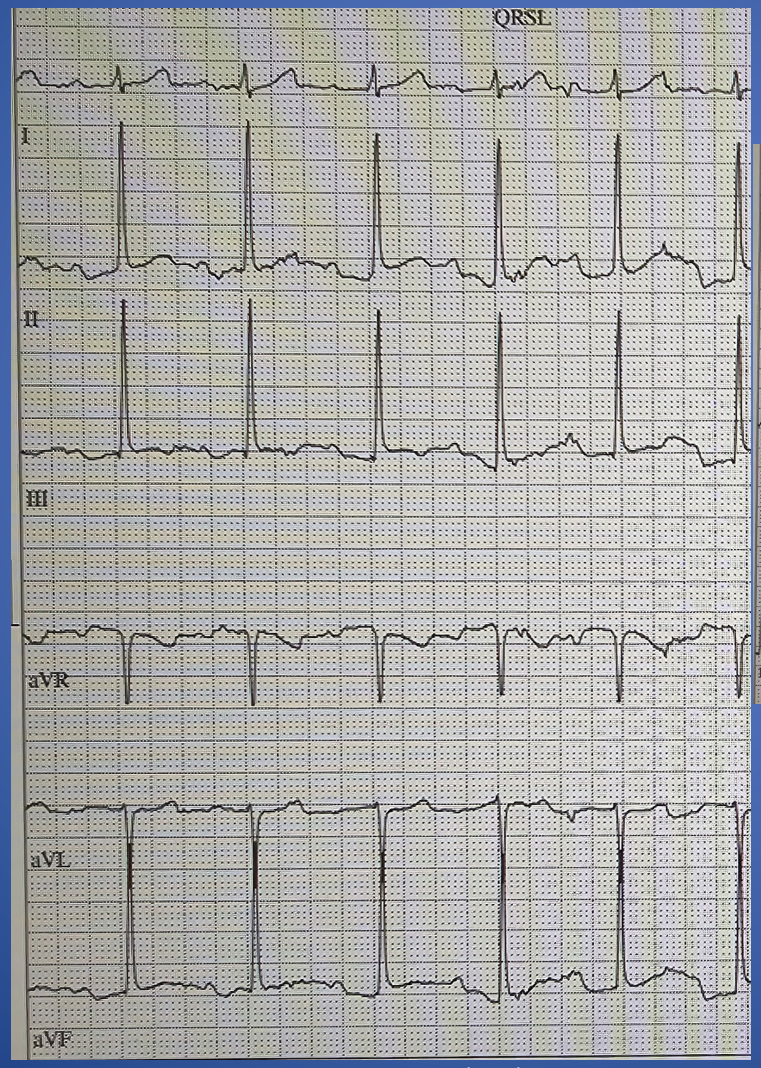




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Ergometry







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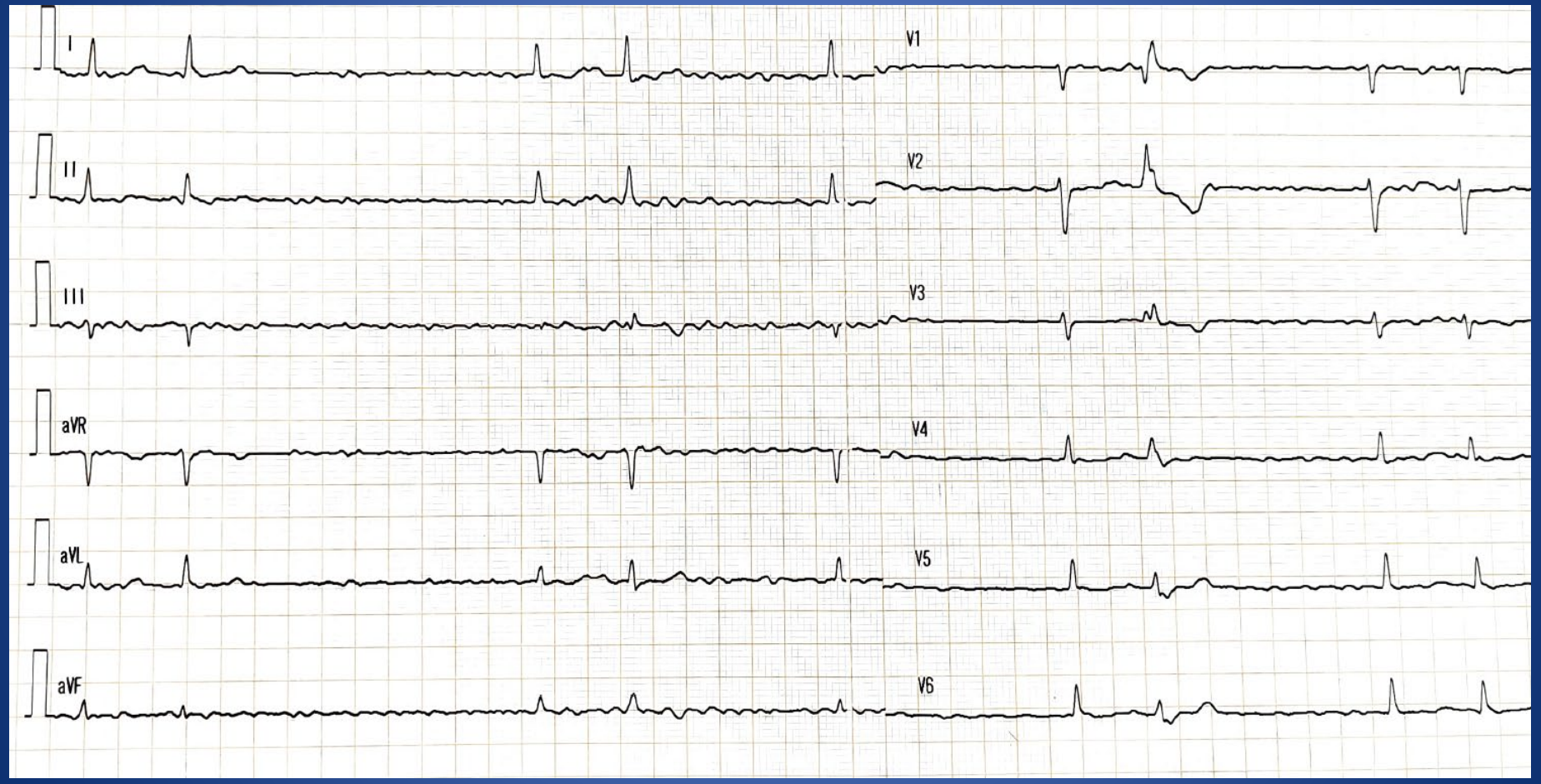
Work-Up

- Echocardiogram was normal
- Cardiac MRI was normal and Cardiac Sacoidosis was excluded
- EPS showed prolonged AH at baseline and normal HV interval
- AV Nodal Wenckebach at 700 ms at baseline
- With Atropine AVN block CL improved to 500 ms and with Isuprel AV Nodal Wenckebach was 340 ms

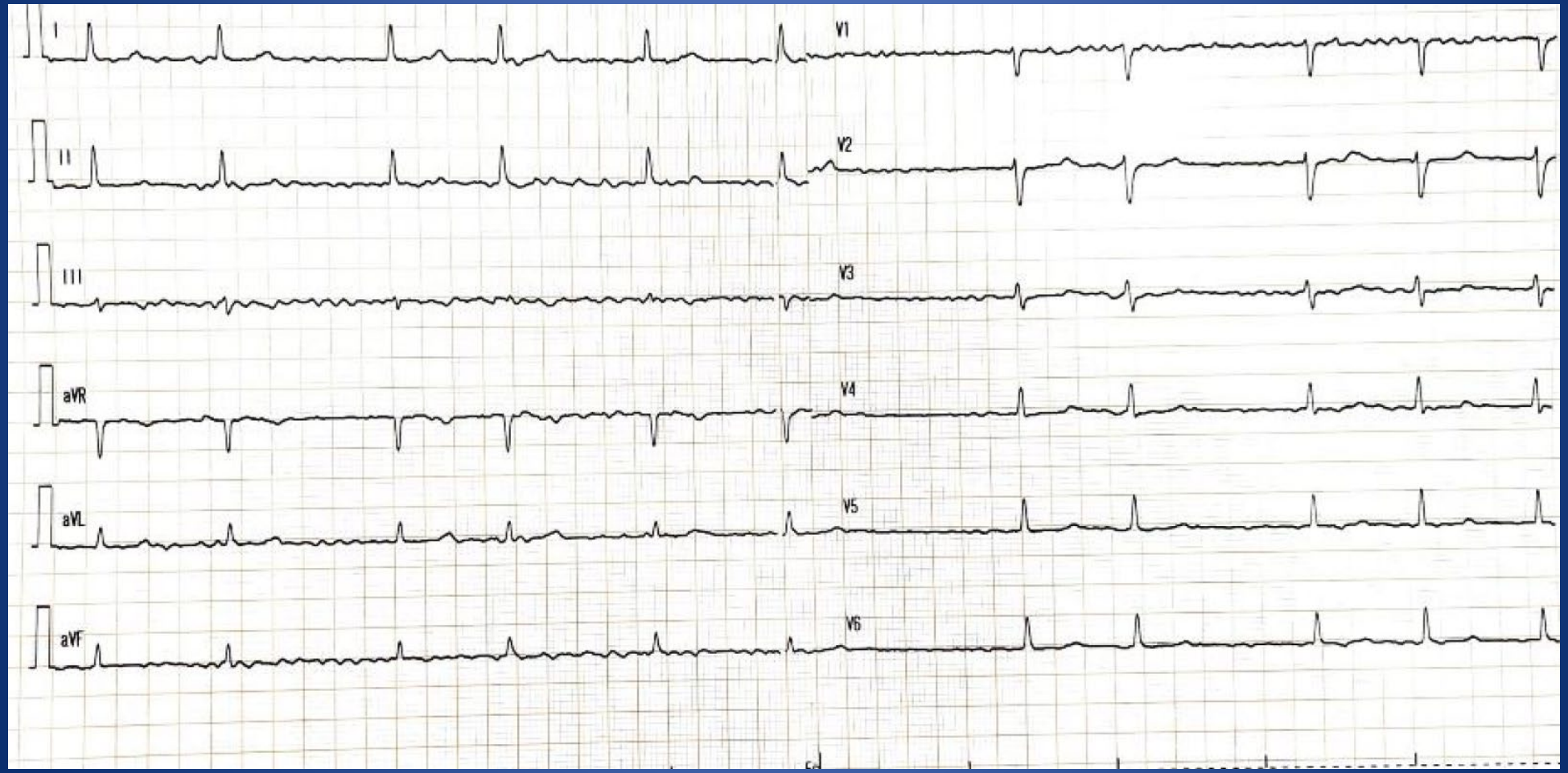
Patient 2

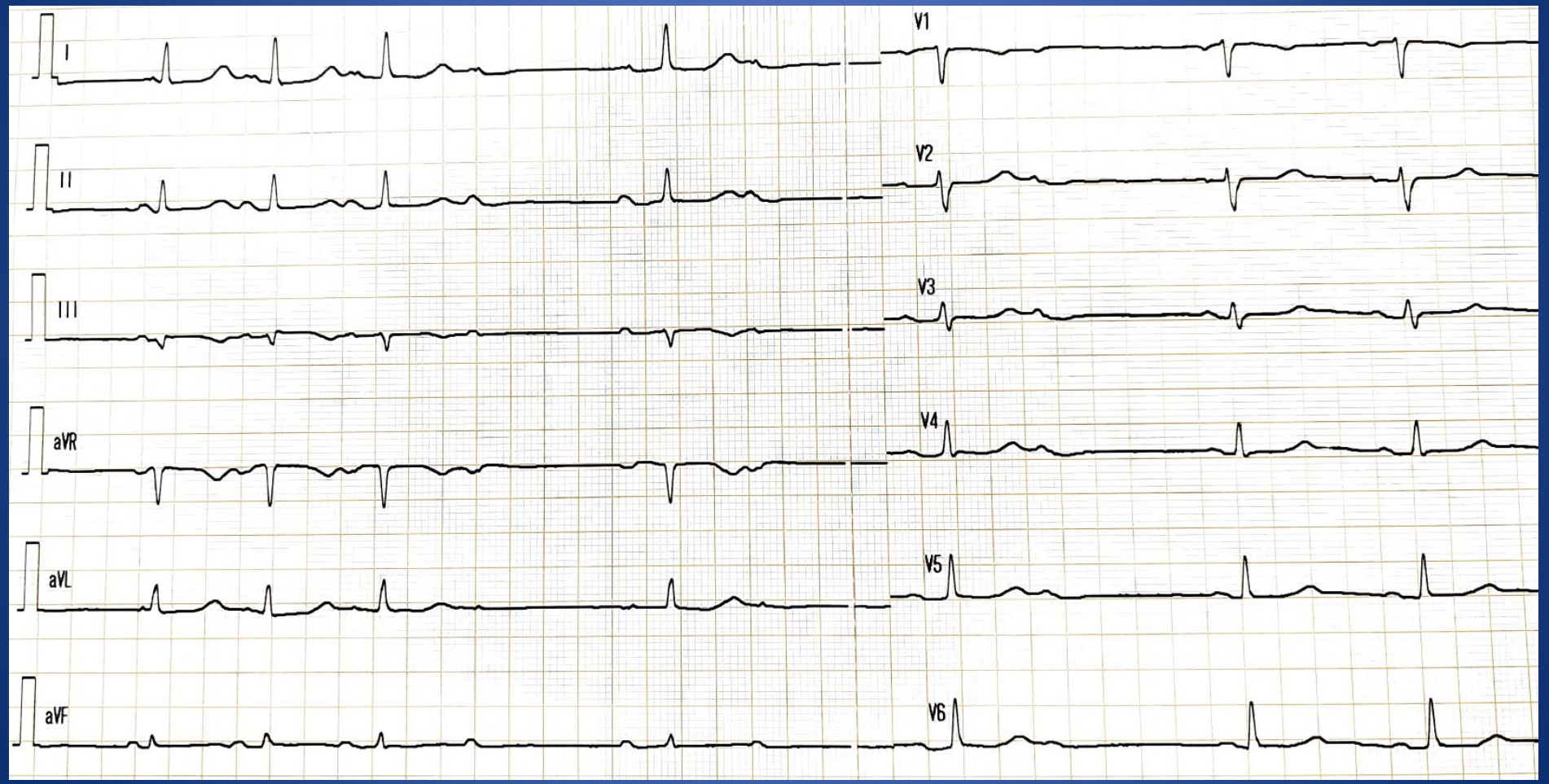
- 35 year old woman, mental retardation
- Otherwise healthy
- Previous episodes of “falls”, presyncopal episodes, and probably some syncopal episodes
- Current Hospitalization for another fall/syncope with fracture of left leg.

ECGs

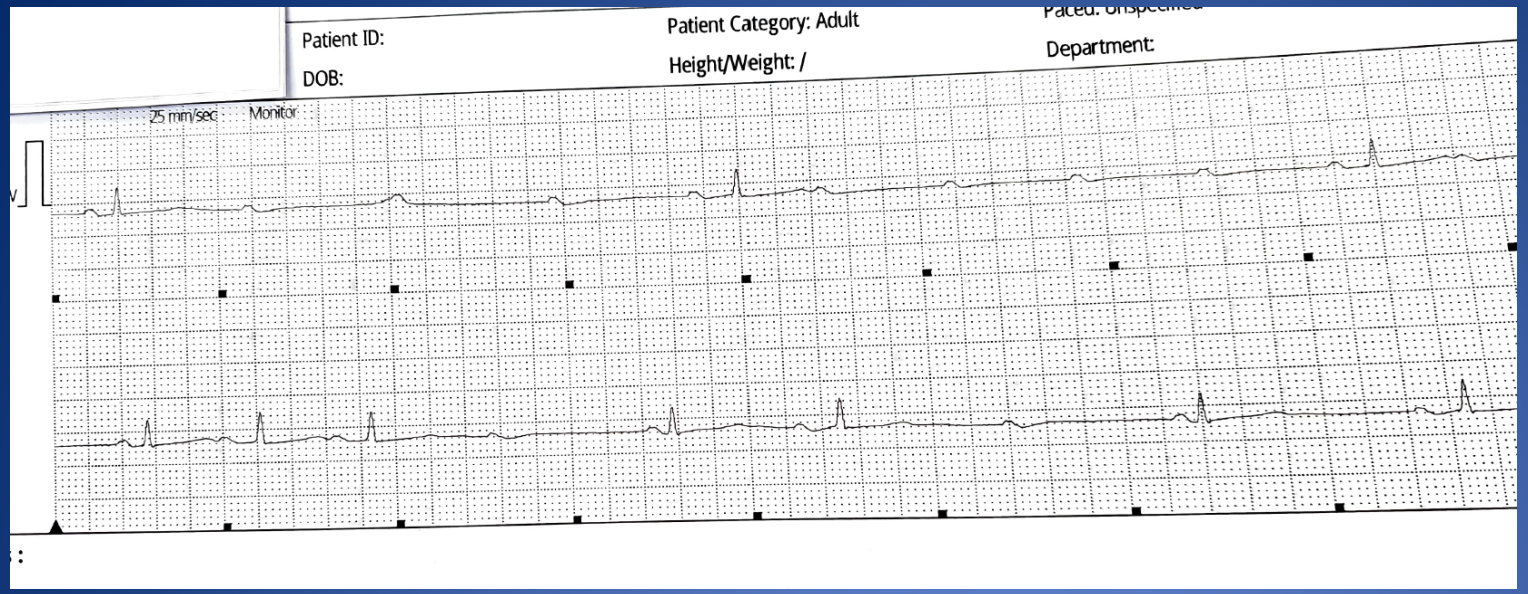


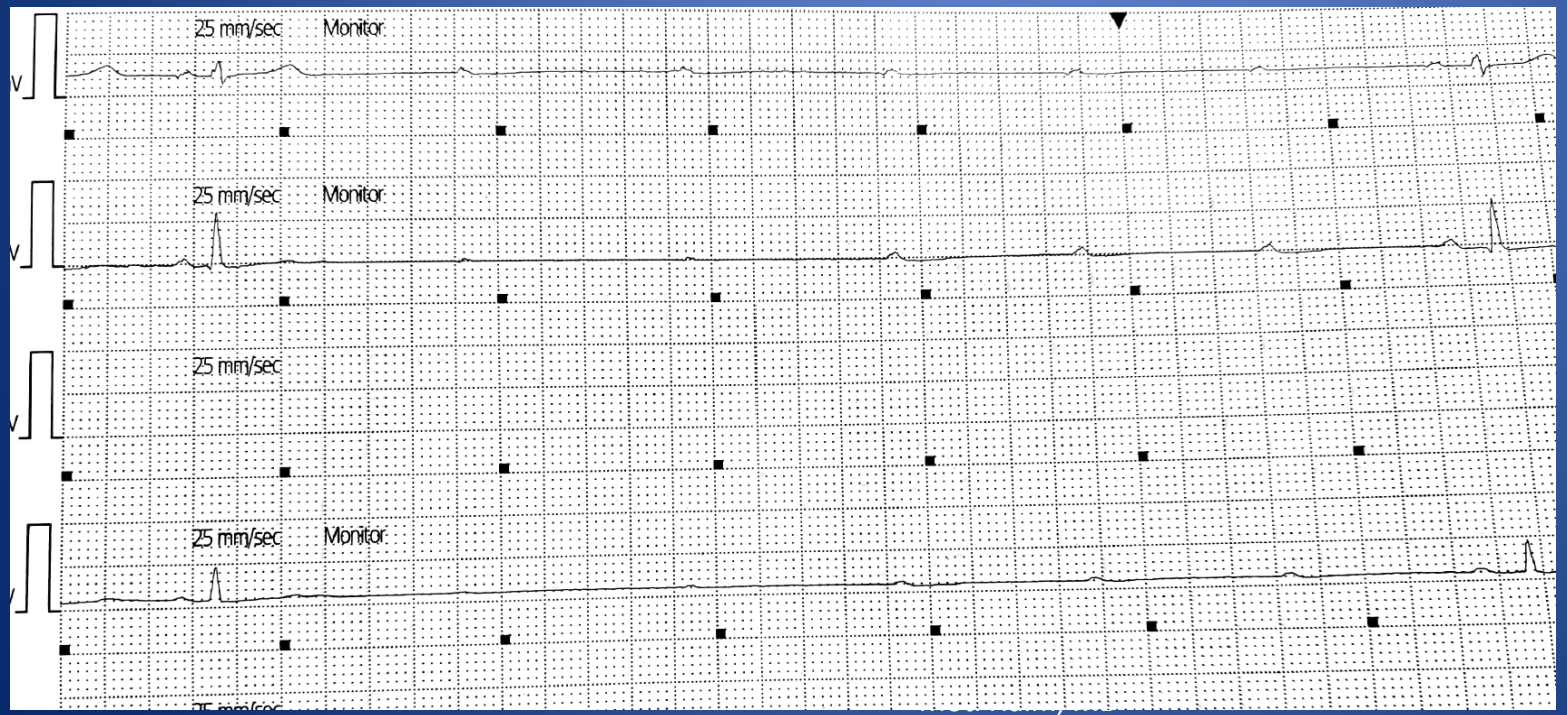
ECGs





Moti Haim, MD


Patient ID:
DOB:
Patient Category: Adult
Height/Weight: /
Department:
25 mm/sec
Monitor


25 mm/sec
Monitor
25 mm/sec
Monitor
25 mm/sec
25 mm/sec
Monitor

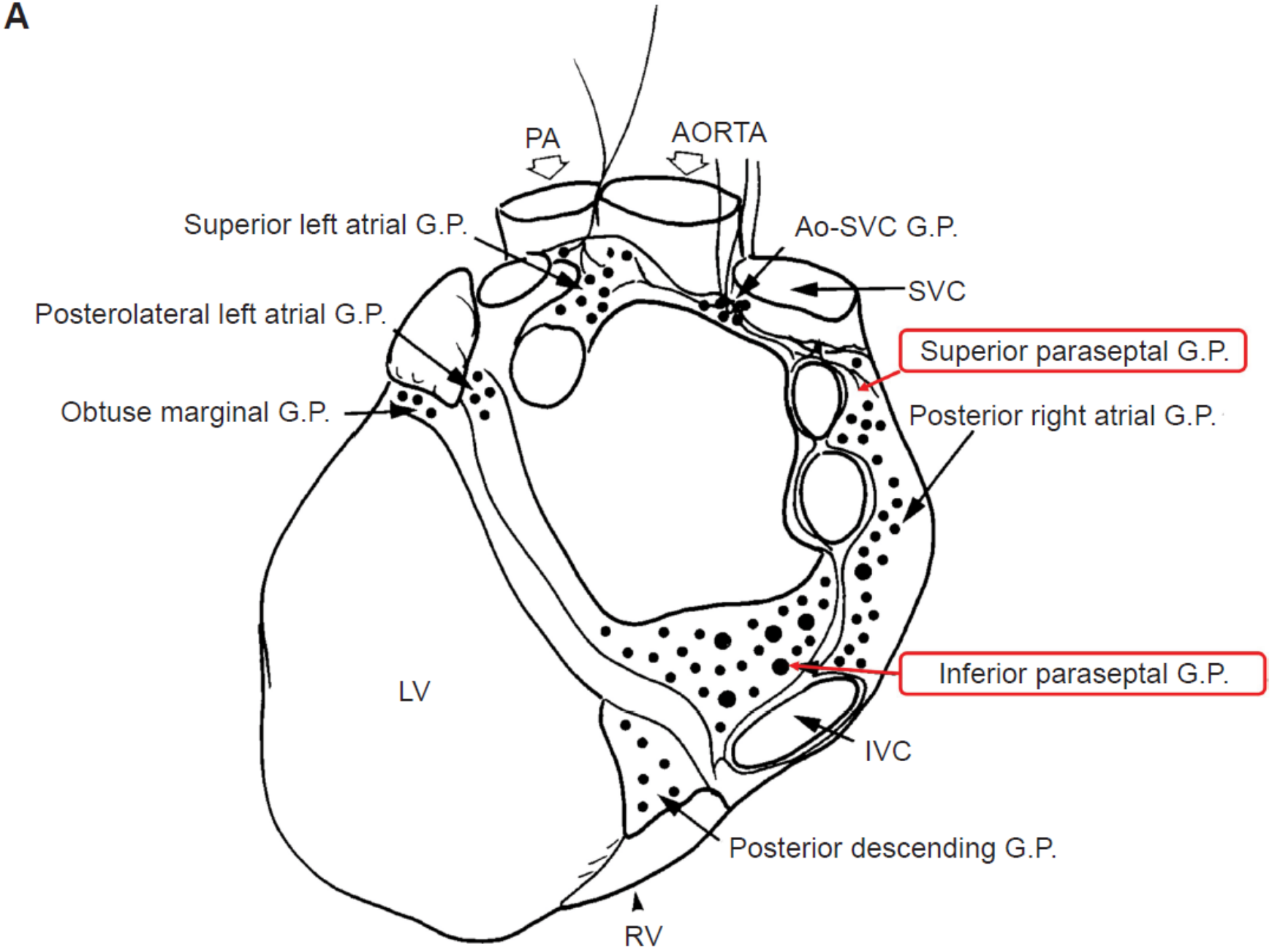
Work-Up

- Echo was normal
- MRI was not performed due to lack of collaboration
- Eps showed normal HB 44 MS, Prolonged AH of 240 ms
- Basic AV Node Wenkebach 800 ms with improvement with Atropine to 270 ms
- Occasional episodes of short self terminating AF –during awake as well as sleeping hours and during EP study

Therapy

- Pacemaker was considered in both pts but CNA was offered
- Anatomical ablation
- ICE guided anatomical ablation of Rt Sup Para septal Gnaglion and Rt Inferior Paraseptal Ganglion
- No EGM guidance
- Success was measured by disappearance of AVB during procedure, improvement in AVN block CL, flat response to Atropine 2 mg IV (<25%) following ablation

A


PA
AORTA
Superior left atrial G.P.
Ao-SVC G.P.
SVC
Posterolateral left atrial G.P.
Superior paraseptal G.P.
Obtuse marginal G.P.
Posterior right atrial G.P.
LV
Inferior paraseptal G.P.
IVC
Posterior descending G.P.
RV

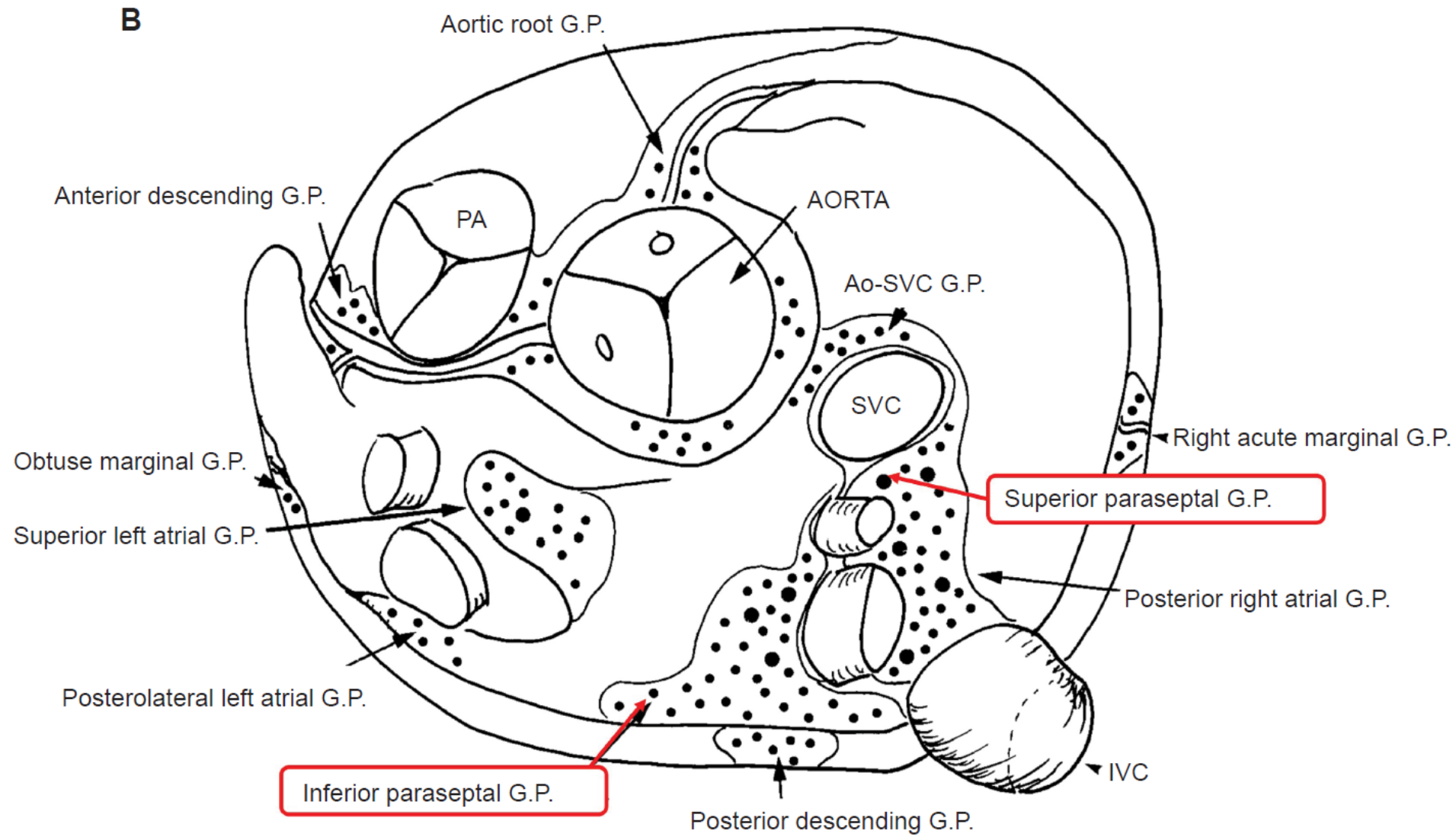
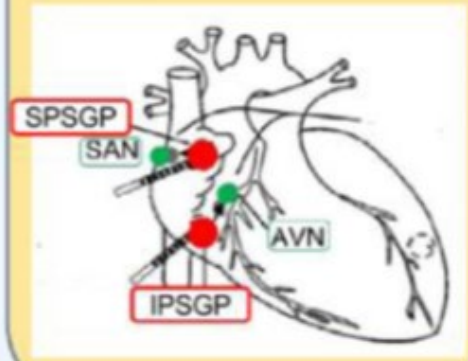


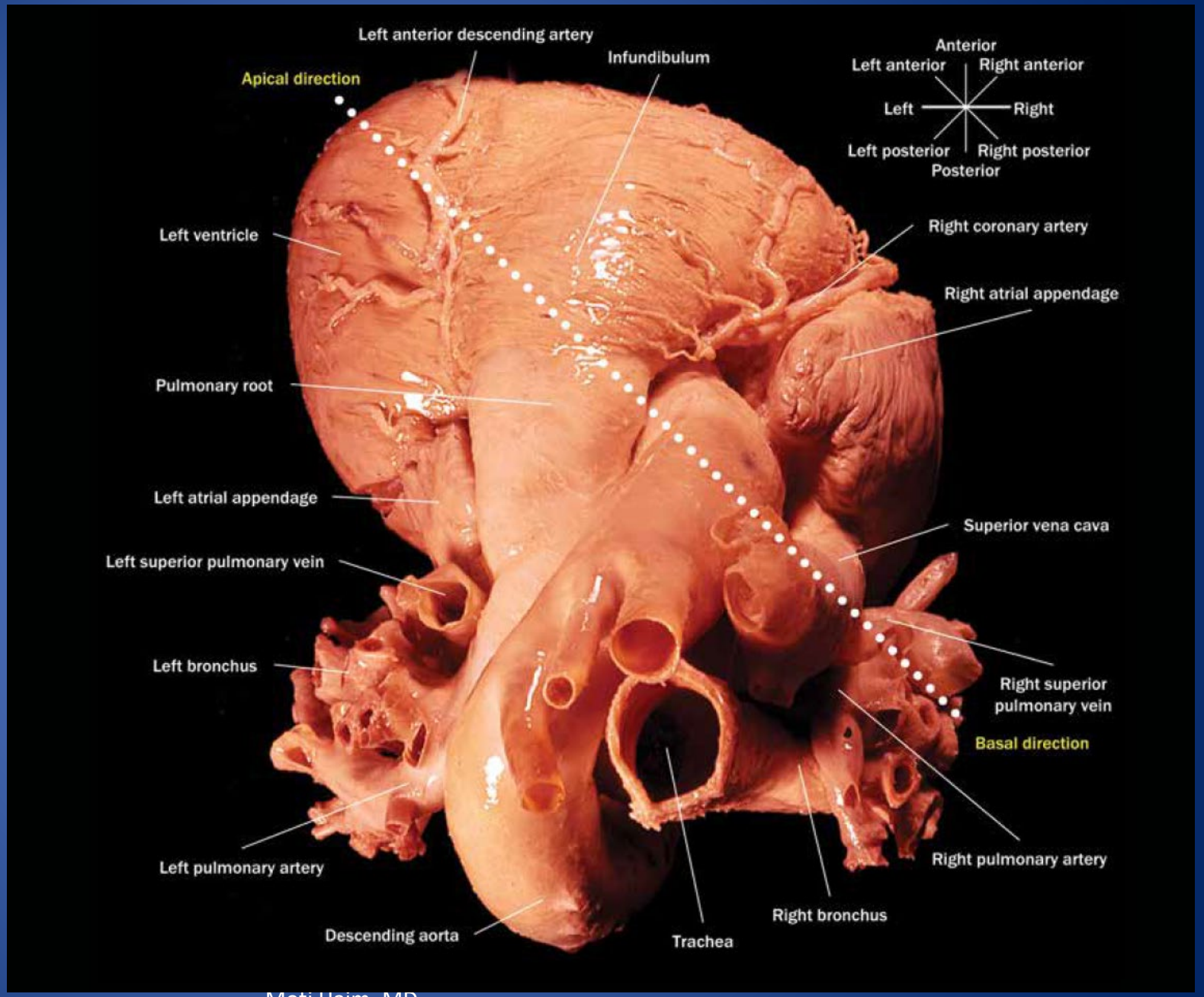
Figure 1 Drawing of the posterior view (*A*) and superior view (*B*) of the human heart and major vessels illustrating the location of the posterior atrial ganglionated plexuses. The SPSGP and the IPSGP are depicted. The SPSGP lays paraseptal close to the SVC and to the sinoatrial node (not shown). The IPSGP is in the inferoposterior part of the interatrial septum close to the AV node (not shown). Positions of the pulmonary veins (PV), superior vena cava (SVC), inferior vena cava (IVC), right ventricle (RV), and left ventricle (LV) are shown. Modified from Armour *et al.*,[6] with permission. AV, atrioventricular; IPSGP, inferior paraseptal atrial ganglionated plexus; SPSGP, superior paraseptal ganglionated plexus.

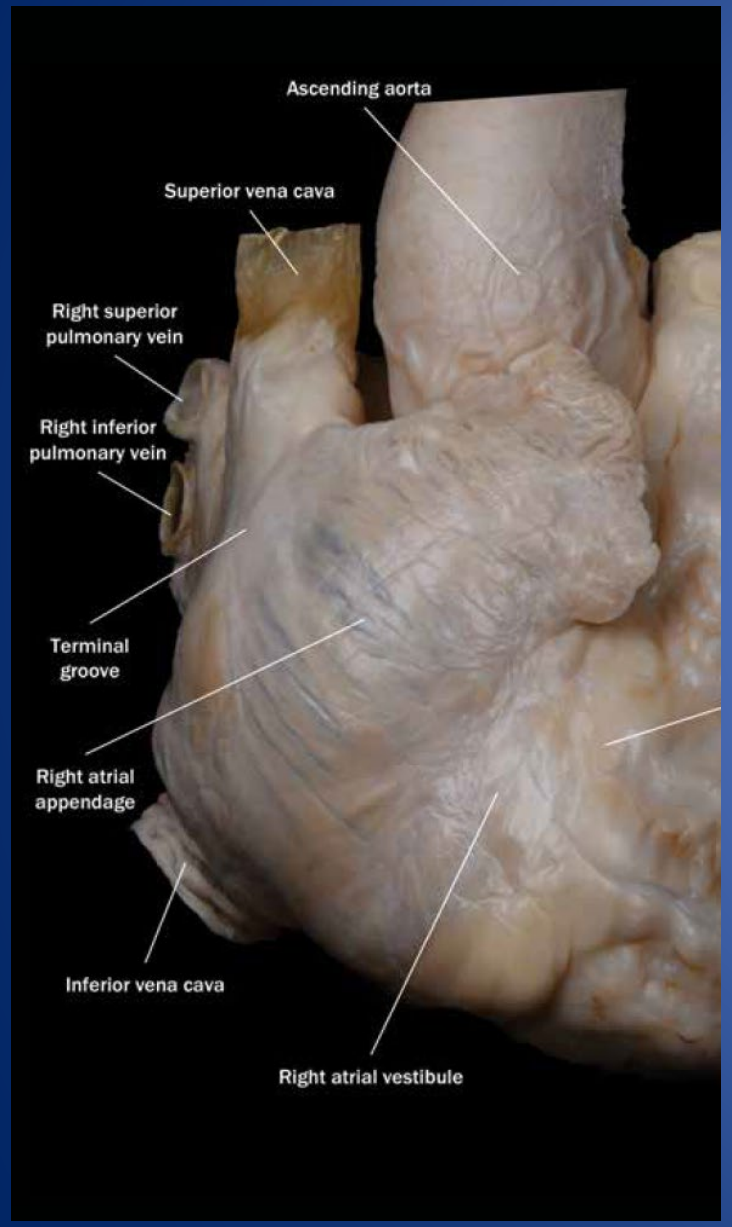
ABLATE
the proper ganglia

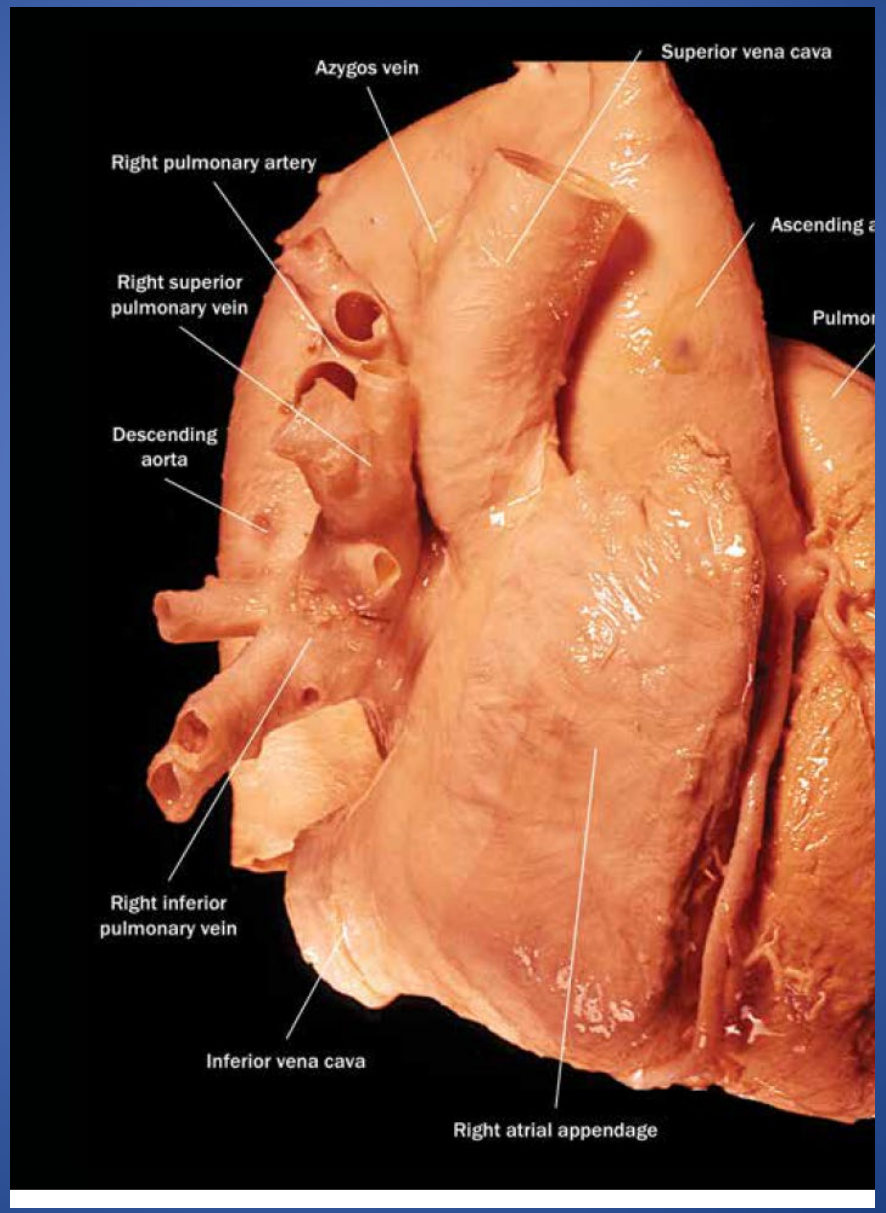
***Target*: SPSGP - IPSGP**



- SPSGP only or SPSGP+IPSGP
- RA vs LA vs RA+LA
- Optimal ablation technique
- Assessment of acute procedural success

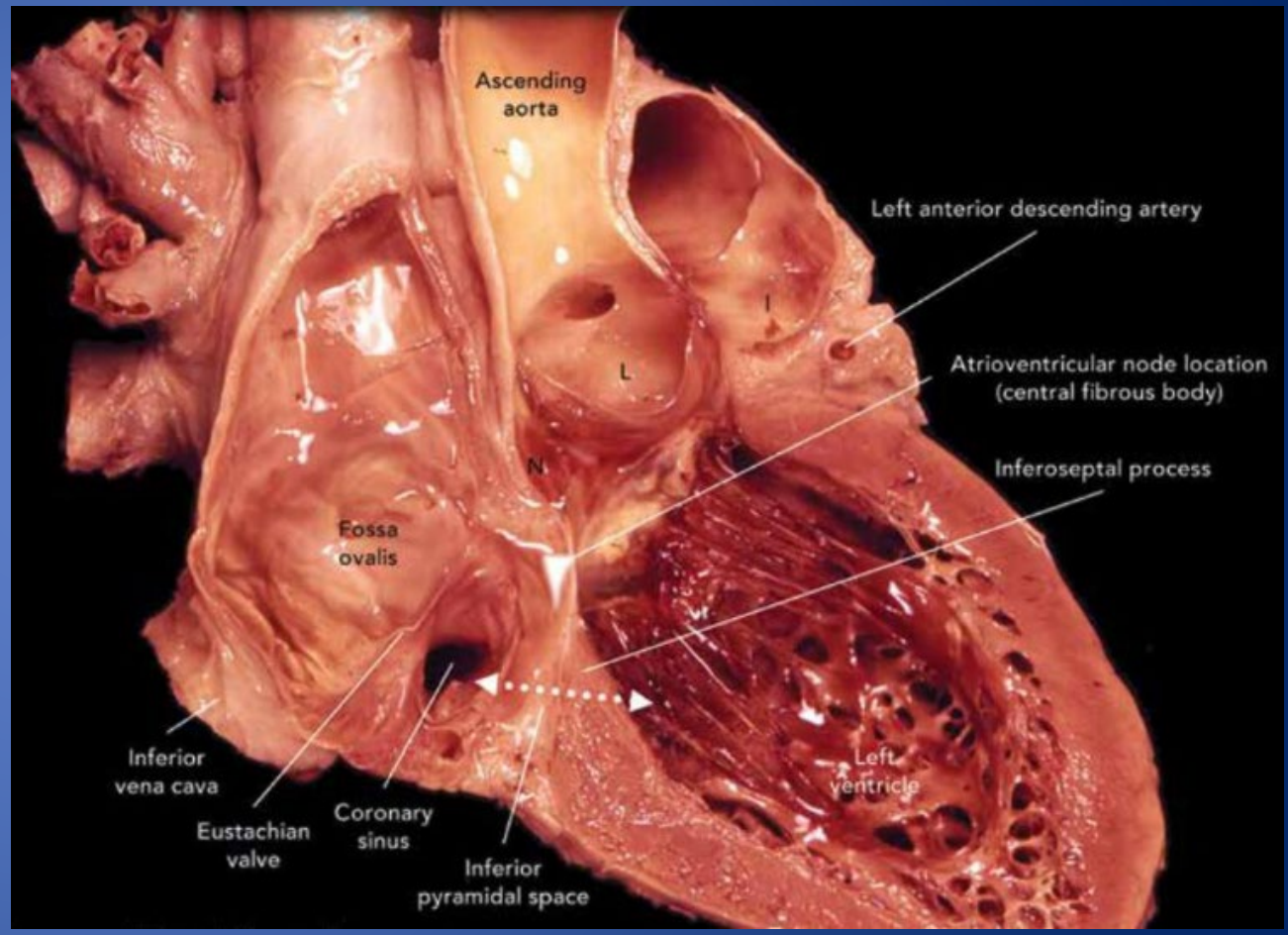



Ascending aorta
Superior vena cava
Right superior pulmonary vein
Right inferior pulmonary vein
Terminal groove
Right atrial appendage
Inferior vena cava
Right atrial vestibule

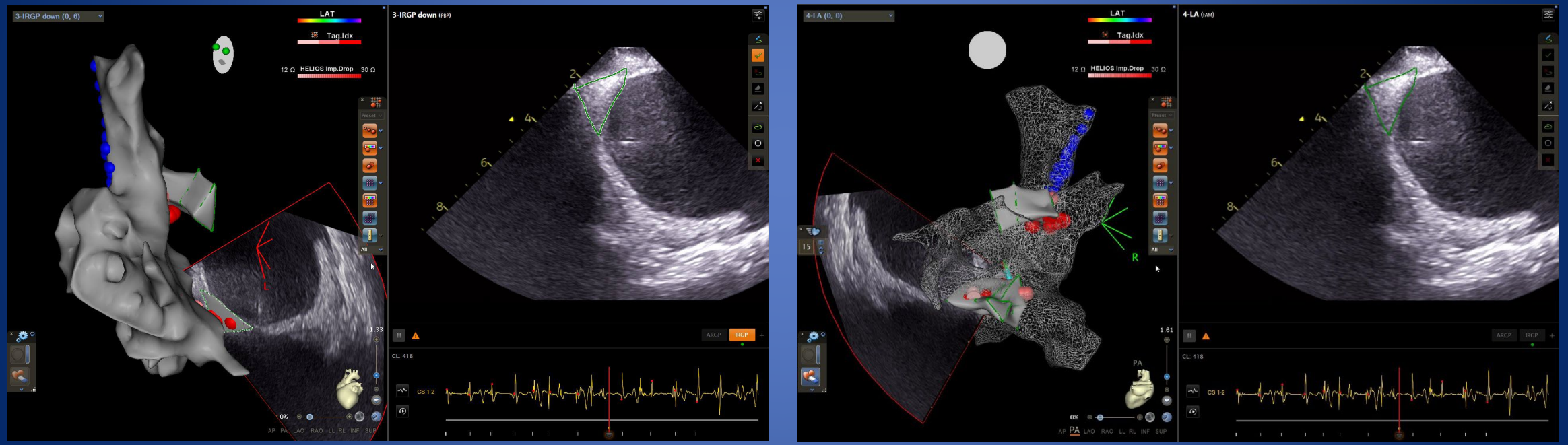

Azygos vein
Superior vena cava
Right pulmonary artery
Right superior pulmonary vein
Descending aorta
Right inferior pulmonary vein
Inferior vena cava
Right atrial appendage

Inf Paraseptal Ganglia



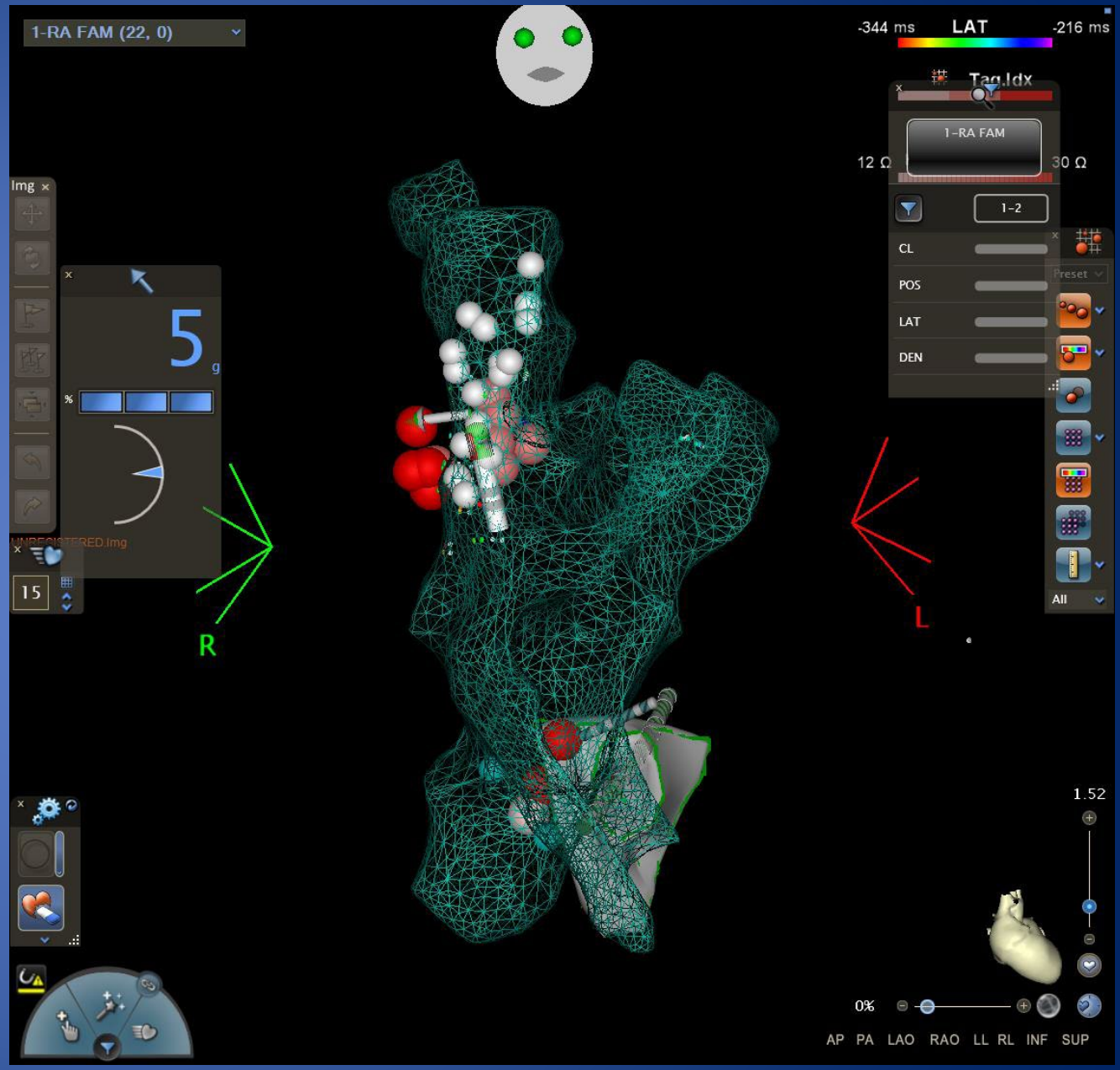


Rt Inferior Paraseptal

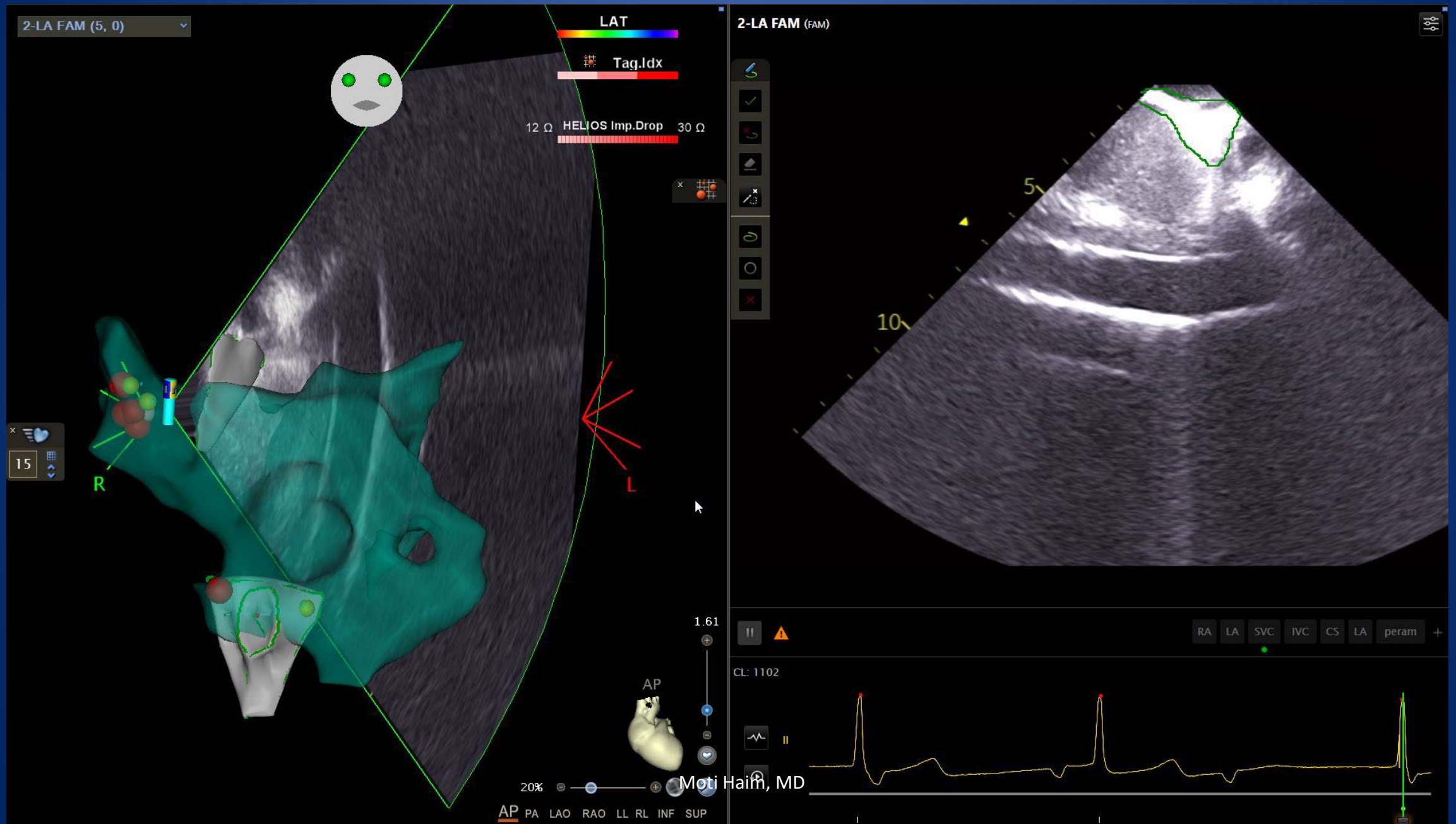


Moti Haim, MD


2-LA FAM (5, 0)
-344 ms
LAT
-216 ms
Tag.Idx
12 Ω
HELIOS Imp.Drop
30 Ω
Preset
All
15
1.77
0%
AP PA LAO RAO LL RL INF SUP

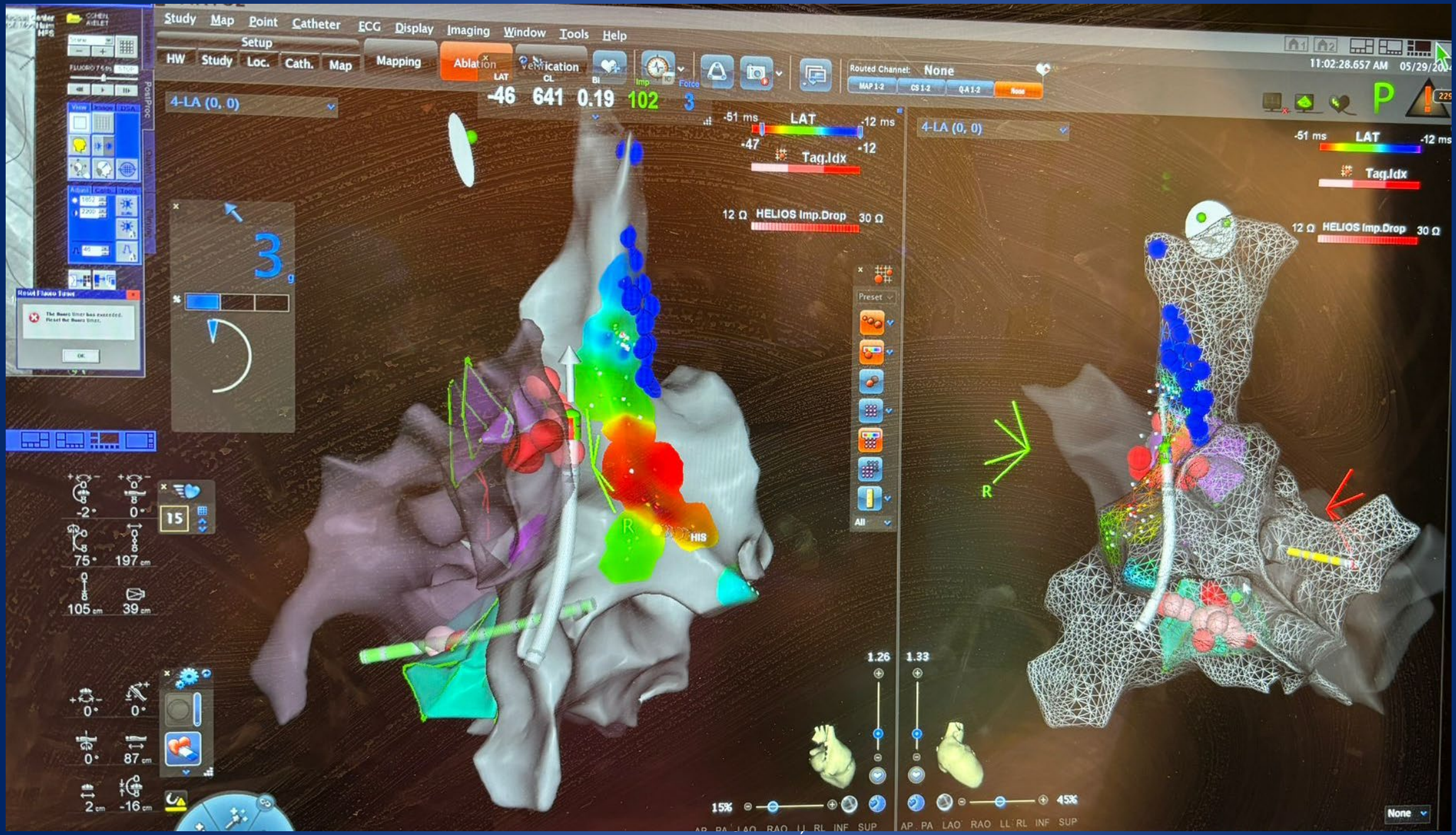

1-RA FAM (22, 0)
-344 ms
LAT
-216 ms
Tag.Idx
1-RA FAM
12 Ω
30 Ω
1-2
CL
POS
LAT
DEN
Preset
All
Img
5
g
%
15
R
L
1.52
0%
AP PA LAO RAO LL RL INF SUP

Moti Haim, MD


2-LA FAM (5, 0)
LAT
Tag.Idx
12 Ω
HELIOS Imp.Drop
30 Ω
R
L
15
1.61
AP
20%
AP PA LAO RAO LL RL INF SUP
2-LA FAM (FAM)
5
10
RA LA SVC IVC CS LA peram
CL: 1102

Moti Haim, MD


1314
CL
-177
LAT (ms)
Loc
0.80
Bi (mV)
N/A
µBi (mV)
200 mm/sec
MAP 1-2
MAP 3-4
CS 1-2
CS 3-4
CS 5-6
CS 7-8
CS 9-10
R
II
-360
-60
0 sec
1-RA FAM (22, 0)
LAT
Tag.Idx
12 Ω
HELIOS Imp.Drop
30 Ω
Preset
View
15
R
1.61
20%
AP PA LAO RAO LL RL INF SUP
1-RA FAM (FAM)
5
10
RA LA SVC IVC CS LA peram
CL: 1102
II

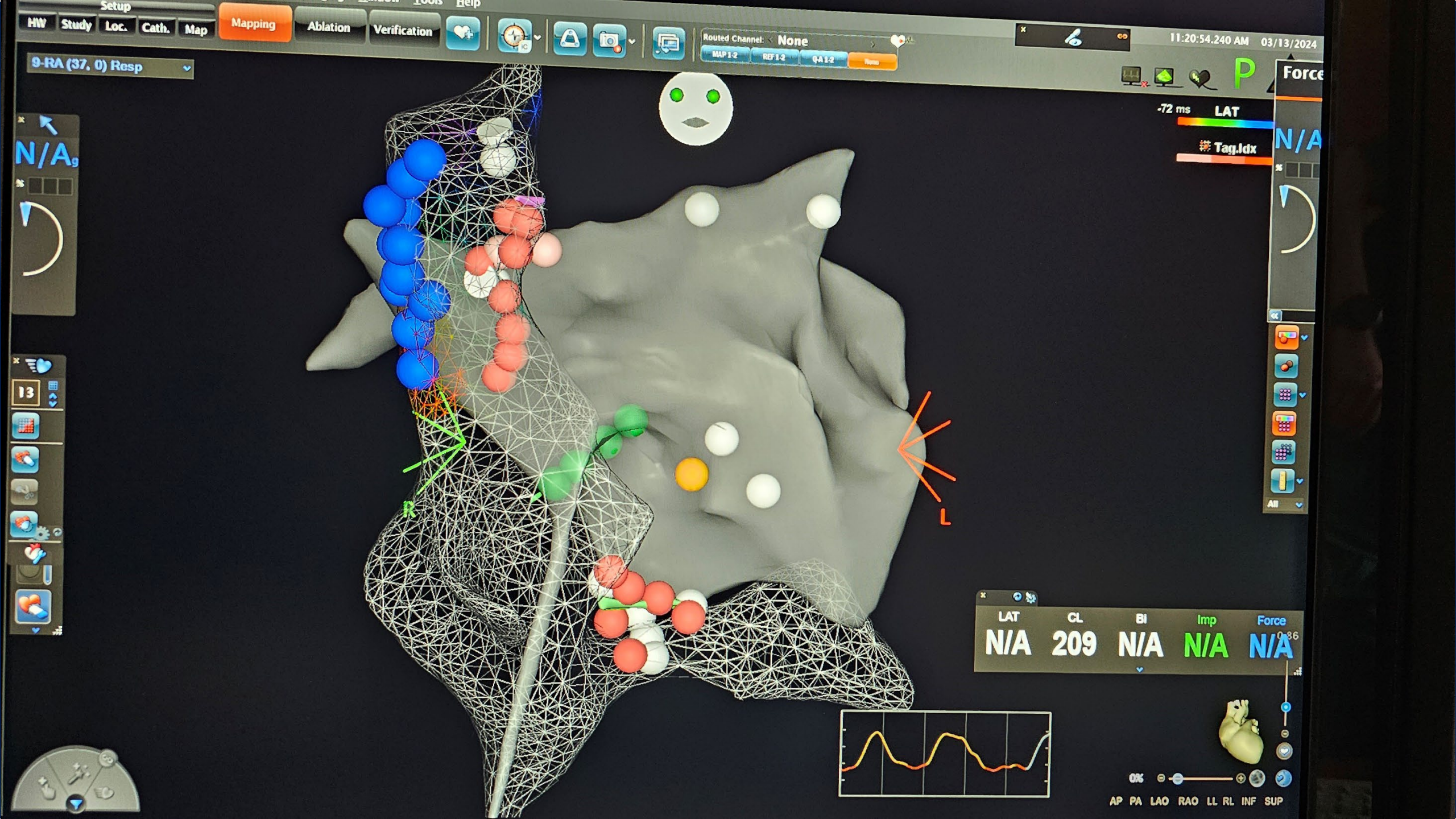

Study Map Point Catheter ECG Display Imaging Window Tools Help
Setup
HW Study Loc. Cath. Map Mapping Ablation Verification
LAT CL BI Imp Force
-46 641 0.19 102 3
4-LA (0, 0)
-51 ms LAT -12 ms
-47 -12
Tag.Idx
12 Ω HELIOS Imp.Drop 30 Ω
Routed Channel: None
MAP 1-2 CS 1-2 QA 1-2
11:02:28.657 AM 05/29/2024
Preset
All
HIS
R
1.26
1.33
15%
45%
AP PA LAO RAO LL RL INF SUP
None


Study Map Point Catheter ECG Display Imaging Window Tools Help
Setup
HW Study Loc. Cath. Map
Mapping
Ablation
Verification
Routed Channel: None
8-LA_FAM (6, 0) Resp
26g
Force Information
26g
150 Ω 70 g
130 56
110 42
90 28
70 14
50 0
0 2 4 6 8 10 Sec
LAT CL BI Imp Force
-152 665 1.16 156 26
AP
AP PA LAO RAO LL RL INF SUP
PHILIPS

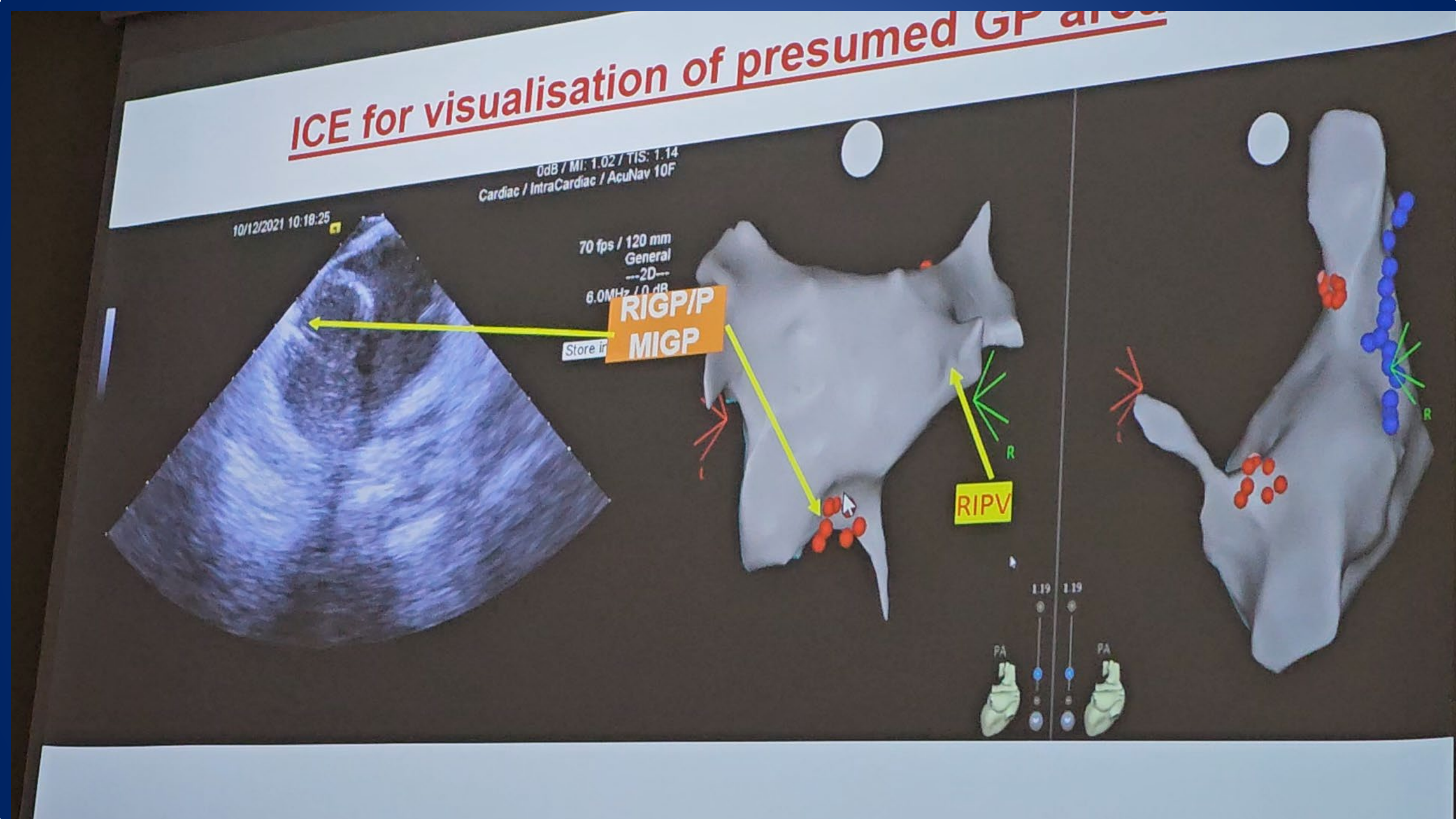

Study Map Point Catheter ECG Display Imaging Window Tools Help
Setup
HW Study Loc. Cath. Map
Mapping
Ablation
Verification
Routed Channel: None
8-LA_FAM (6, 0) Resp
27g
Force Information
27g
150 Ω 70 g
130 56
110 42
90 28
70 14
50 0
0 2 4 6 8 10 Sec
LAT CL BI Imp Force
-213 450 197 N/A 27
LAO
AP PA LAO RAO LL RL INF SUP
LabSystem PRO
Patient Amplifier
Start Protocol:
V6
CL
*252
HR
*238
ABL UniD
Archive:
EKG EP
March 13, 202
8:36:37
8:36:38
9:18:57


Study Map Point Catheter ECG Display Imaging Window Tools Help
Setup
HW Study Loc. Cath. Map
Mapping
Ablation
Verification
Routed Channel: None
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8-LA_FAM (6, 0) Resp
-72 ms
LAT
Tag.Idx
LAT CL BI Imp Force
-216 453 197 N/A 27
RAO
AP PA LAO RAO LL RL INF SUP

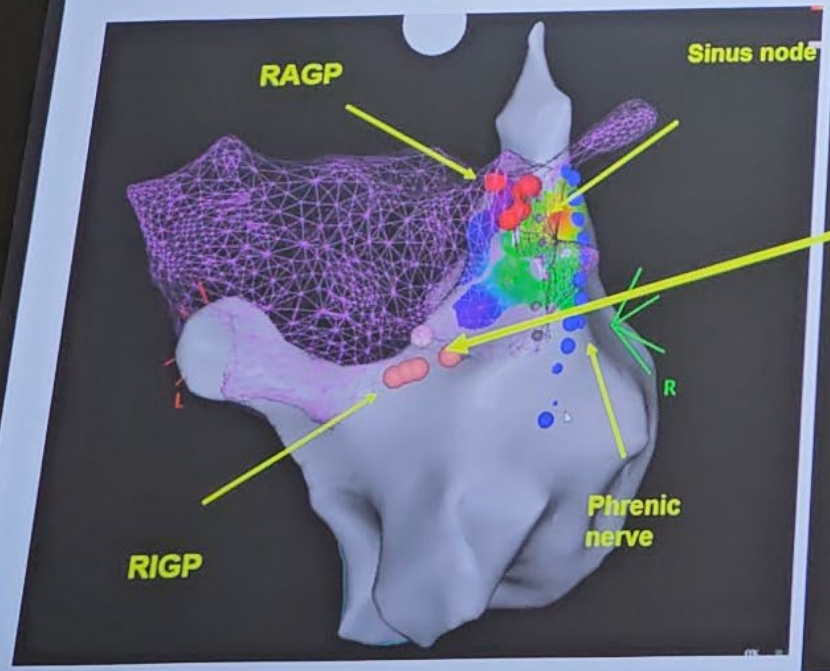

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Mapping
Ablation
Verification
Routed Channel: None
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8-LA_FAM (6, 0) Resp
-72 ms LAT
Tag.Idx
Force
L
R
LAT CL BI Imp Force
-222 450 197 N/A 27
PA
AP PA LAO RAO LL RL INF SUP
LabSystem PRO v2.8a
Patient Amplifier Start Mark RT
Start Protocol: Study Info
V6
CL
HR
ABL1-2
Abl3-4
ABL UniD
Archive:
EKG EPS 12 ODP
March 13, 2024 08:36:38
8:36:37 Majewska, Sand
8:36:38 Ablation
9:18:57
9:20:05
For Help, press F1

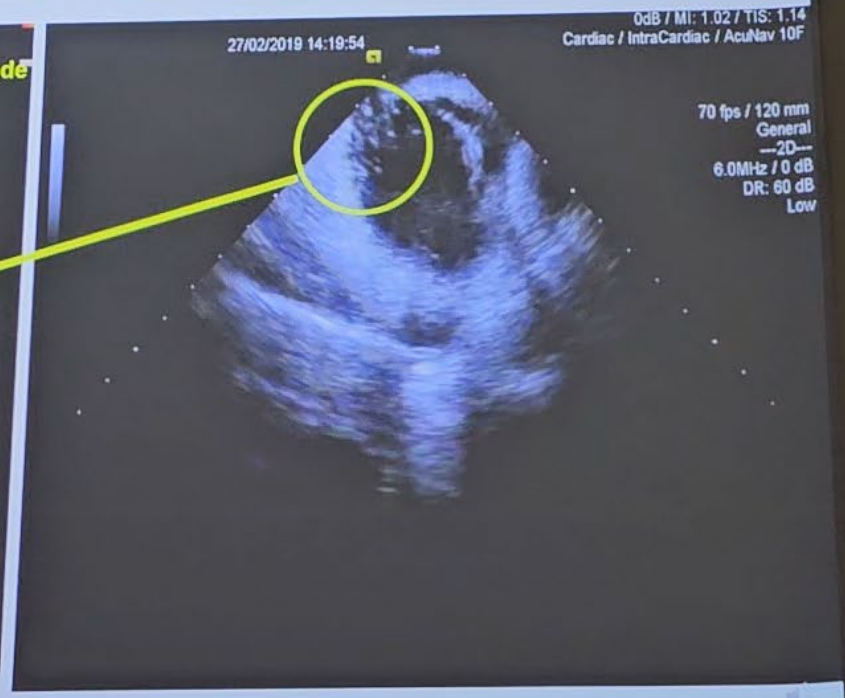

Setup
HW
Study
Loc.
Cath.
Map
Mapping
Ablation
Verification
Routed Channel: None
MAP 1-2
REF 1-2
OA1-2
11:20:54.240 AM 03/13/2024
9-RA (37, 0) Resp
N/A
-72 ms
LAT
Tag Idx
Force
N/A
R
L
LAT
CL
BI
Imp
Force
N/A
209
N/A
N/A
N/A
0%
AP PA LAO RAO LL RL INF SUP

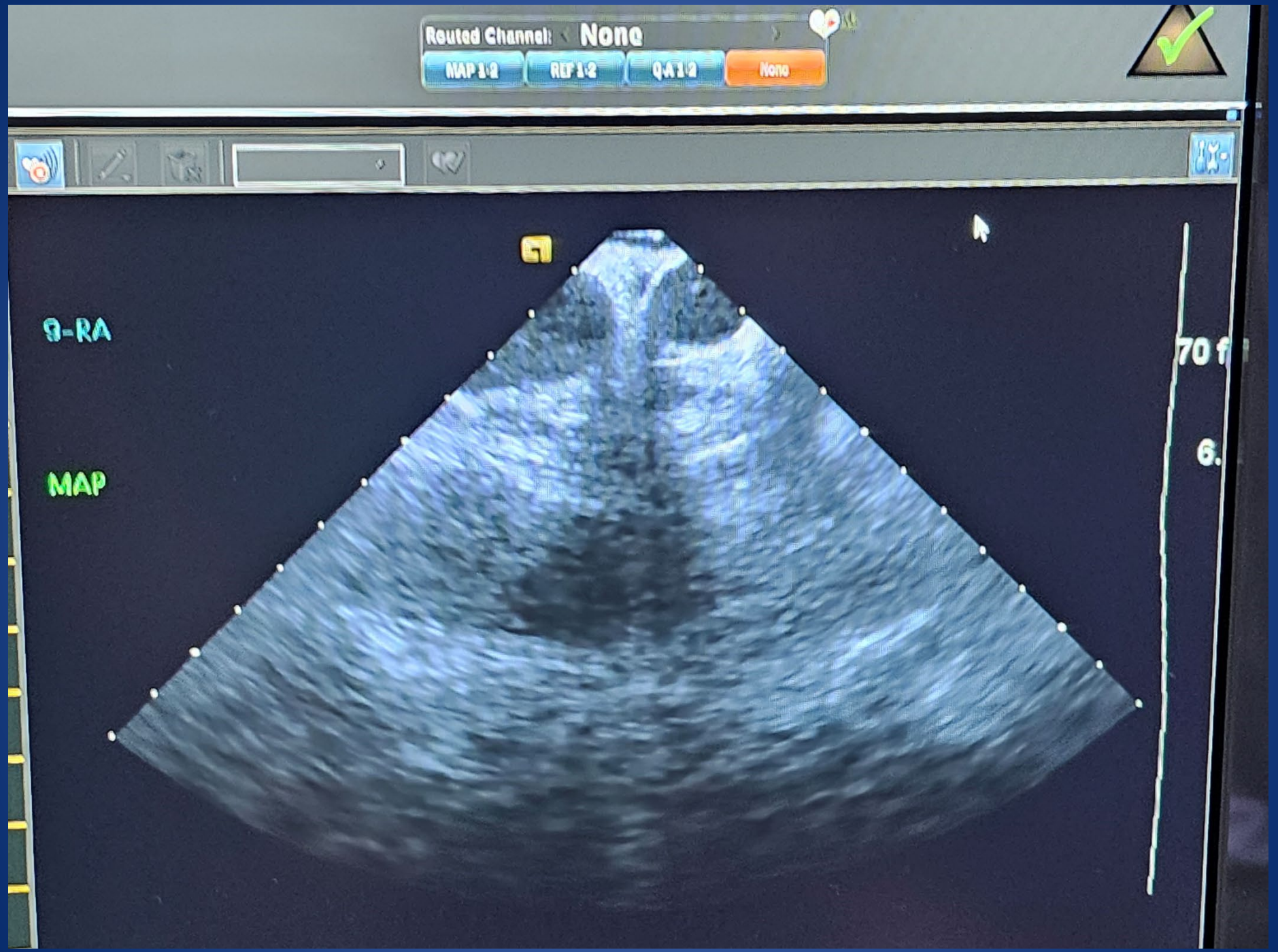

ICE for visualisation of presumed GP area
27/02/2019 14:19:55
Cardiac / IntraCardiac / AcuNav 10F
70 fps / 120 mm
General
RIGP/
PMIGP
RIPV
PA
PA


ICE for visualisation of presumed GP
0dB / MI: 1.02 / TIS: 1.14
Cardiac / IntraCardiac / AcuNav 10F
10/12/2021 10:18:25
70 fps / 120 mm
General
---2D---
RIGP/P
MIGP
Store
RIPV
R
PA
PA

Our approach

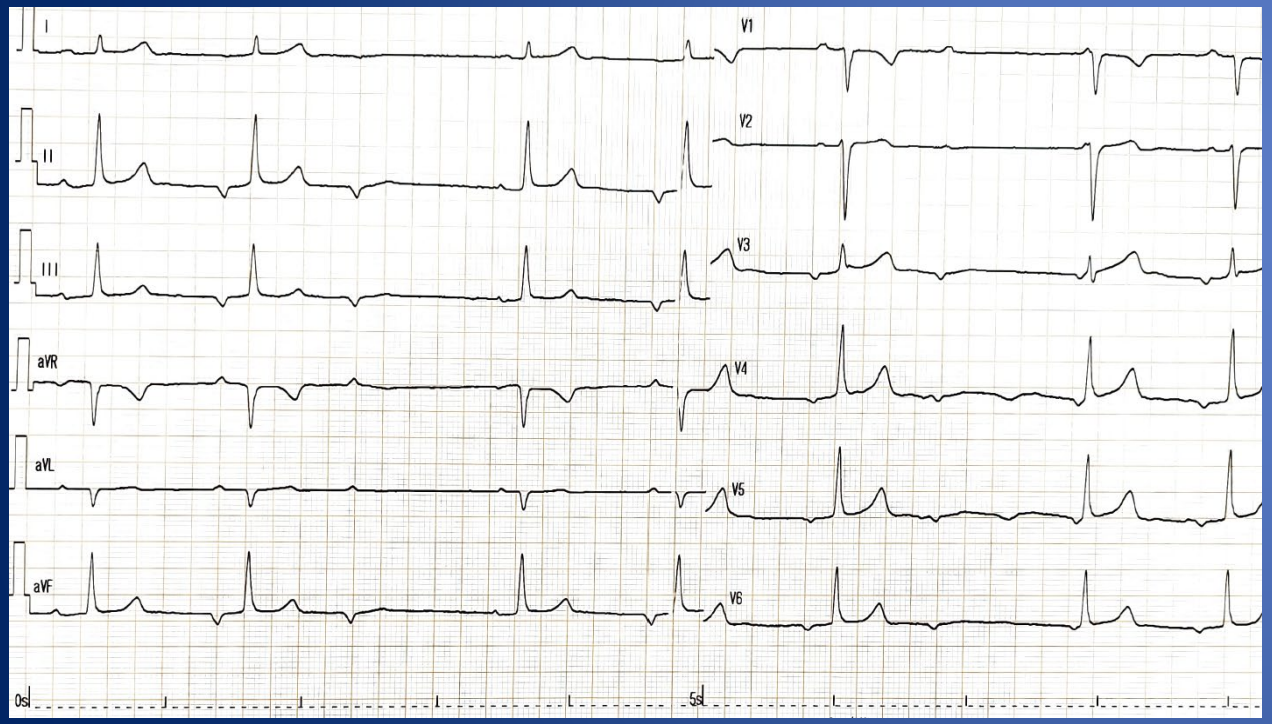




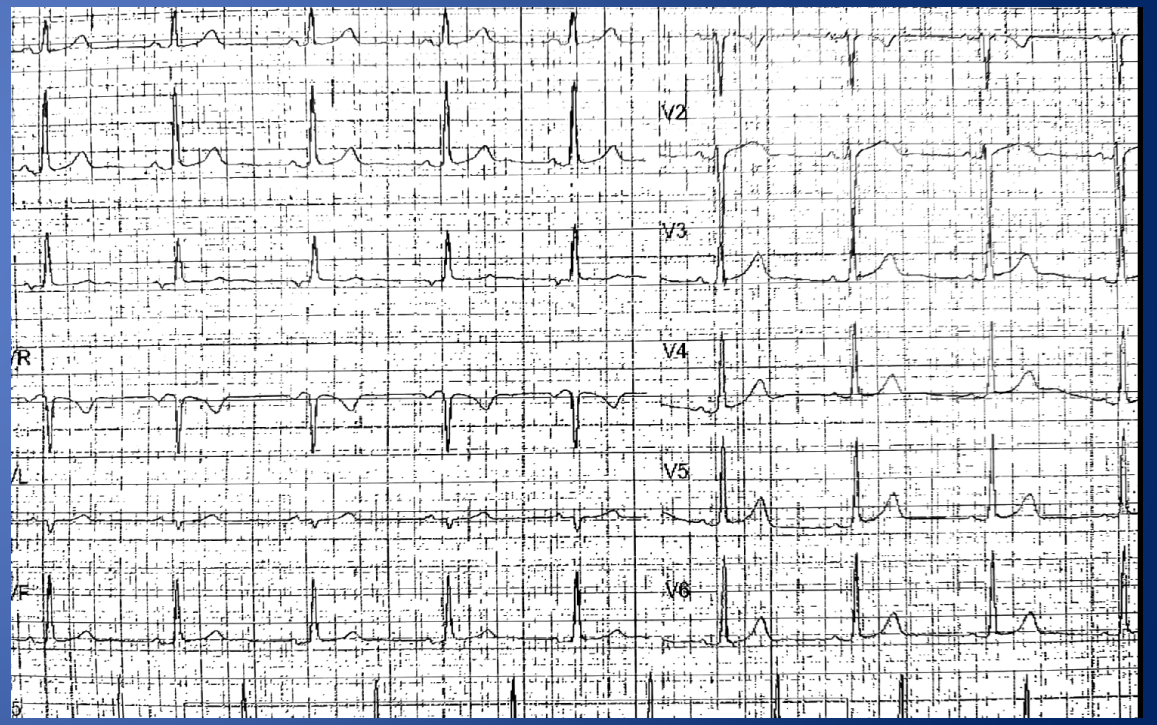

Routed Channel:
None
MAP 1:2
REF 1:2
Q-A 1:2
None
9-RA
MAP
70 f
6.

ECG POST PATIENT 1

BASELINE



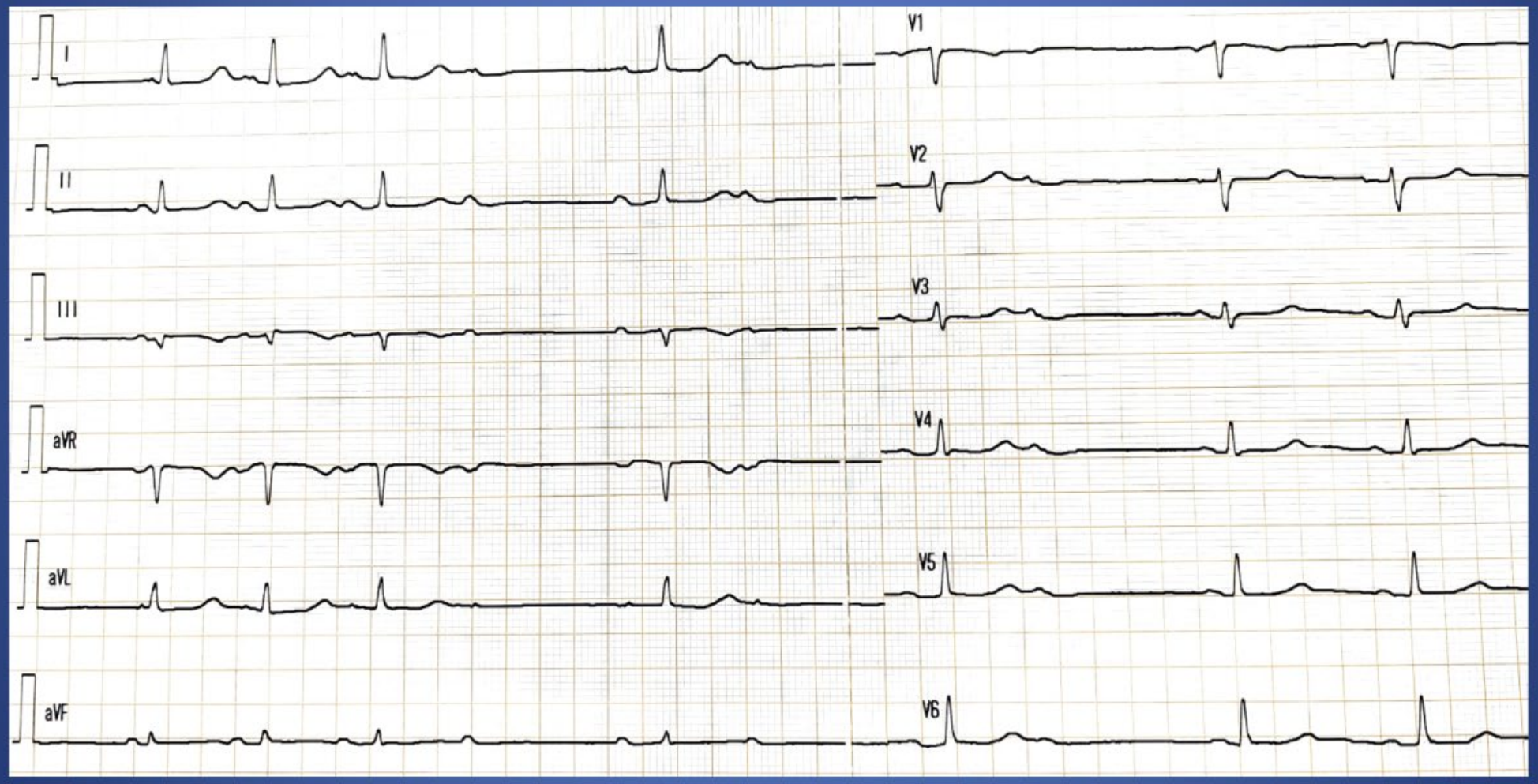
30 DAY F UP



Patient 2

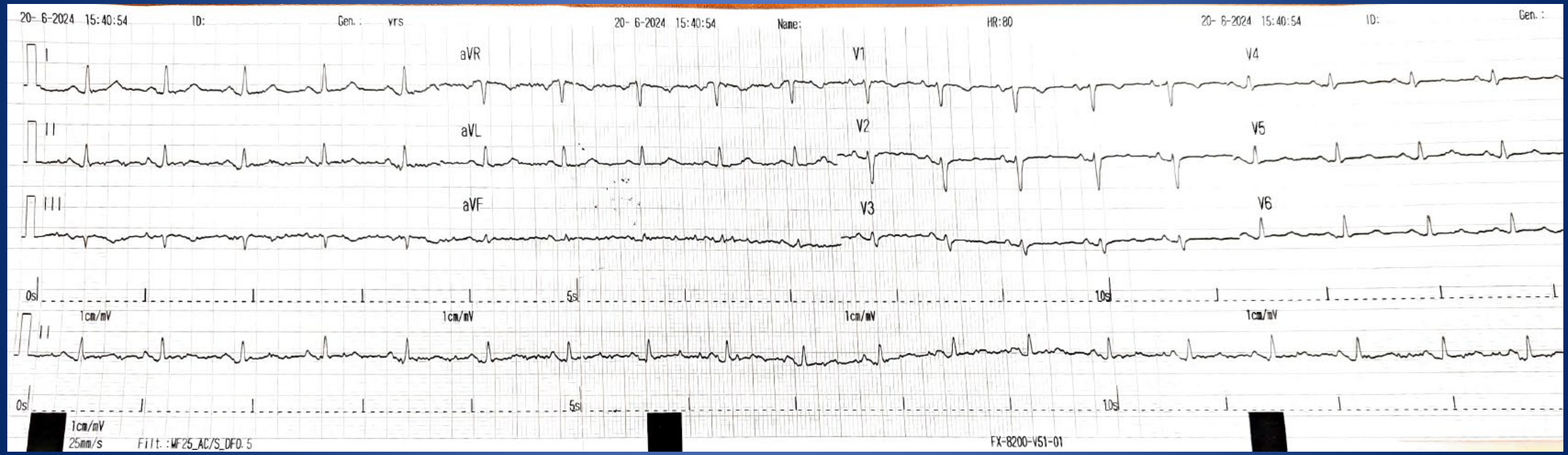
- AF broke into NSR during ablation anterior to RSPV ostium.
- Had a recurrent AF episode for few hours after 48 hours and in NSR with normal conduction on 30 day follow-up
- Follow- Up ECG in NSR

2ECG POST PATIENT **BASELINE**



2ECG POST PATIENT

30 DAY F UP



Anatomically guided approach

- The anatomically guided approach can be applied in two different ways: as an adjunct to electrogram analysis or HFS, or purely anatomical as a stand-alone strategy using isolated right-atrial or left-atrial/bi-atrial approaches
- Intracardiac echocardiography or computed tomography can be used used to identify important anatomical landmarks and epicardial fat pads with presumed GP
- A recently published meta-analysis did not show any significant differences in freedom from syncope based on the technique used to identify GPs.
- However, overall data are limited since 465 patients were included across 14 cohort studies. Thus, comparative data are lacking and validation studies are needed

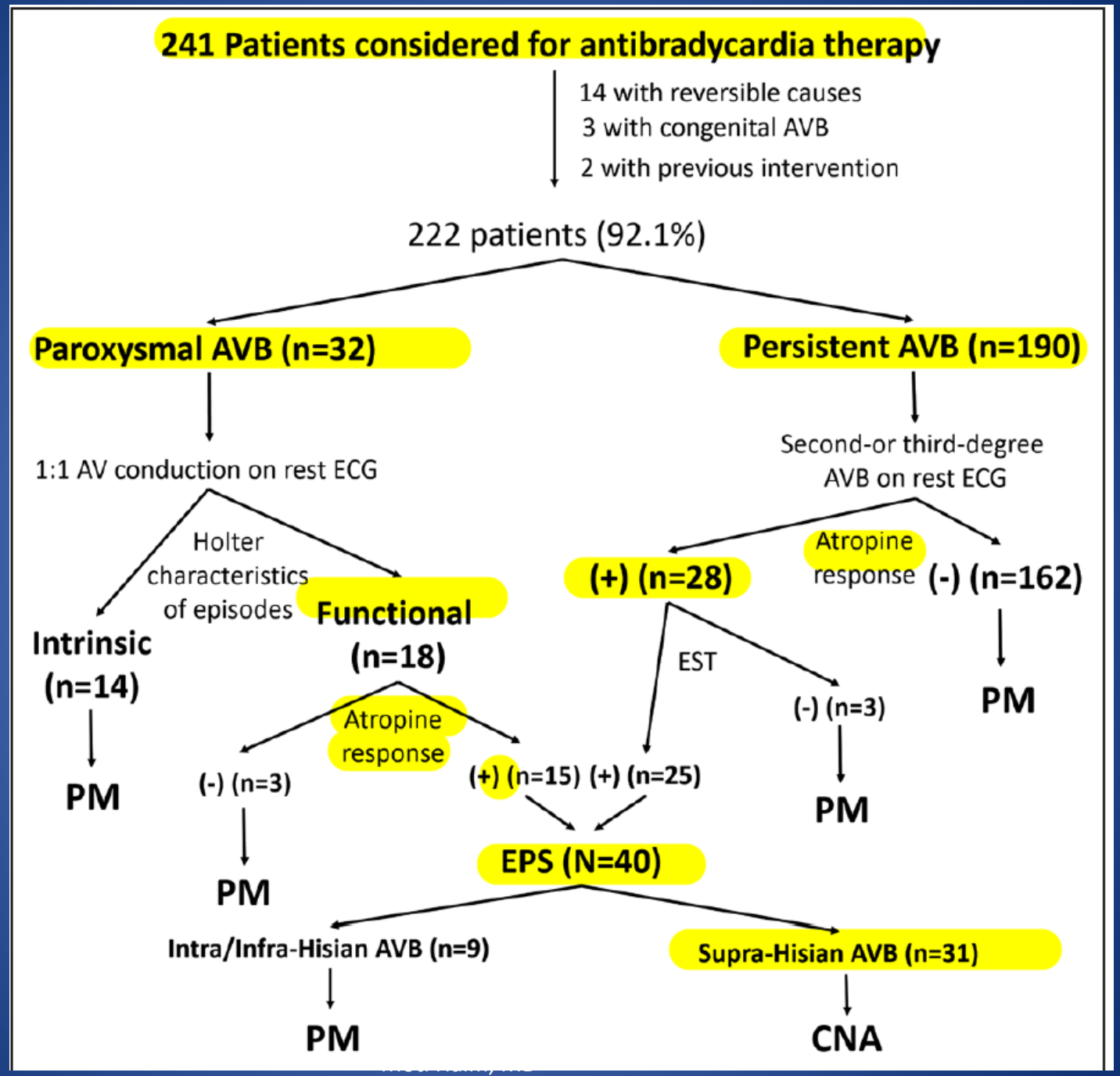
Circulation: Arrhythmia and Electrophysiology

ORIGINAL ARTICLE

Cardioneuroablation for Treatment of Atrioventricular Block

Tolga Aksu, MD; Rakesh Gopinathannair, MD; Serdar Bozyel, MD; Kivanc Yalin, MD; Dhiraj Gupta, MD

Circ Arrhythm Electrophysiol. 2021



Circ Arrhythm Electrophysiol. 2021

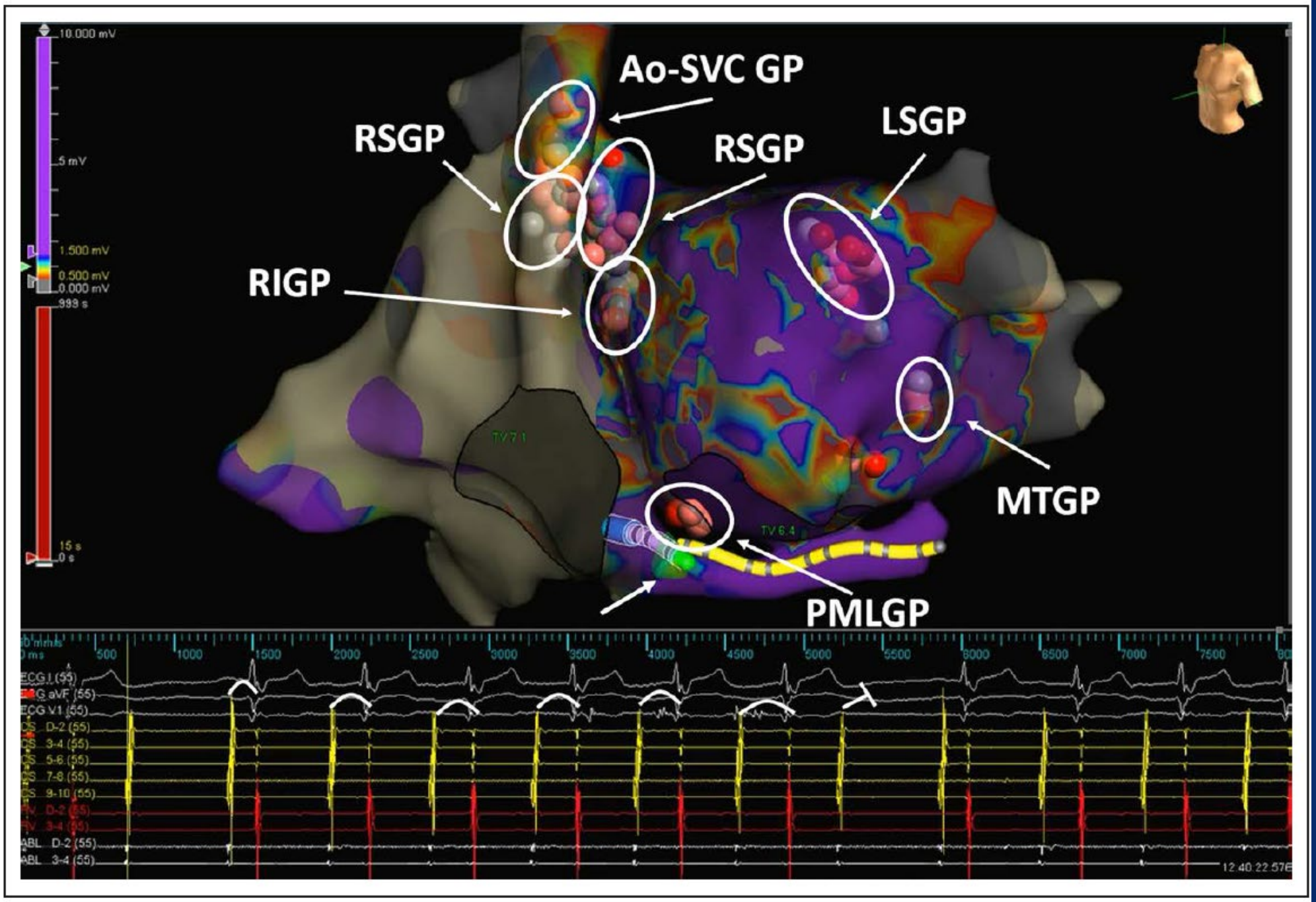


Figure 3 Three-dimensional endocardial surface of the left atrial and right atrial structures and locations of biatrial

Table 2. Comparison of Baseline Characteristics and Results in Patients With Paroxysmal and Persistent Resting Atrioventricular Block

	All patients (n=31)	Persistent (N=17)	Paroxysmal (N=14)	*P* value
Age, y	40.1±13	40.9±12	39.2±15	0.735
Sex (male), n (%)	18 (58.0%)	11 (64.7%)	7 (50%)	0.409
Syncope burden/y (n)	3.1±2	3.8±2	2.3±1	0.068
Follow-up, mo	19.3±15	23.4±17	14.4±12	0.108
Accompanying arrhythmias, n (%)*				
SND	7 (22.5%)	3 (17.6%)	4 (28.5%)	0.214
AF	8 (25.8%)	7 (41.1%)	1 (7.1%)	0.214
HUTT-positive VVS response, n (%)				
Vasodepressor	4 (12.9%)	3 (17.6%)	1 (7.1%)	0.230
Cardioinhibitory	3 (9.6%)	2 (11.7%)	1 (7.1%)	0.230
Mixed	1 (3.2%)	1 (5.8%)	0 (0%)	0.230
Acute success, n (%)	30 (96.7%)	16 (94.1%)	10 (100%)	0.356
Procedure time (minutes)	80.0±19	88.4±19	73.8±19	0.045†
Primary outcome, n (%)	28 (90.3%)	14 (82.3%)	14 (100%)	0.197

Circ Arrhythm Electrophysiol. 2021

Moti Haim, MD

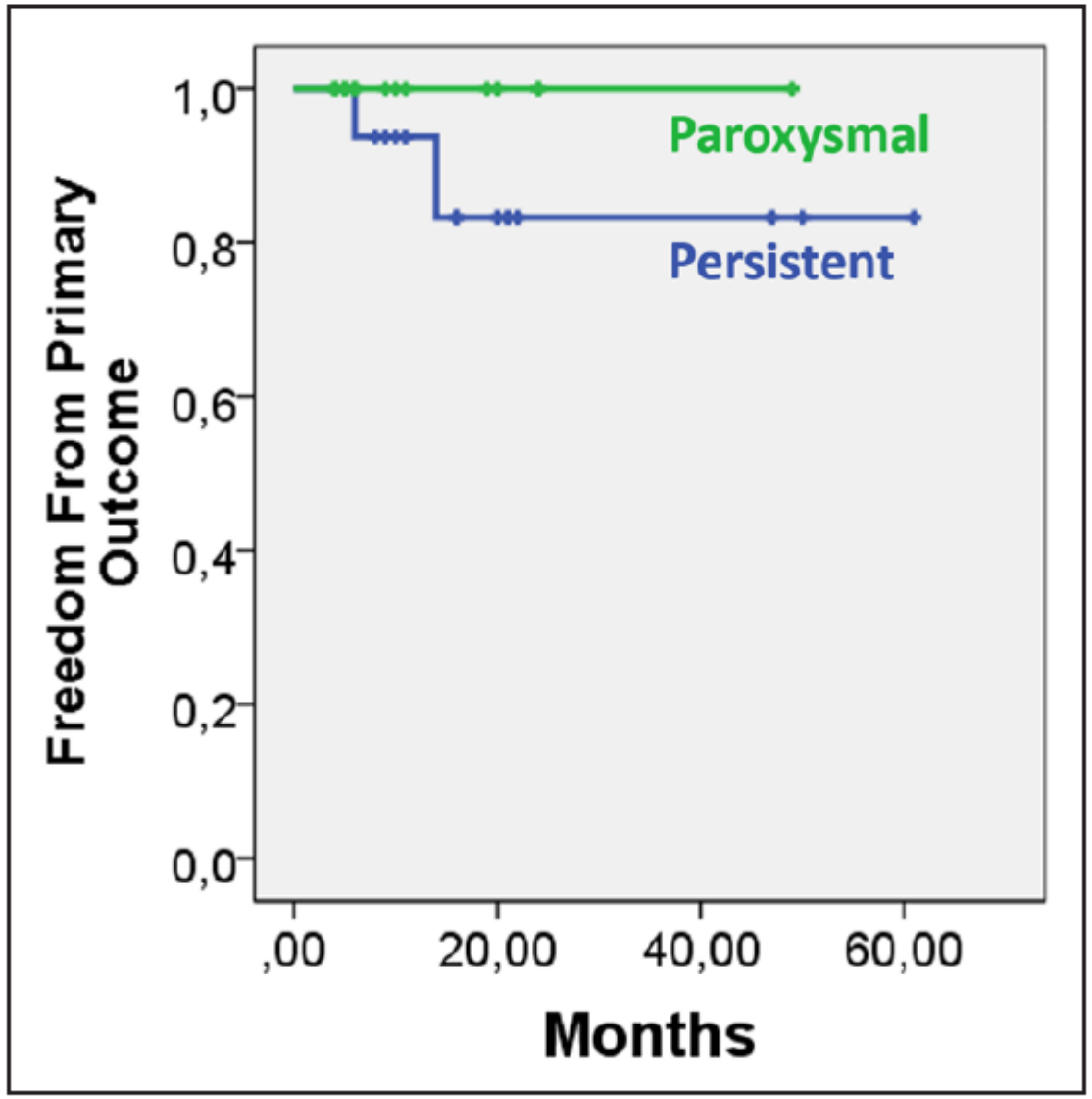


Figure 5. **The Kaplan-Meier curves for primary outcome free survival in the patients with paroxysmal and persistent atrioventricular block.**

There were no major complications related to the cardioneuroablation procedures. Two patients developed groin hematoma that was managed conservatively.

Procedural and Intermediate-term Results of Electroanatomical-guided CardioNeuroablation for Treatment of SupraHisian Second or Advanced Degree AV Block: PIRECNA Multicenter Registry

Presenter: Henry Huang, MD

Associate Professor, Rush University Medical Center

04/07/2024

112%

Objectives of PIRECNA Registry

- Retrospective, international multicenter registry
- Evaluate the effectiveness and safety of CNA for treatment of symptomatic Vagally-induced AVB
- Assess procedural characteristics and intermediate-term outcomes of CNA

Study Design and Population

- Start in 2021
- End in 2023
- 20 international participating centers

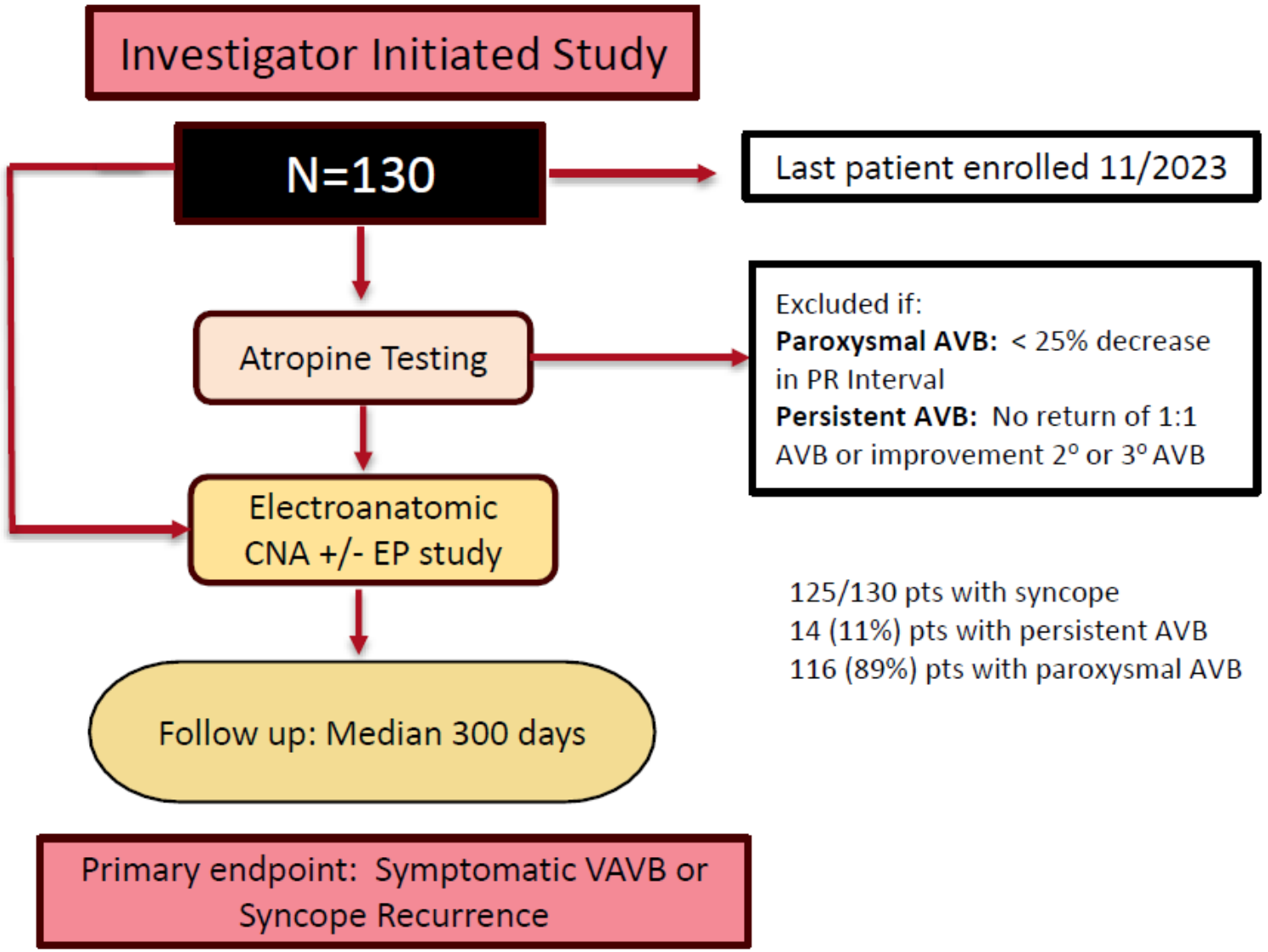
Inclusion

- Symptomatic paroxysmal or persistent Vagal-AVB after robust evaluation*
- EA-CNA procedures

Exclusion

- Infranodal AVB
- Nocturnal-only AVB

*Stepwise evaluation including ECG, prolonged ECG monitoring (Holter, event recorder, ILR, in-hospital telemetry), exercise response test, IV atropine testing



Procedural Protocol for CNA

- General or conscious sedation
- +/- EPS with conduction study
- **Mapping:** Anatomic-based, fractionated EGMs (> 3 deflections), ECVS
- **Ablation:** Irrigated, power-controlled 30-50Ws
- **Endpoints:** Abolish EGMs (<0.1 mV residual), non-capture, ECVS
- **(+) Vagal response** defined as >20% ↓in SR or >20% ↑ in PR interval

Definition Acute Procedural Success:

Persistent AVB pts

Achievement of 1:1 AV conduction

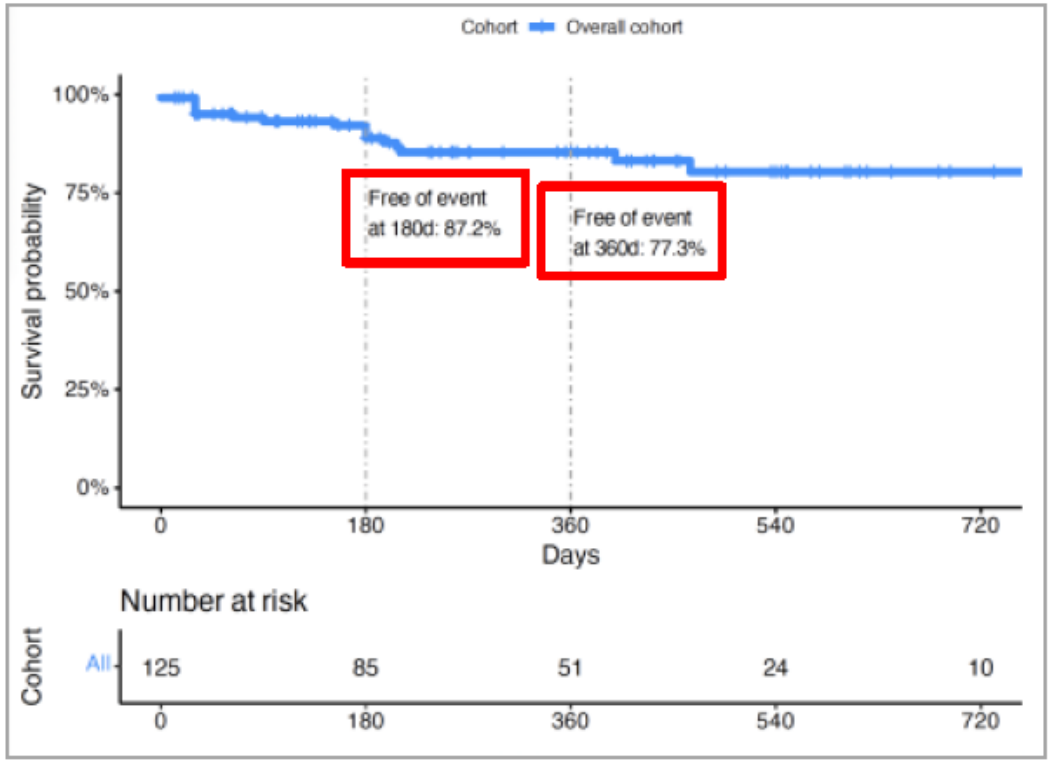
Paroxysmal AVB pts

1) Reduction in PR interval by ≥ 25% compared to pre-ablation atropine testing
2) Final sinus rate <75% of SR recorded during pre-ablation atropine test
3) ECVS: absence of AVB or change in SR with proximal CS pacing

Results

- 130 CNA procedures performed
- Acute procedural success - 125/130 (96.2%) of cases
- Of 5 pts with procedural failure:
  - 3/5 pts with progression of AVB with ablation
  - 2/5 pts w/o improvement in AVB
  - 3/5 pts subsequently underwent PPM implantation
- Median procedure time 105.5 min (90,123 min)
- 90% underwent bi-atrial ablation
- ECVS performed 73/130 (56%) of cases

Follow Up Results



Characteristics	Overall (n=130)	Primary Outcome (+) (n=17)*	Primary Outcome (-) (n=108)*	P value**
Experienced operator (n, %)	67, 52	6, 35	59, 55	0.14
ECVS (n, %)	73, 56	7, 41	64, 59	0.2
Sex, female (n, %)	74, 57	8, 47	61, 56	0.5
Age (year)	34.0 (28, 45)	48.0 (33-62)	34 (27-42)	0.012
No. syncopal episodes prior to enrollment	2 (1, 4)	1 (0-4)	2 (1-4)	
History of AF (n, %)	8, 6.2	5, 29	3, 2.8	0.001
Hypertension (n, %)	21, 16	9, 53	47, 44	<0.001
CAD (n, %)	5, 3.8	3, 18	2, 1.9	0.018
DM (n, %)	7, 5.4	1, 5.9	6, 5.6	>0.9
Heart Rate (bpm)	62 (54, 70)	60	62.5	0.3
PR Interval (ms)	180 (160, 210)	205.5 (180-245)	180 (160-200)	0.022
Paroxysmal AVB (n, %)	116, 89	13, 76	101, 95	0.021
Persistent AVB (n, %)	14, 11	4, 24	5, 4.7	

- Median f/u: 300 days (150, 496 days)
- 17/125 (14%) met primary outcome

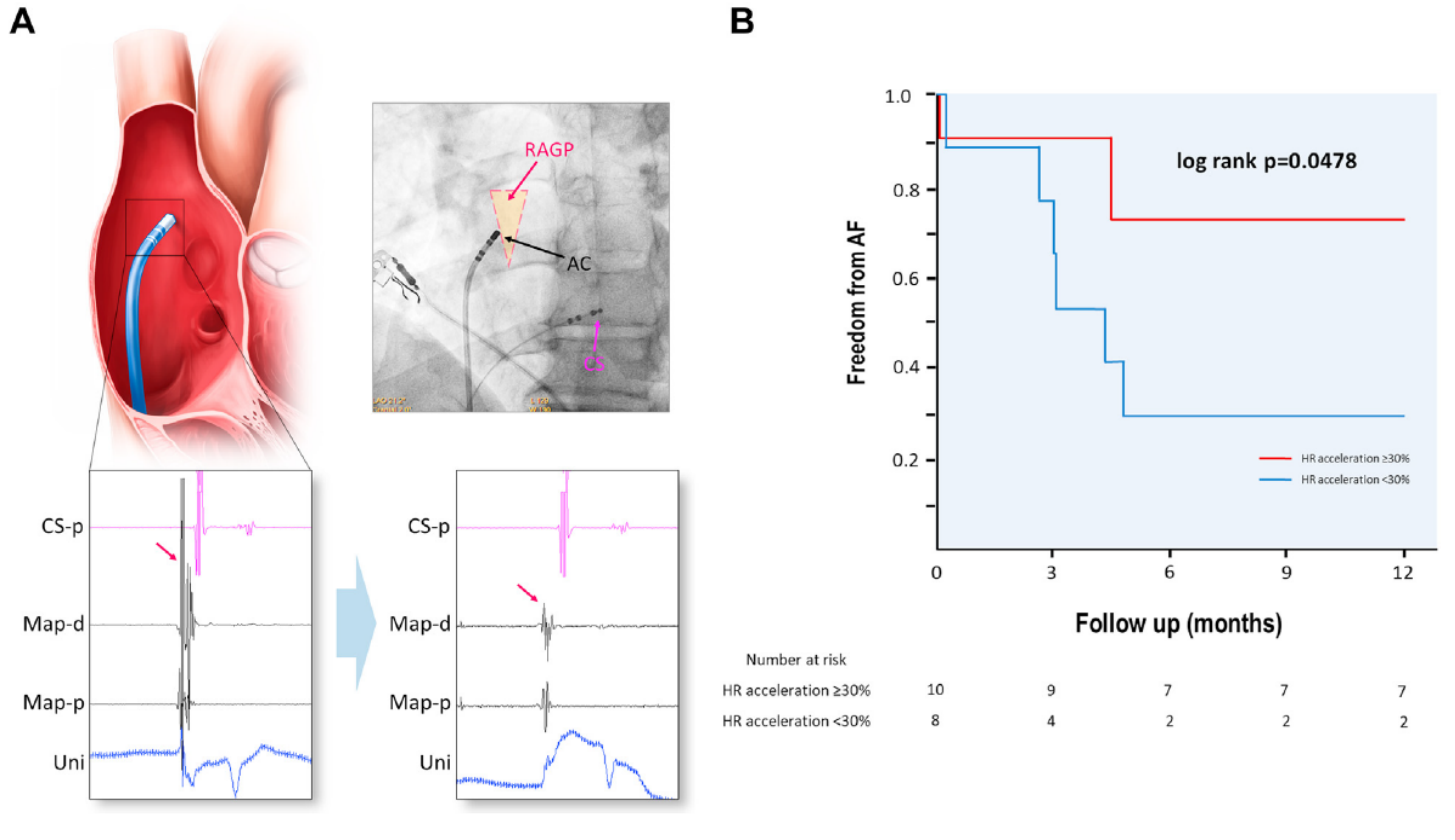
- 8/7 pts -> **Syncopal recurrence**; 9/14 with **≥ 2° AVB**
- 99/130 (76%) had 24-72 hour holters

AF

LETTERS: RESEARCH LETTER

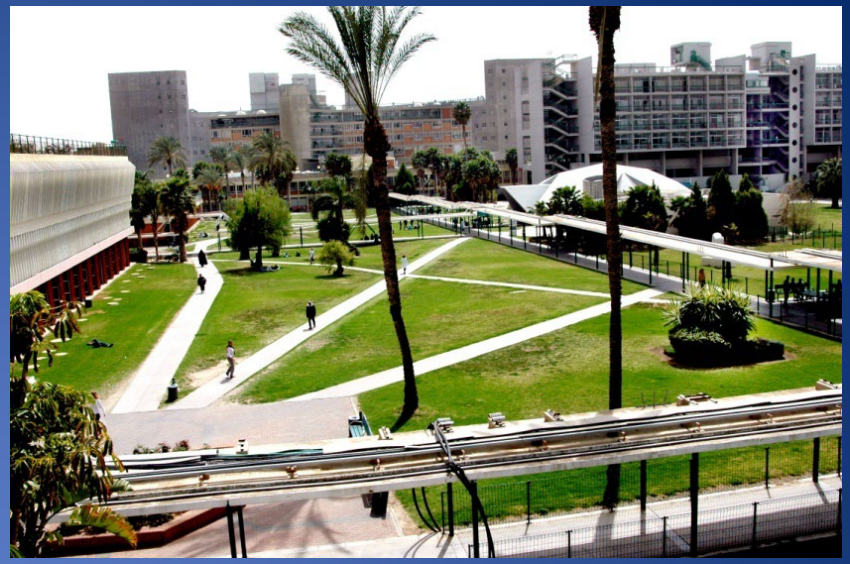
Cardioneuroablation of Right Anterior Ganglionated Plexus for Treatment of Vagally Mediated Paroxysmal Atrial Fibrillation

FIGURE 1 Right-Atrial Cardioneuroablation of Vagally Mediated Paroxysmal Atrial Fibrillation



(A) (Top) Schematic illustration of ablation catheter (AC) position in the right atrium and fluoroscopic view in the left anterior oblique projection of AC at the right anterior ganglionated plexus (RAGP) area. (Bottom) Intracardiac signals from AC recorded before (left) and after (right) cardioneuroablation (CNA) showing fragmented bipolar atrial electrogram at baseline and reduced amplitude after CNA (red arrows). CS = coronary sinus. (B) Kaplan-Meier curves comparing survival free from atrial fibrillation (AF) in patients with heart rate (HR) acceleration ≥30% vs heart rate acceleration <30% achieved during RAGP ablation.





תודה רבה Thank You





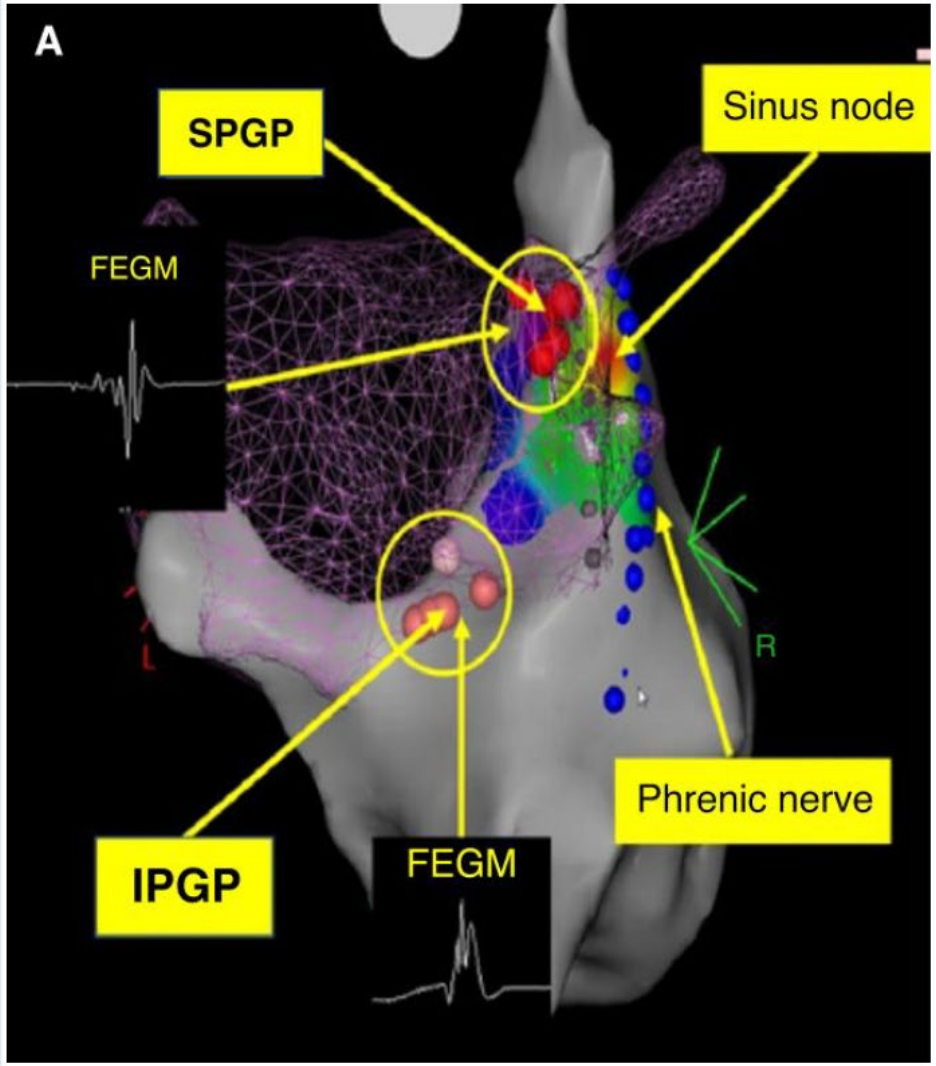
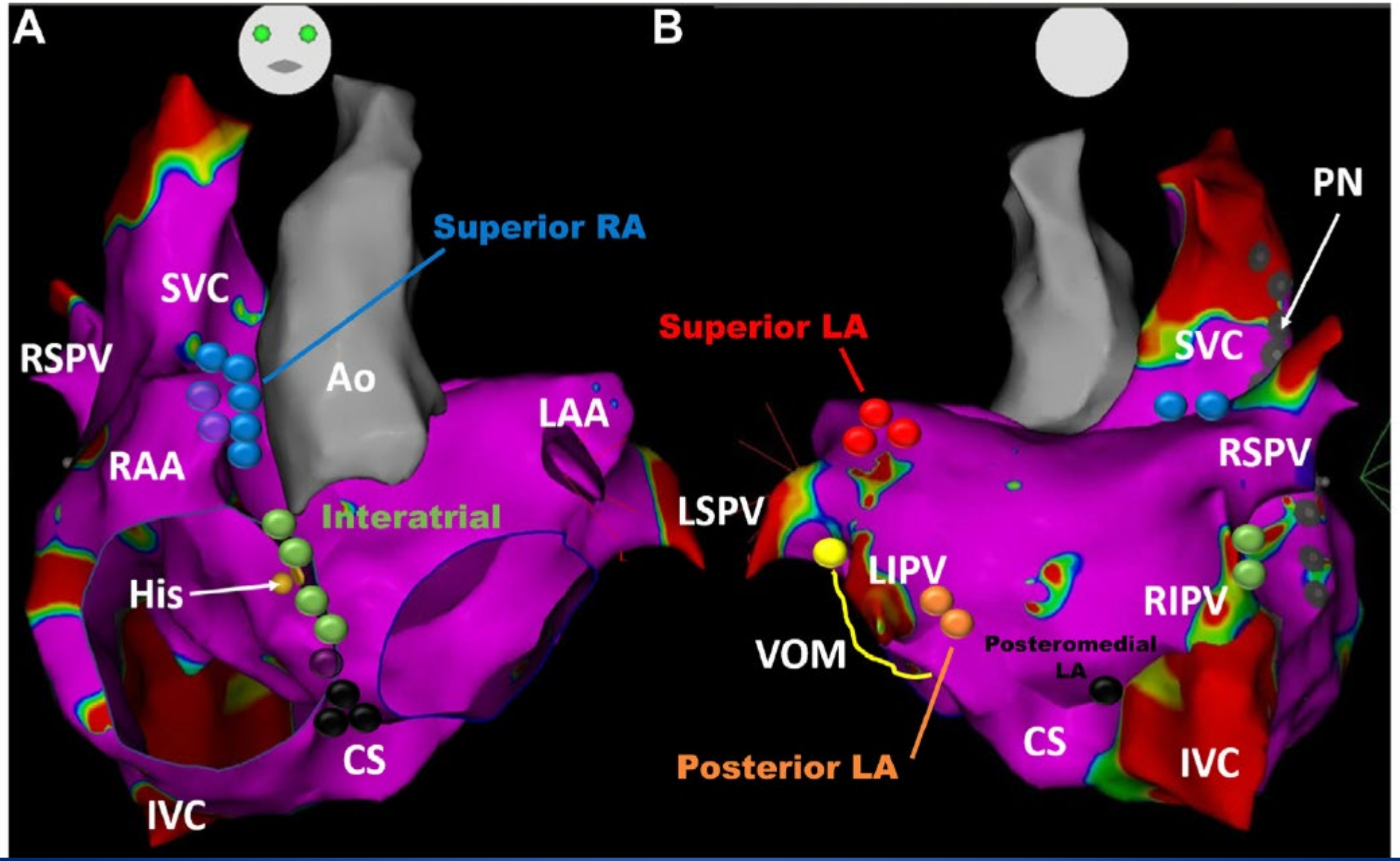
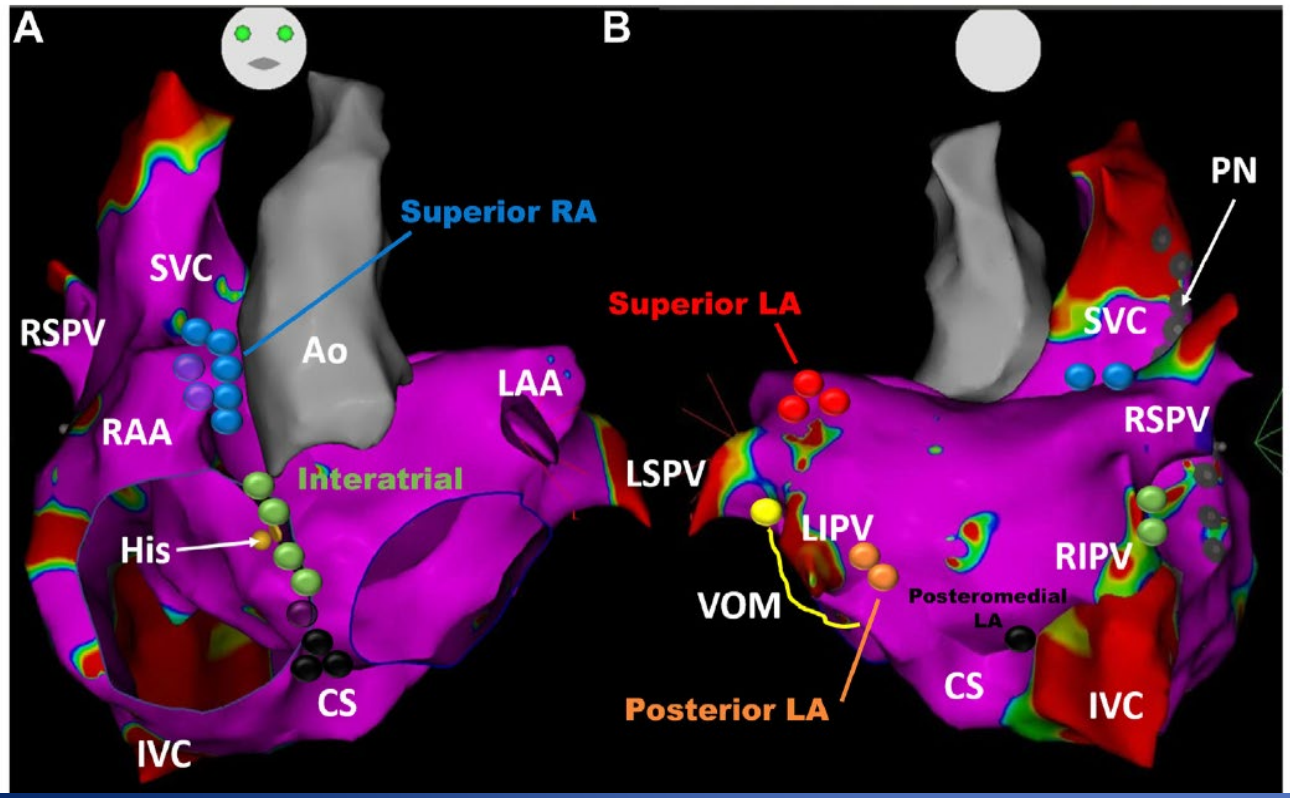


Figure 2 Electroanatomic map of the RA. Typical site of radiofrequency application (red bullets) of the SPSGP and of the IPSGP. An example of fragmented atrial electrograms recorded in the site of the lesion is shown. Modified from Piotrowski *et al.*,[3] with permission. IPSGP, inferior paraseptal ganglionated plexus; RA, right atrium; SPSGP, superior paraseptal ganglionated plexus.


A
B
Superior RA
SVC
RSPV
Ao
LAA
RAA
Interatrial
His
CS
IVC
Superior LA
LSPV
LIPV
VOM
Posterior LA
PN
SVC
RSPV
RIPV
Posteromedial LA
CS
IVC


A
B
Superior RA
SVC
RSPV
Ao
LAA
RAA
Interatrial
His
CS
IVC
Superior LA
LSPV
LIPV
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RSPV
RIPV
Posteromedial LA
CS
IVC

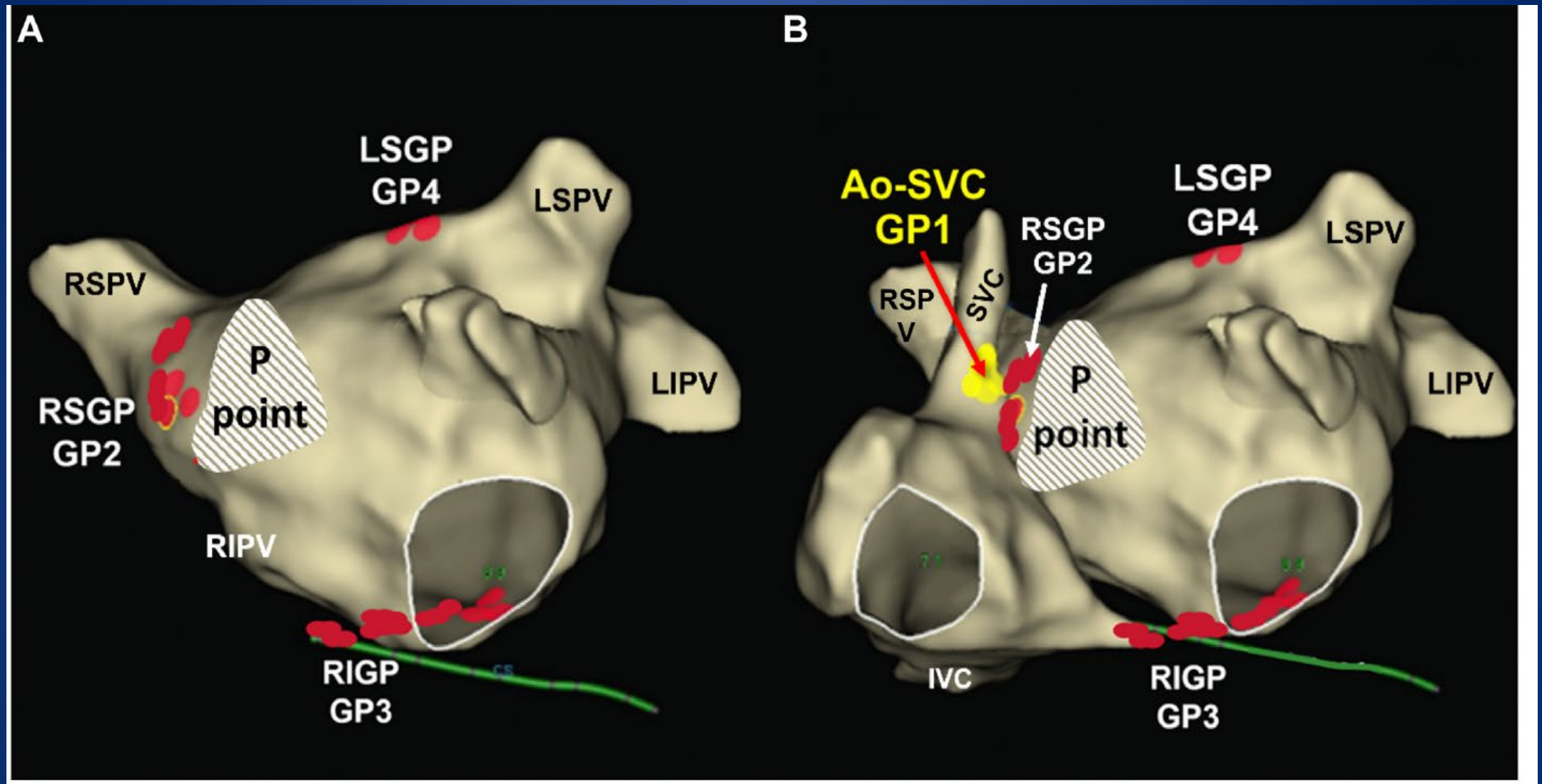
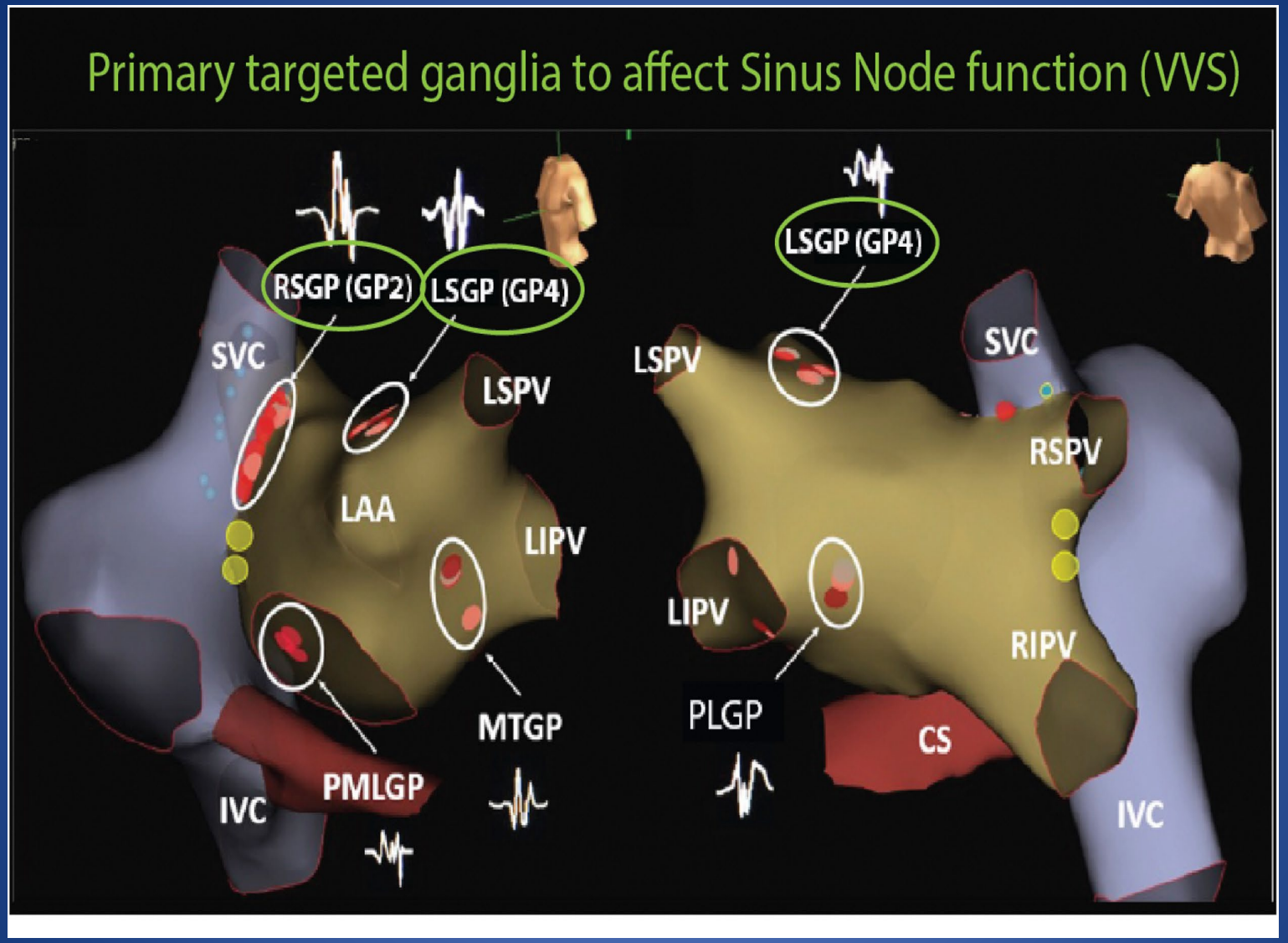
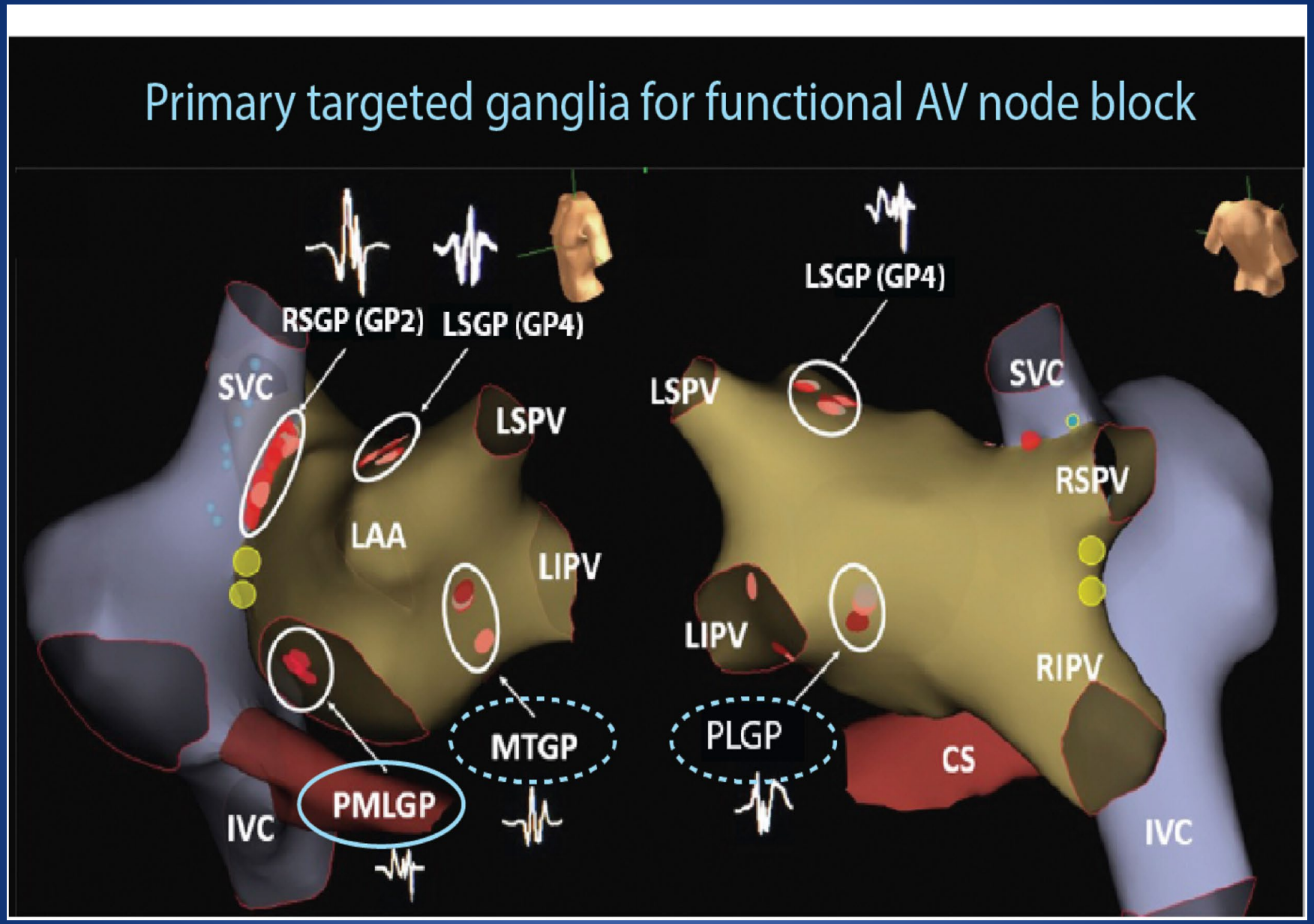


Figure 3 Location of the putative endocardial ablation sites for the 4 main ganglionated plexi (GPs) and P point in a 3-dimensional electroanatomical model. Electroanatomical model of the left atrium (**A**) and electroanatomical model of the right and left atria (**B**): the GP between the superior vena cava and aorta (Ao-SVC) (GP1), the right superior GP (RSGP) (GP2), the right inferior GP (RIGP) (GP3), and the left superior GP (LSGP). In some patients, there may be an extended GP4 or even an left inferior GP. In this nomenclature, right and left describe the relative position in the left atrium and numbered GPs are used because the sites on the electroanatomic map represent the putative sites of the GPs. IVC = inferior vena cava; LIPV = left inferior pulmonary vein; LSPV = left superior



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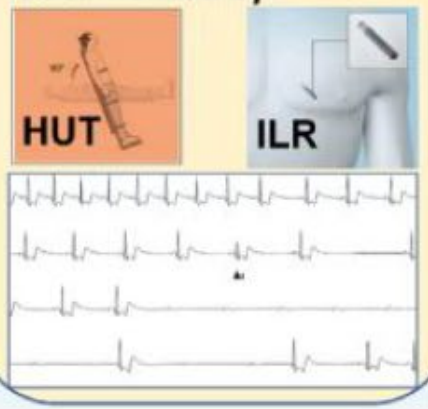
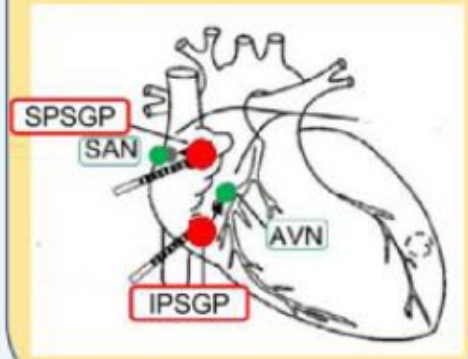
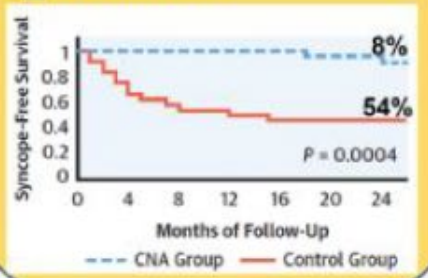


Heart Rhythm O2 2023 4401-413DOI: (10.1016/j.hroo.2023.02.007)

Clinical controversy: methodology and indications of cardioneuroablation for reflex syncope

Michele Brignole [1]*, Tolga Aksu [2], Leonardo Calò [3], Philippe Debruyne [4], Jean Claude Deharo [5], Alessandra Fanciulli[6], Artur Fedorowski [7,8,9], Piotr Kulakowski[10], Carlos Morillo [11], Angel Moya[12], Brian Olshansky [13], Roman Piotrowski [10], Sebastian Stec [14], and Dan Wichterle[15,16]

Cardioneuroblation for reflex syncope

	IDENTIFY the proper candidate	ABLATE the proper ganglia	VERIFY the effect of ablation	PROVE the efficacy of therapy
What is known	Asystolic reflex syncope documented by: 	*Target*: SPSGP - IPSGP 	*At 2 years:* ↓ Syncope recurrence ↓ Heart rate variability ↑ Heart rate 	• Need for large RCTs • Need for longer follow-up
What is not known	*Less suitable in:* • Mixed forms • Non-syncopal extrinsic SND/AVB *Do not perform in:* • VD forms • Intrinsic SND/AVB	• SPSGP only or SPSGP+IPSGP • RA vs LA vs RA+LA • Optimal ablation technique • Assessment of acute procedural success	• Long-term efficacy (reinnervation) • Patient's expectation effect • Physician's expectation effect • Subgroup efficacy	• Non-inferiority of CNA vs pacemaker in pts >40 yrs • Superiority of CNA vs conventional therapy in pts <60 years • Superiority of CNA vs sham CNA • Potential harm of long-term vagal denervation

Cardioneuroablation for the Treatment of Reflex Syncope and Functional Bradyarrhythmias. A Scientific Statement of the EHRA of the ESC, the HRS, the APHRS and the LAHRS

Authors

Tolga Aksu (Document Chair)

Alphabetically

EHRA Members

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LAHRS Members

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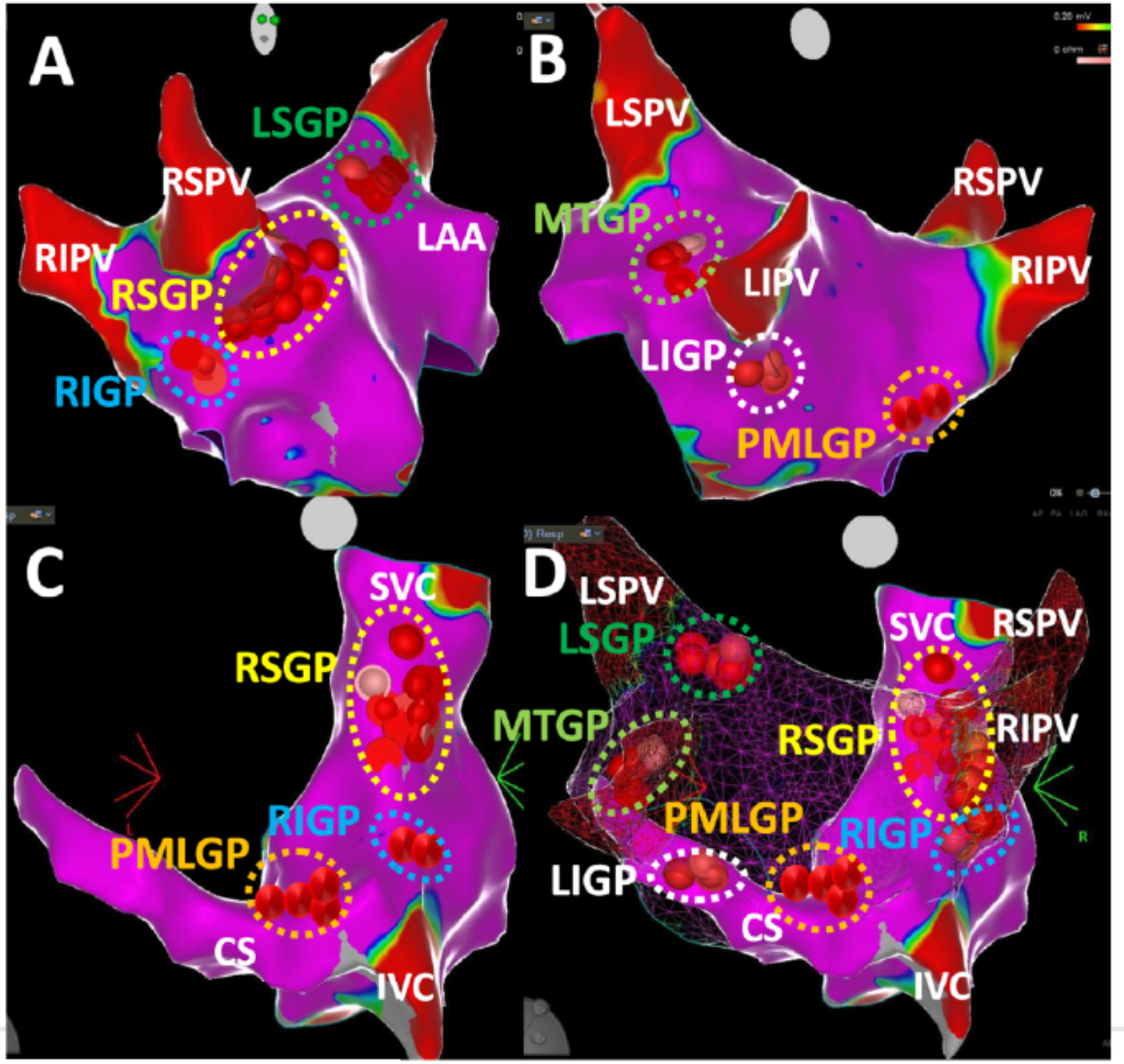
08 April 2024

Anatomy of Intrinsic Cardiac Autonomic Nervous System for Cardioneuroablation

- According to the GP nomenclature of Armour et al, the following anatomical areas called GP and contain most of the intrinsic ganglia:

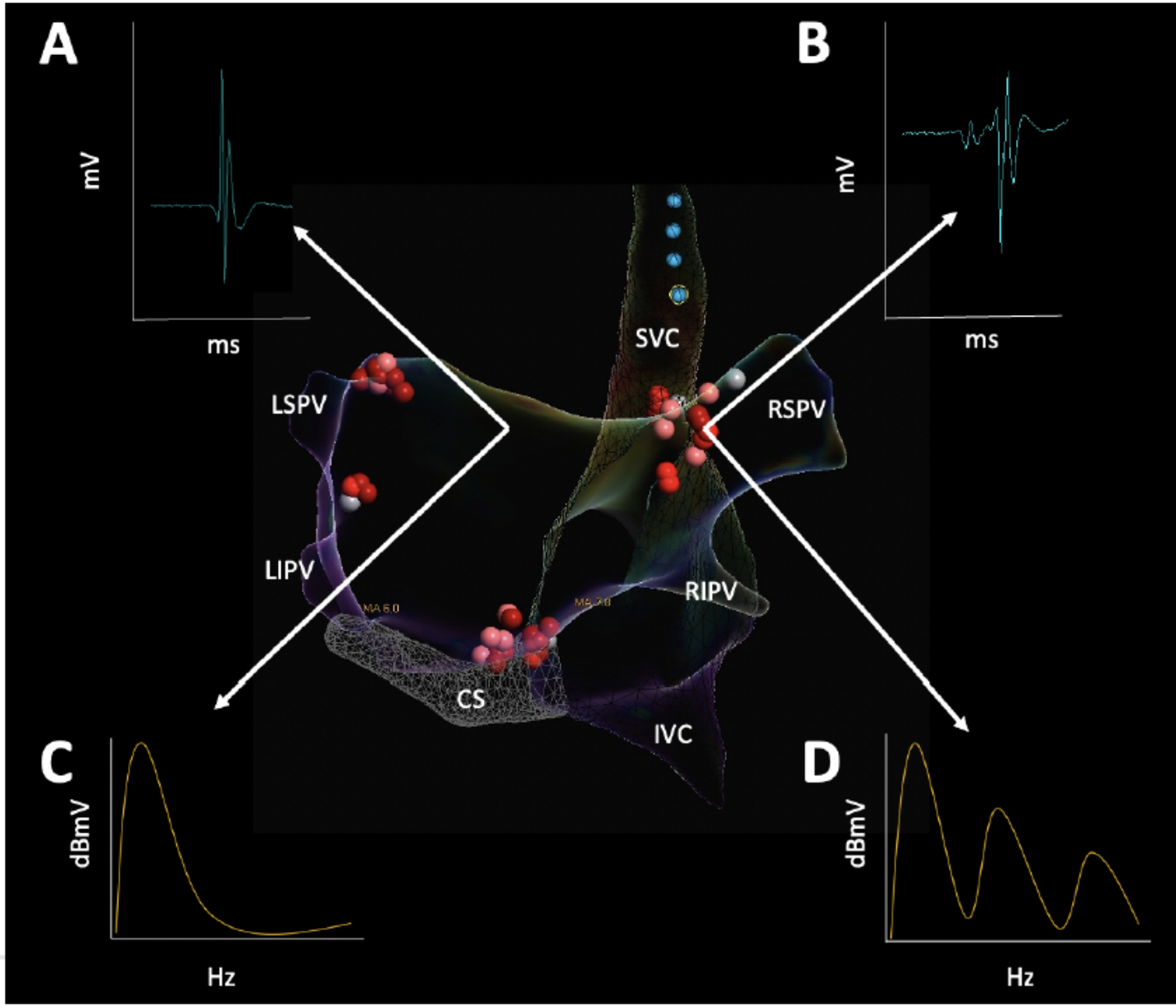
1) RSGP, located on the anterosuperior surface of the LA around the ostium of the RSPV and superolateral surface of the RA below the junction of the SVC and the RA
2) RIGP, located adjacent to the interatrial groove around the ostium of the RIPV.
3) LSGP, located on the anterosuperior surface of the LA around the ostium of the LSPV.
4) LIGP, located on the inferolateral surface of the posterior LA around the ostium of the LIPV
5) PMLGP, located on the posteromedial surface of the LA around the ostium of the CS

- The VOM also provides parasympathetic fibres to surrounding left atrial structures and the CS (MTGP)



Electrogram-based approach

- The electrogram-based approach assumes that, in the normal heart, areas of distal endocardial inputs of GP are characterised by highly fractionated atrial EGMs, contrary to the surrounding atrial myocardium with non-fractionated or less fractionated atrial EGMs.
- Time-domain analysis of fractionated EGMs has limitations in both specificity and sensitivity. Specificity may be limited, as fractionated EGMs may represent areas of atrial fibrosis, PV potentials, or double potentials in such areas in the RA as the slow pathway region, CS os or RA-SVC junction



High-frequency stimulation

- During HFS, rapid electrical impulses with frequency of 20 Hz, voltage of 10 to 20 V, and pulse duration of 5 ms, are delivered via standard electrophysiology catheters endocardially to each GP site
- The expected autonomic vagal response (VR) characterised by immediate sinus bradycardia (increased R-R interval by 50%) and/or transient ventricular asystole (>3 s) or AVB
- However, a VR elicited in this way is neither sensitive nor specific to localize GP because HFS may stimulate not only GPs but also nerves that extend from GPs towards the atrial region
- Another limitation of HFS is AF induction during mapping

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Anatomically guided approach

- The anatomically guided approach can be applied in two different ways: as an adjunct to electrogram analysis or HFS, or purely anatomical as a stand-alone strategy using isolated right-atrial or left-atrial/bi-atrial approaches
- Intracardiac echocardiography or computed tomography can be used used to identify important anatomical landmarks and epicardial fat pads with presumed GP
- A recently published meta-analysis did not show any significant differences in freedom from syncope based on the technique used to identify GPs.
- However, overall data are limited since 465 patients were included across 14 cohort studies. Thus, comparative data are lacking and validation studies are needed

Ablation Methods and Techniques

First author (year)	GP Detection Method	Guidance for mapping	Atrium	Targeted GPs	Catheter	Ablation Settings
Pachon (2005)[4]	Spectral Analysis	Scopy	Both	RSGP, RIGP, LSGP, PMLGP, LIGP, CT	4 mm NI	60-70 °C/15-30s
Pachon (2011)[5]	Spectral Analysis	Ensite	Both	RSGP, RIGP, LSGP, LIGP, PMLGP, CT	8 mm NI/I	50 J/60°C or 30 J/45°C
Yao (2012)[6]	HFS	Ensite	Left	RSGP, RIGP, LSGP, LIGP	8 mm NI	Up to 60 W and 60°C/60s
Zhao (2015)[7]	HFS	Carto	Both	RSGP, RIGP, LSGP, LIGP, CT	I, non-CF	30-35W/43°C/40-60s
Aksu (2016)[8]	Spectral Analysis + HFS	Ensite	Both	RSGP, RIGP, PMLGP	I, non-CF	Up to 35W/43°C
Sun (2016)[9]	HFS vs Anatomical	Ensite	Left	RSGP, RIGP, LSGP, LIGP	8 mm NI	Up to 60W/60°C/60s
Qin (2017)[10]	Anatomical	Carto	Both	RSGP, RIGP, LSGP, LIGP, PMLGP	I, non-CF	Up to 40W/43°C/30s
Rivarola (2017)[11]	Anatomical	Carto/Ensite	Both	RSGP, RIGP, LSGP, LIGP, PMLGP	I, non-CF	20-35W/50°C/30-60s
Debruyne (2018)[12]	Anatomical	Carto	Right	RSGP	I, CF	Up to 40W/CF>8 g/30s
Aksu (2019)[13]	Spectral Analysis + HFS vs FEGM	Ensite	Both	RSGP, RIGP, LSGP, LIGP, PMLGP	I, non-CF	Up to 35W/43°C
Hu (2019)[14]	HFS and/or Anatomical	Ensite	Left	RSGP, RIGP, LSGP, LIGP		Up to 40W/60°C/10-30s
Aksu (2020)[15]	FEGM	Ensite	Both	RSGP, RIGP, LSGP, LIGP	I, non-CF	Up to 35-40W/at least 30s
Pachon (2020)[16]	FEGM	Ensite	Both	RSGP, RIGP, LSGP, PMLGP	I, non-CF	40 W/40 °C/30–120s
Debruyne (2021)[17]	Anatomical	Carto	Right	RSGP	I, CF	Up to 40W/CF>8 g/90s
Aksu (2021)[18]	FEGM	Ensite	Both	RSGP, RIGP, PMLGP, LSGP, LIGP, MTGP	I, non-CF	Up to 35-40W/at least 30s
Calo (2021)[19]	FEGM+Anatomical	Carto	Right	RSGP, RIGP, PMLGP	8 mm NI	50–70W/60°C/30– 60 s
Mesquita (2021)[81]	Anatomical	Carto/Ensite	Both	RSGP, RIGP, PMLGP	I, non-CF/CF	20-25W/43°C/30s
Aksu (2022)[20]	FEGM	Carto/Ensite	Both	RSGP, RIGP, LSGP, LIGP	I, non-CF	Up to 35-40W/at least 30s
Xu (2022)[21]	HFS	Carto/Ensite	Left	RSGP, RIGP, LSGP, LIGP, PMLGP	I, CF	35W/43°C/FTI:400gs
Candemir (2022)[87]	Anatomical	Carto/Ensite	Right	RSGP, PMLGP	I	Up to 45W/ at least 60s
Tu (2022)[88]	HFS and Anatomical	Carto	Left	RSGP, RIGP, LSGP, LIGP	I	Up to 40W/60°C
Piotrowski (2023)[22]	Anatomical+ICE+FEGM	Carto	Both	RSGP, PMLGP	I, CF	31-35W/43°C/AI:400-500
Stec (2023)[23]	Anatomical	Ensite	Both	RSGP, RIGP, PMLGP, LSGP, LIGP, MTGP	I, non-CF	ND
Wileczek (2023)[24]	Anatomical	Ensite	Both	RSGP, RIGP, PMLGP, LSGP, LIGP, MTGP	I, non-CF	ND
Rivarola (2023)[25]	Anatomical	Carto/Ensite	Both	RSGP, RIGP	I, Non-CF/CF	20-30W/48°C/30–60s Up to 40W/CF:8-15 g/40s or AI:500
Francia (2023)[57]	Anatomical	Ensite	Both	RSGP, RIGP, LSGP, LIGP, MTGP	I, CF	Up to 40-50W/ at least 24s
Kulakowski (2023)[83]	ICE+Anatomical+ FEGM	Carto	Both	RAGP, RIGP, PMLGP and LSGP/LIGP when needed	I, CF	Up to 35 W, AI up to 500
Santos Silva (2023)[89]	Anatomical	Carto	Both	RSGP, RIGP, LSGP, MTGP	I, CF	AI up to 500

Writing Committee Position

- In a recently published metanalysis, freedom from syncopal recurrence with right-atrial approaches was around 82% which was significantly lower than with more extensive left-atrial ablation strategies (LA ablation only (94.0%) and bi-atrial ablation (92.7%))
- Although the RSGP usually has a relatively constant anatomic location which may be accessed through the RA, the interindividual PMLGP location varies widely, and hence ablation of this structure by right-atrial approach might be more challenging
- Although RSGP (superior paraseptal GP) and PMLGP (inferior paraseptal GP) represent the main targets for parasympathetic denervation of the SAN and AVN, respectively, the bi-atrial approach may be needed in some patients to achieve full parasympathetic denervation of the AVN

Procedural Endpoints

- Depending on the GP mapping method used, various procedural endpoints have been defined
- In studies using an electrogram-based approach, the elimination of targeted electrograms is suggested as an ablation endpoint
- In the case of the HFS approach, the ablation endpoint is the elimination of positive VRs to HFS at any site showing a positive response before ablation
- As a relatively new tool, ECVS can be used and repeated multiple times during CNA to assess the completeness of vagal denervation and selective denervation of the SAN and AVN

Procedural and Long-term Risks

- Procedure-related major complications after CNA should not differ from those associated with established left and right atrial catheter ablation procedures
- The damage of the SAN artery was described during ablation of RSGP because superior septal radiofrequency lesions may be close to this artery
- An increase in HR is an expected effect of CNA and may be symptomatic even if not fulfilling the criteria for inappropriate sinus tachycardia
- It is not yet known whether the post-CNA state shares the increased morbidity and mortality with other conditions associated with impaired cardiovagal innervation.
- Therefore, the possibility of unknown long-term risks should be discussed with patients before the procedure.
- Long-term studies evaluating the impact of CNA-related reduced cardiovagal responsivity on morbidity or mortality are needed to address these safety issues.

A proposed algorithm for the selection of reflex syncope patients for CNA based on available literature

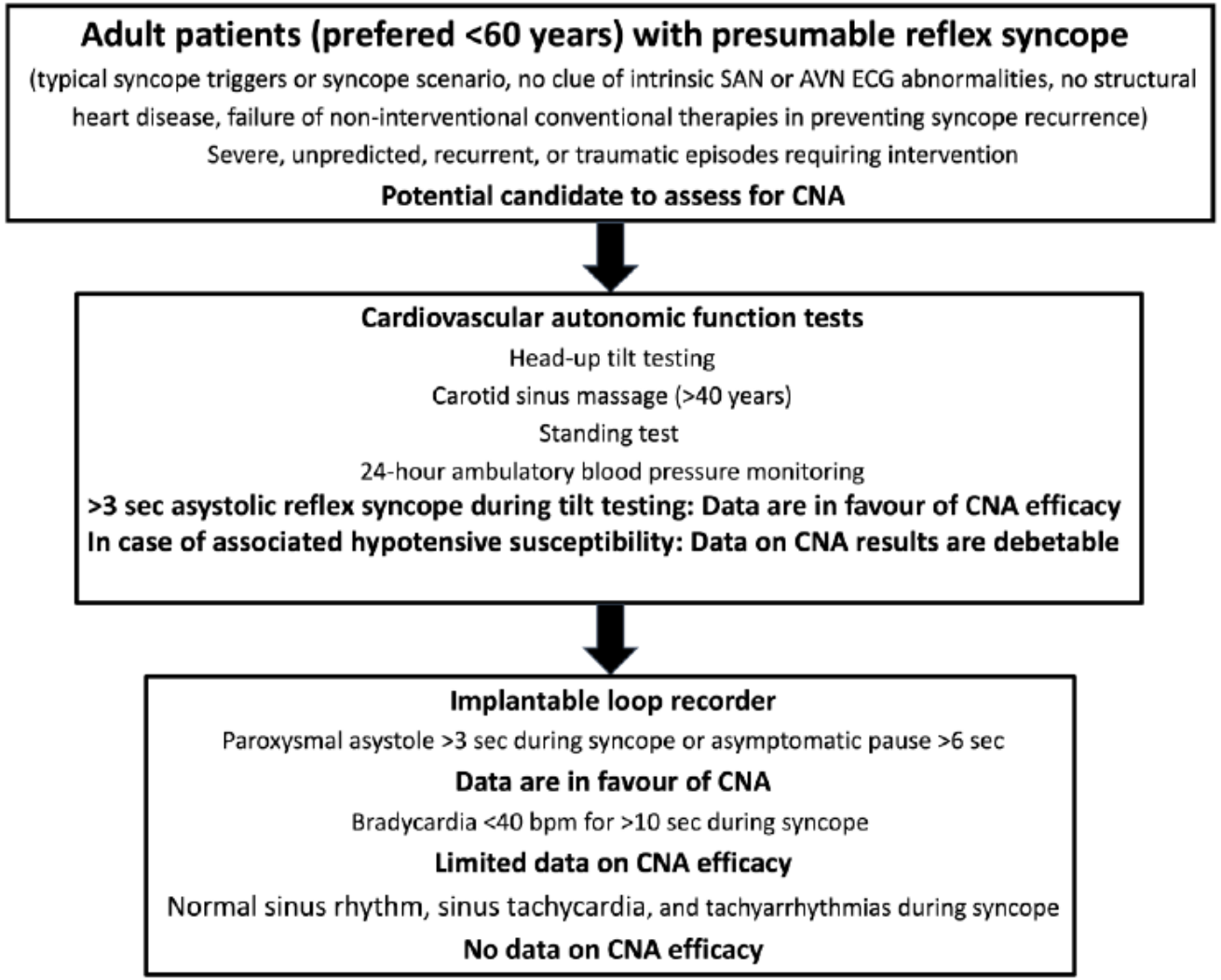


Table 2 Possible patient selection considerations for CNA in different conditions

Condition	Patient considerations
Vasovagal syncope	• Cardioinhibitory response to tilt table testing (type 1, 2A, or 2B) • Significant and persistent debilitating symptoms that are refractory to conservative strategies such as physical countermeasures and exercise and medications • Shared decision-making process that discusses alternatives and the current limited evidence base for CNA
Functional AV block	• Younger (<50 years of age) • Periods of symptomatic AV block associated with hypervagotonia in whom permanent pacing is being considered for treatment. • Atropine restores AV conduction • No associated structural heart disease or other disorder associated with AV block (eg, metabolic, infectious, genetic causes) • Shared decision-making process that discusses alternatives and the current limited evidence base for CNA • Electrophysiology study confirms an intact conduction system and the absence of intra/infra-His disease.
Functional sinus bradycardia	• Younger (<50 years of age) • Periods of symptomatic sinus bradycardia associated with hypervagotonia in whom permanent pacing is being considered for treatment • Intrinsic sinus node disease is not present • Shared decision making process that discusses alternatives and the current limited evidence base for CNA

AV atrioventricular; CNA cardioneuroablation

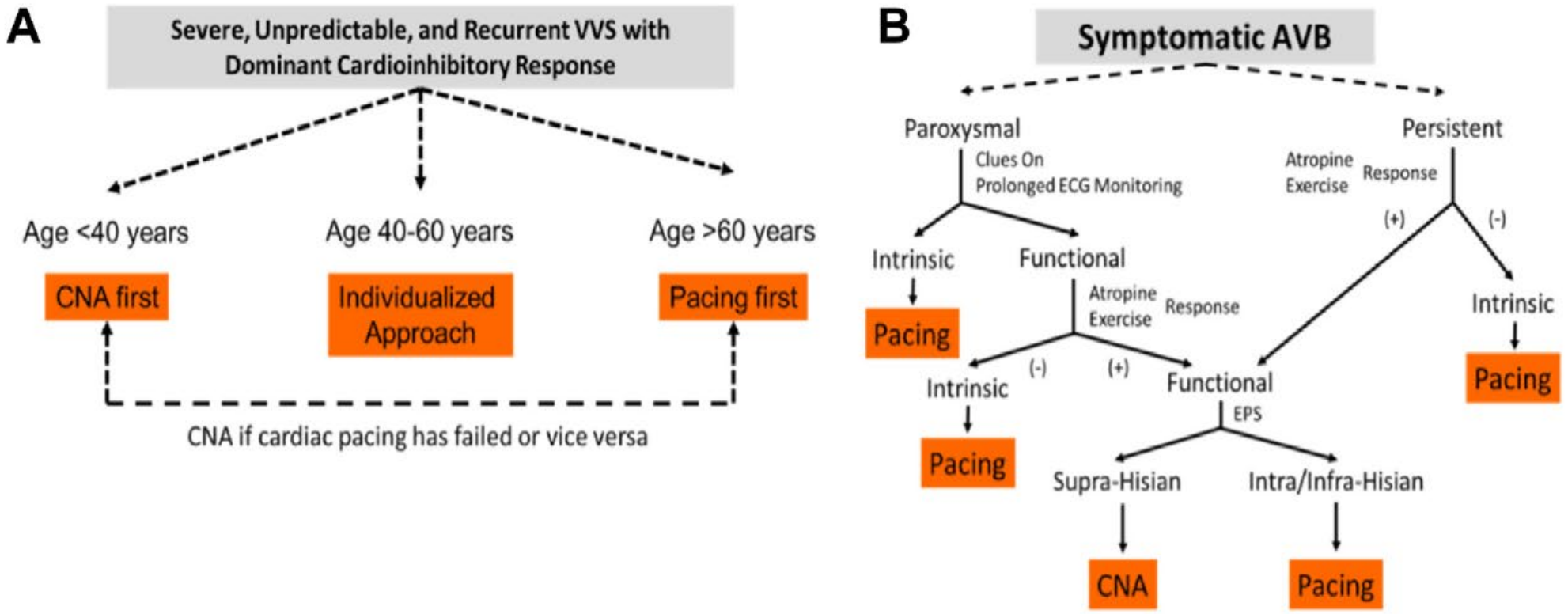


Figure 3

Schematic practical decision pathway for the management of (A) vasovagal syncope (VVS) and (B) atrioventricular block (AVB). CNA = cardioneuroablation; ECG = electrocardiographic; EPS = electrophysiology study.

(Heart Rhythm 2024;21:100–105

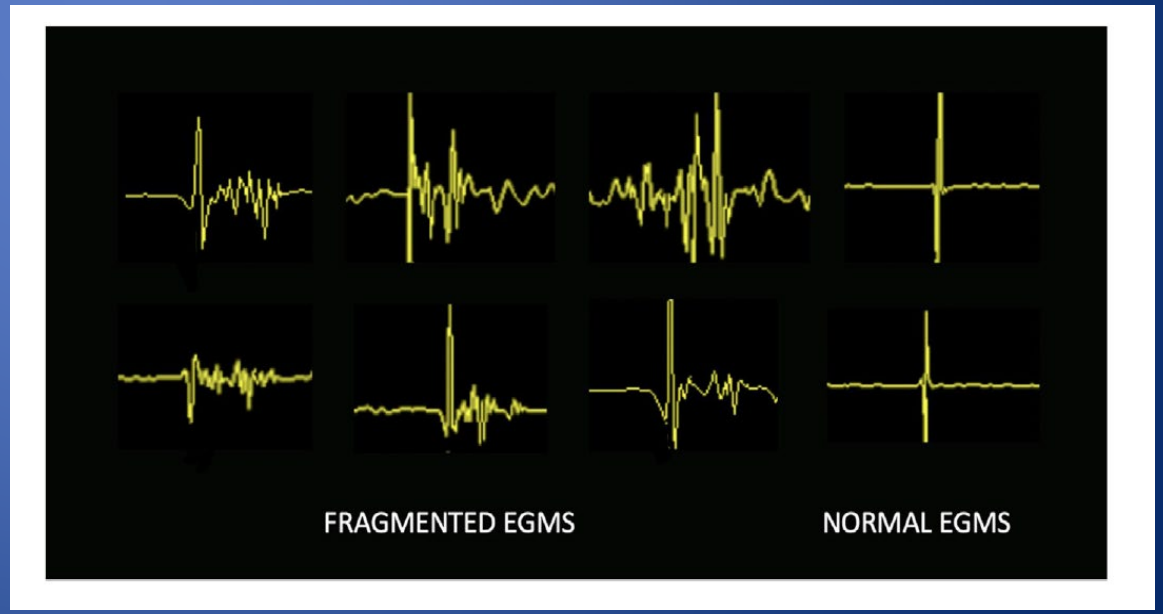
Table 4 Methods for GP identification, technique-specific endpoints, and technique-independent endpoints that can be used with any GP mapping strategies

GP identification	Mapping technique	Technique specific endpoints	Technique independent endpoints
Anatomic	Construct a 3-dimensional model of the atria (with or without additional imaging modalities) and perform ablation at expected GP locations	Electrogram elimination or attenuation	• Absence of a vagal response with extravascular vagal stimulation • Absence of a heart rate response with atropine
High-frequency stimulation	Ablation at endocardial sites associated with a vagal response (transient AV block, asystole, or an increase in the R-R interval) with very rapid stimulation (20 Hz, 10–20 V, pulse duration 5 ms and <5-s total duration)	Elimination of the vagal response with ablation or post	• Sustained increase in heart rate
Electrogram morphology	Spectral analysis: Ablation at sites characterized by multiple harmonics with frequencies >80 Hz Fractionation: Identifying sites with ≥4 deflections, particularly with higher amplitudes (>0.7 mV)	Electrogram elimination or attenuation	

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procedure

- Sedation or General Anesthesia
- CS, ABLATION, ICE
- Ready for TS
- RECORDER 100/200-500 HZ ON ABLATION- LOOK FOR FRACTIONATION



Moti Haim, MD

- 30-35W posterior wall LA
- 40 w ANTERIOR WALL

Procedure

- סימון עצב פרני לפני צריבות ב RA-SVC JCT
- בצריבה בקיר אחורי ב LAלרדת ב POWER
- מטרות
- - היעדר תגובה וגאלית ב ECS
- היעלמות AVB והולכה 1:1

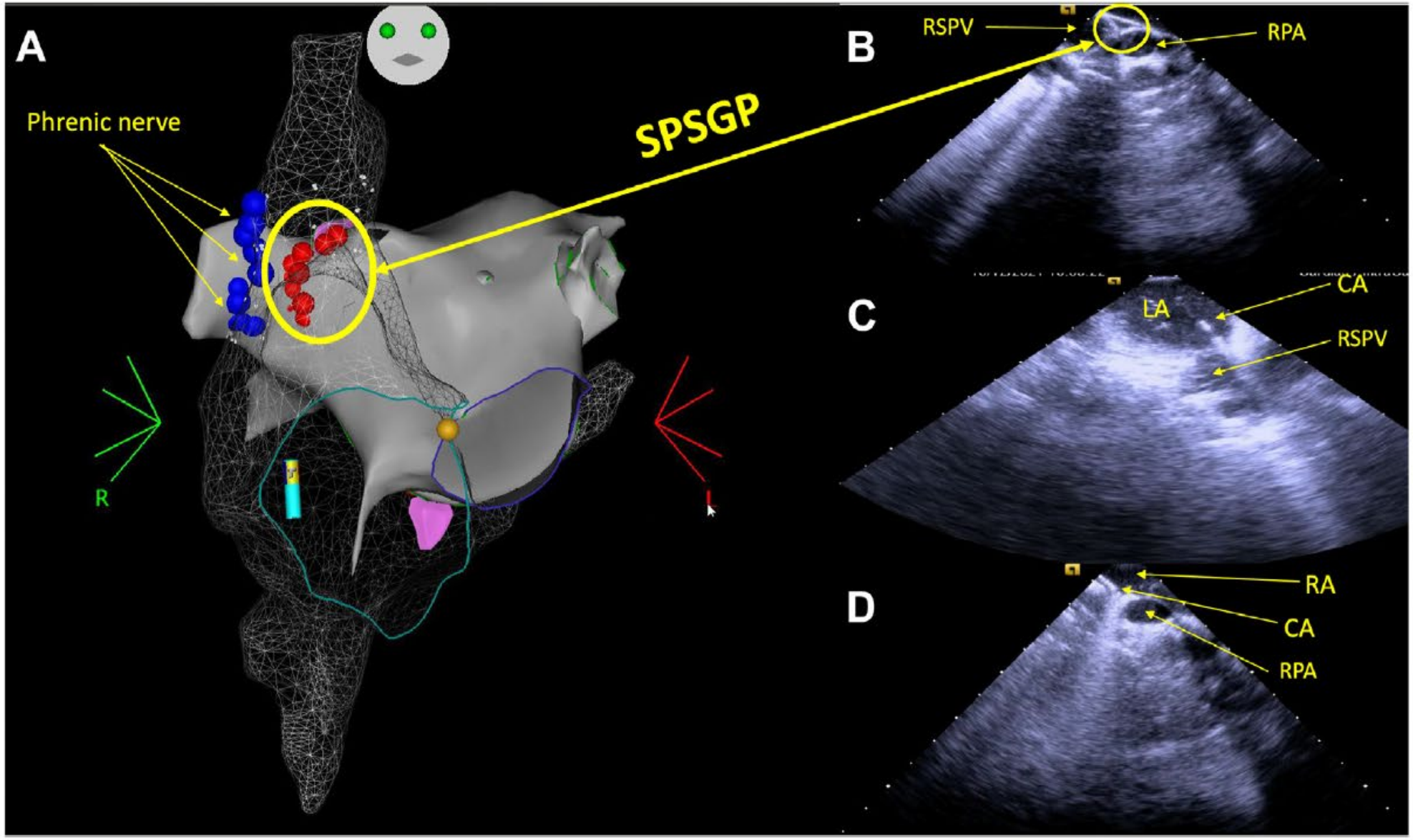


Figure 1

Original example of electroanatomic CARTO map with radiofrequency (RF) application points and corresponding intracardiac echocardiography (ICE) images during ablation of superior paraseptal ganglionated plexus (SPSGP). A: Electroanatomic CARTO map (anterior view) with ablation points *(red dots)* and delineated course of phrenic nerve *(blue dots)*. B: ICE image showing presumed localization of SPSGP between right superior pulmonary vein (RSPV) and right pulmonary artery (RPA). C: ICE image showing ablation catheter (CA) during RF delivery from the left atrium (LA). D: ICE image showing AC during RF delivery from the right atrium (RA).

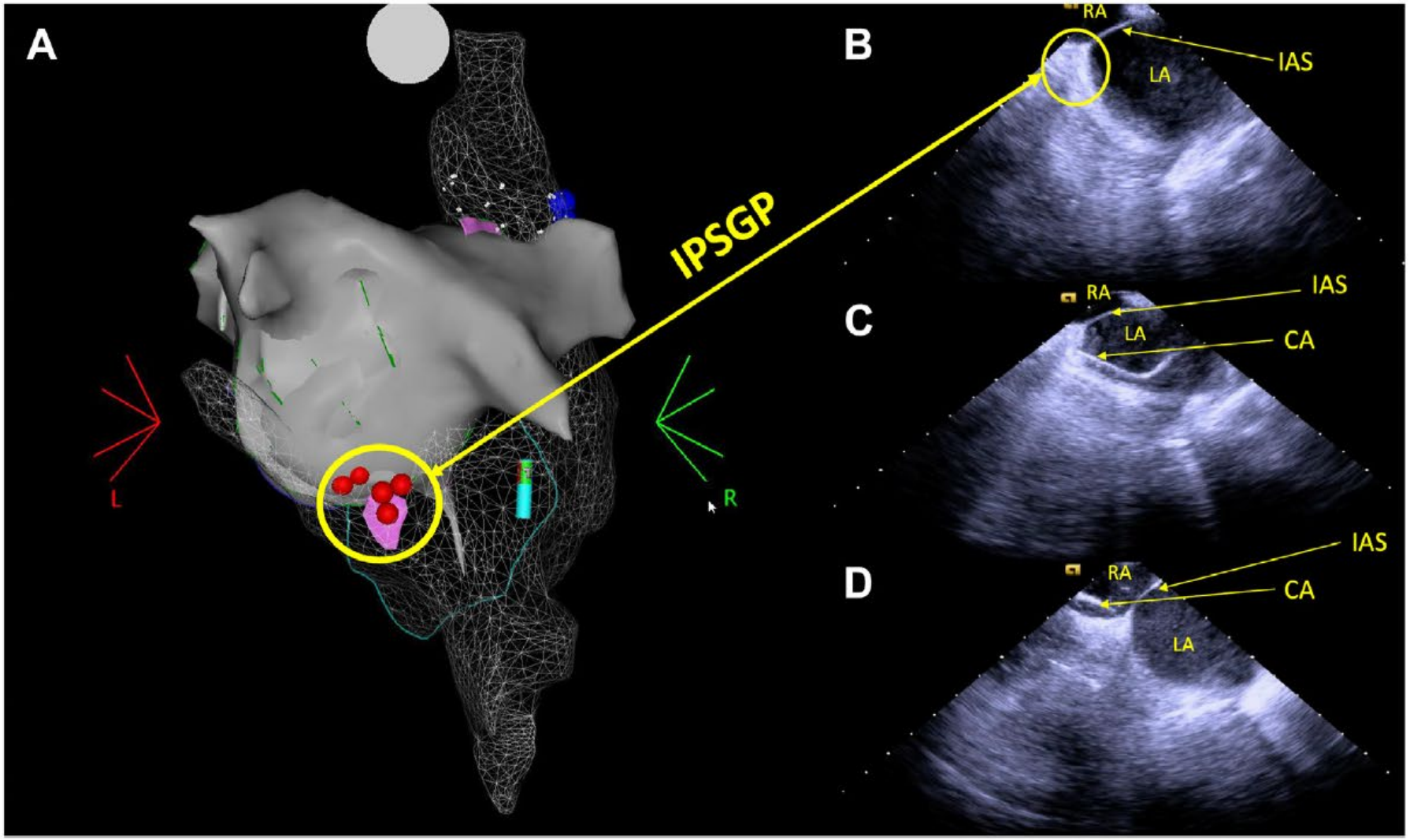


Figure 2

Original example of electroanatomic CARTO map with radiofrequency (RF) application points and corresponding intracardiac echocardiography (ICE) images during ablation of inferior paraseptal ganglionated plexus (IPSGP). A: Electroanatomic CARTO map (posterior view) with ablation points *(red dots)*. B: ICE image showing presumed localization of IPSGP between left atrium (LA), right atrium (RA), and inferior edge of interatrial septum (IAS), called the "pyramidal space". C: ICE image showing ablation catheter (CA) during RF delivery from LA. D: ICE image showing AC during RF delivery from RA.

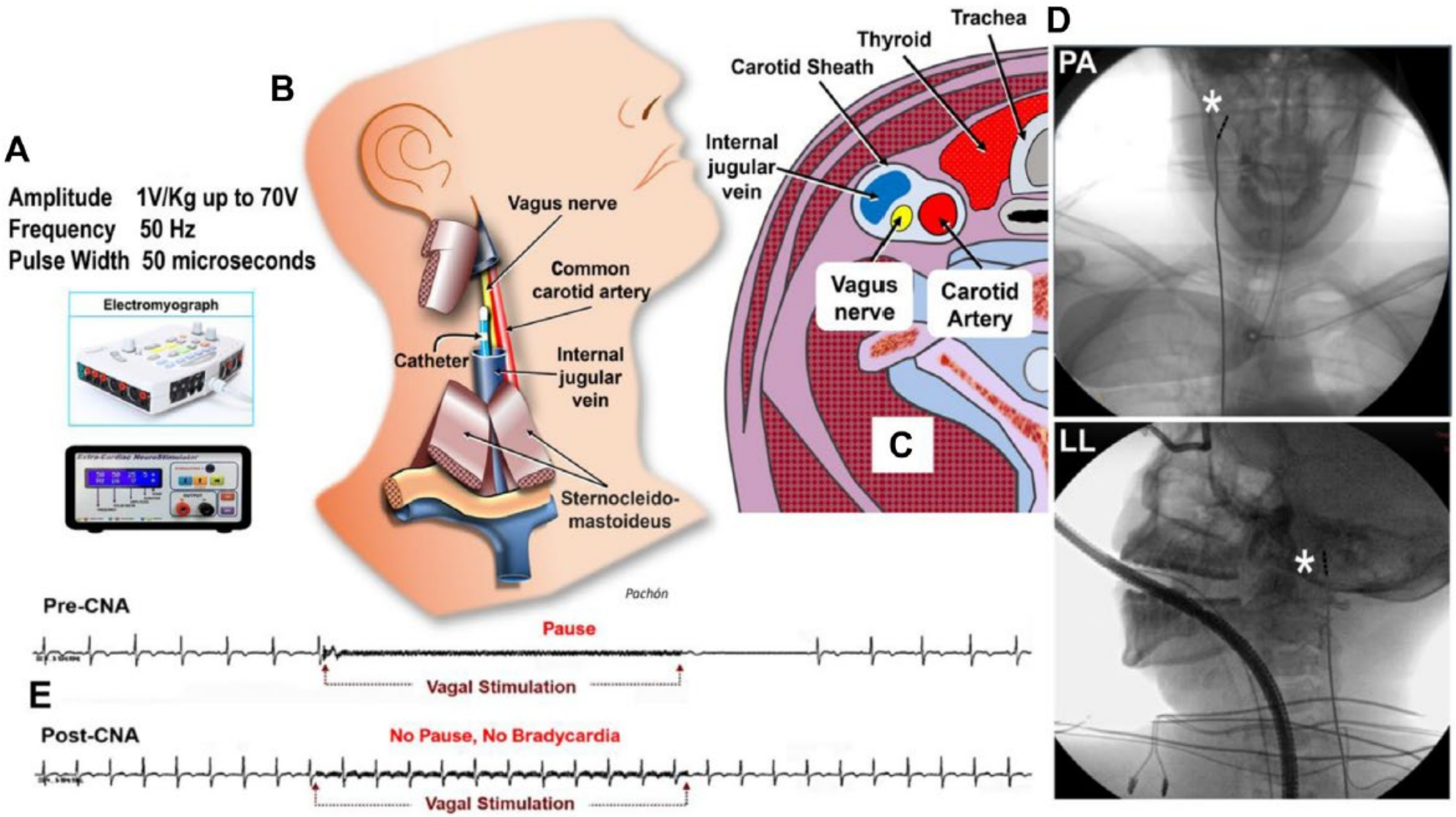
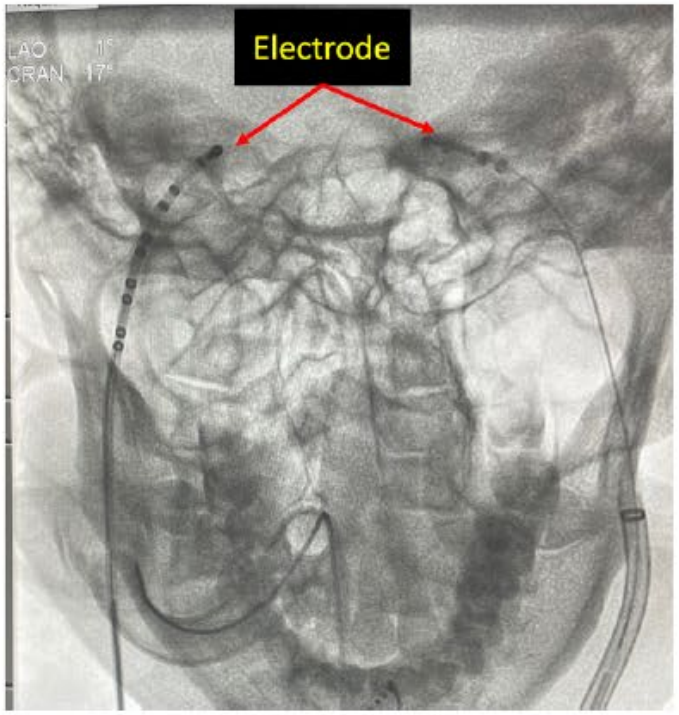
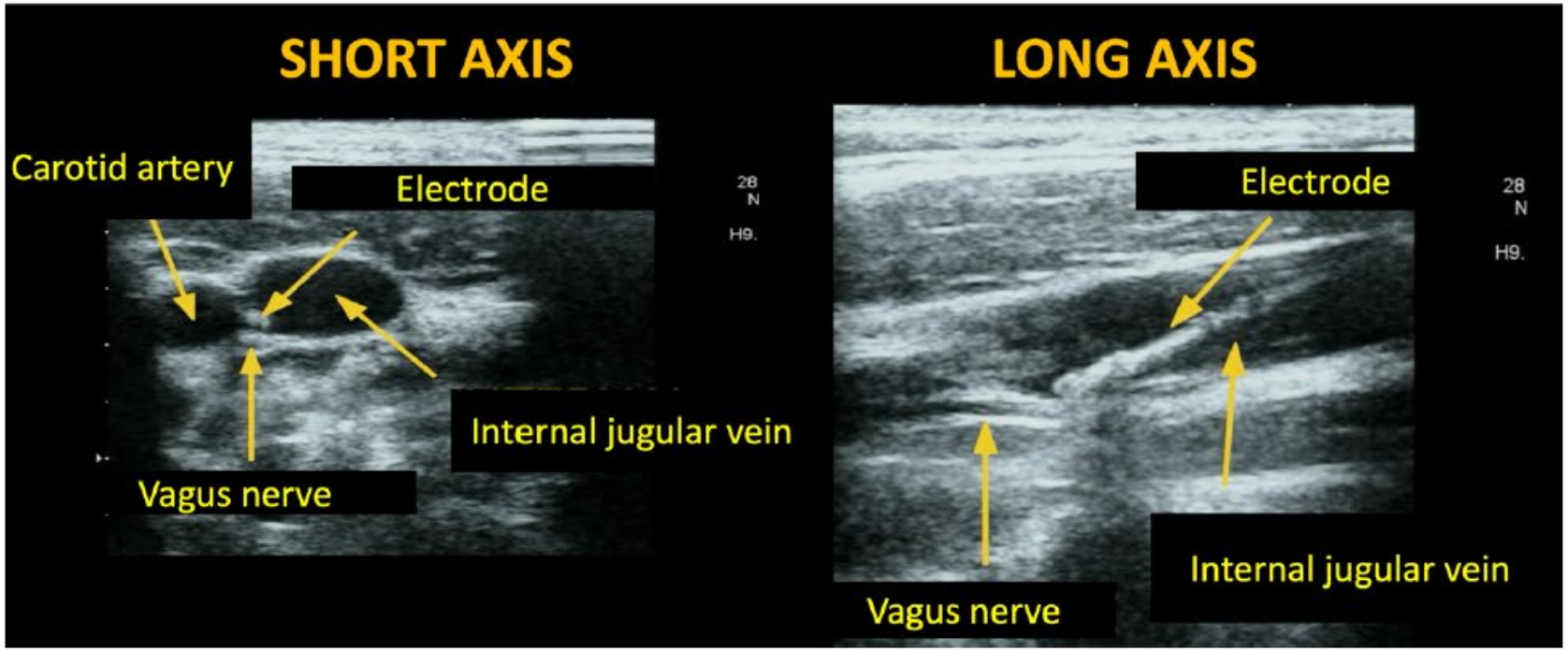


Figure 7 **A:** Optimized vagal stimulation parameters. **B:** Drawing showing the lead inside the internal jugular vein and its closeness to the vagus nerve. The closest site is usually located near the jugular foramen at the base of the cranium. **C:** Cervical cross-section scheme showing the carotid sheath and the relationship between the vagus nerve and the internal jugular vein. **D:** Anteroposterior (top) and lateral (bottom) radiographs showing the position of the lead just below the right jugular foramen to proceed with the stimulation of the right vagus nerve. **E:** Electrocardiography of extracardiac vagal stimulation before cardioneuroablation (CNA) showing long sinus arrest (top), and again, extracardiac vagal stimulation after CNA showing no more vagal response (bottom) (see Video). Asterisk indicates catheter tip. LL = left lateral; PA = lateral.

X-ray-guided Extra-Cardiac Vagal Stimulation



Ultrasound-guided Extra-Cardiac Vagal Stimulation



CEXTRACARAIC VAGAL STIM VIDEO

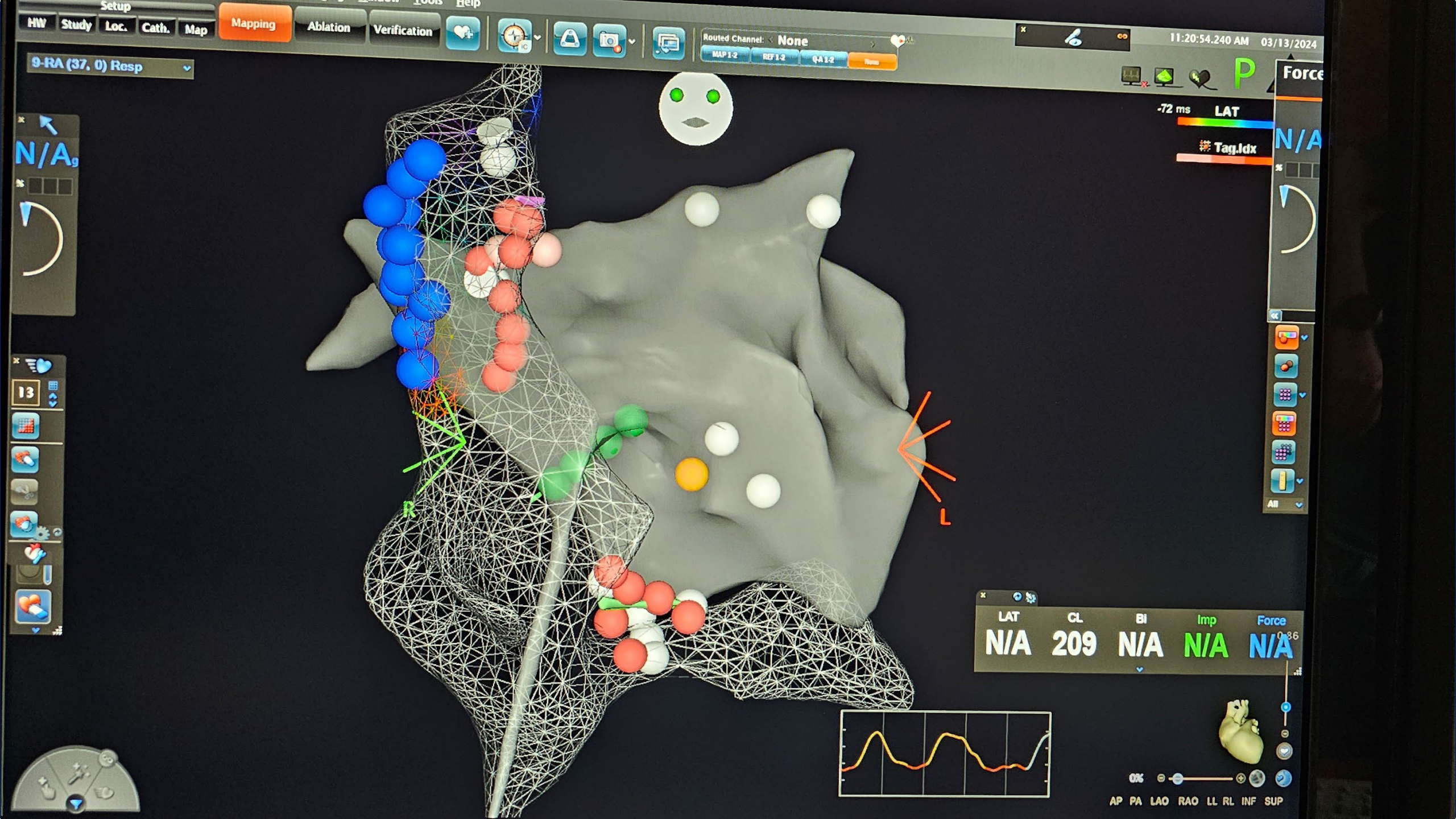



Study Map Point Catheter ECG Display Imaging Window Tools Help
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Mapping
Ablation
Verification
Routed Channel: None
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26g
Force Information
26g
150 Ω 70 g
130 56
110 42
90 28
70 14
50 0
0 2 4 6 8 10 Sec
LAT CL BI Imp Force
-152 665 1.16 156 26
AP
AP PA LAO RAO LL RL INF SUP
PHILIPS

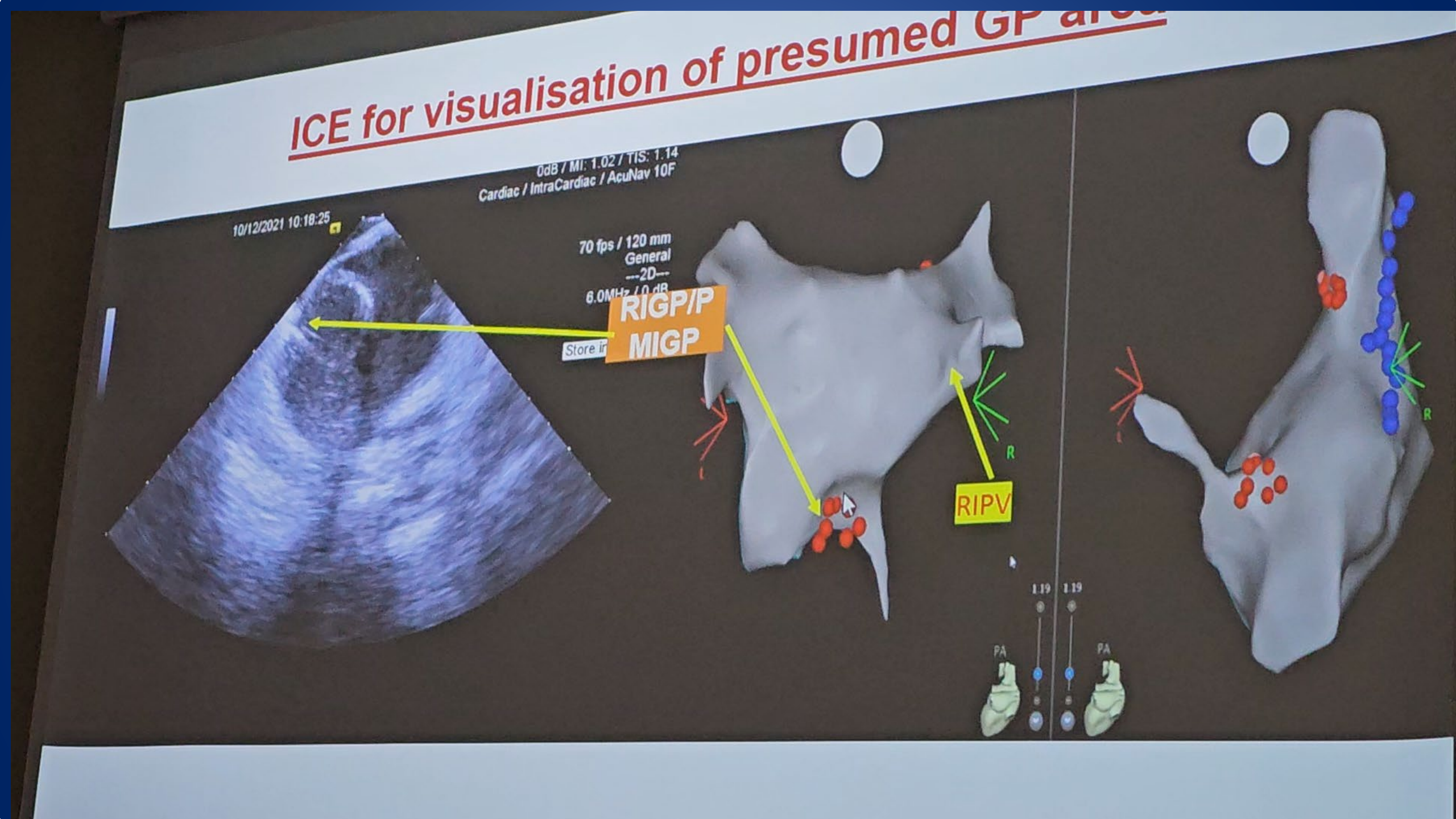

Study Map Point Catheter ECG Display Imaging Window Tools Help
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HW Study Loc. Cath. Map
Mapping
Ablation
Verification
Routed Channel: None
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27g
Force Information
27g
150 Ω 70 g
130 56
110 42
90 28
70 14
50 0
0 2 4 6 8 10 Sec
LAT CL BI Imp Force
-213 450 197 N/A 27
LAO
AP PA LAO RAO LL RL INF SUP
LabSystem PRO
Patient Amplifier
Start Protocol:
V6
CL
*252
HR
*238
ABL UniD
Archive:
EKG EP
March 13, 202
8:36:37
8:36:38
9:18:57


Study Map Point Catheter ECG Display Imaging Window Tools Help
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Mapping
Ablation
Verification
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LAT CL BI Imp Force
-216 453 197 N/A 27
RAO
AP PA LAO RAO LL RL INF SUP

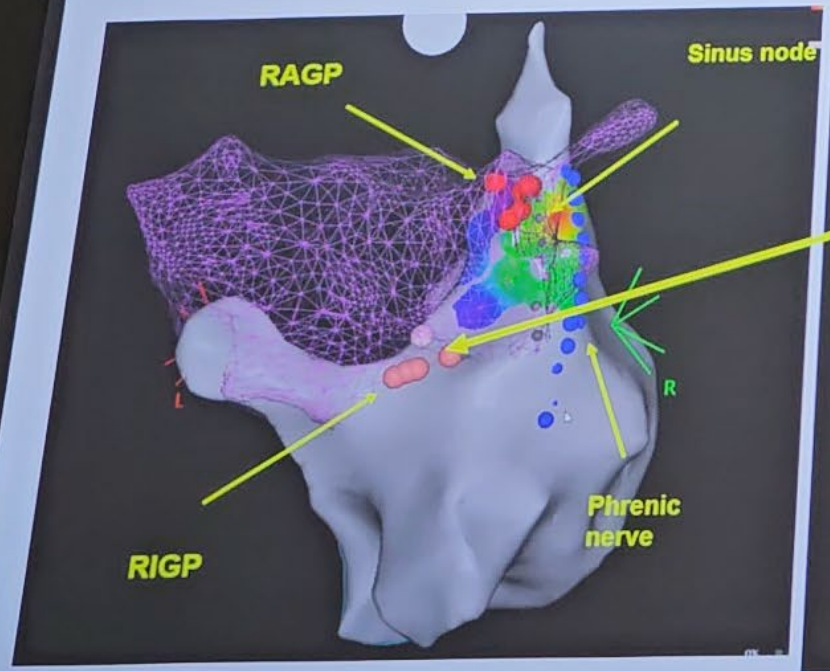

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Ablation
Verification
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Tag.Idx
Force
L
R
LAT CL BI Imp Force
-222 450 197 N/A 27
PA
AP PA LAO RAO LL RL INF SUP
LabSystem PRO v2.8a
Patient Amplifier Start Mark RT
Start Protocol: Study Info
V6
CL
HR
ABL1-2
Abl3-4
ABL UniD
Archive:
EKG EPS 12 ODP
March 13, 2024 08:36:38
8:36:37 Majewska, Sand
8:36:38 Ablation
9:18:57
9:20:05
For Help, press F1

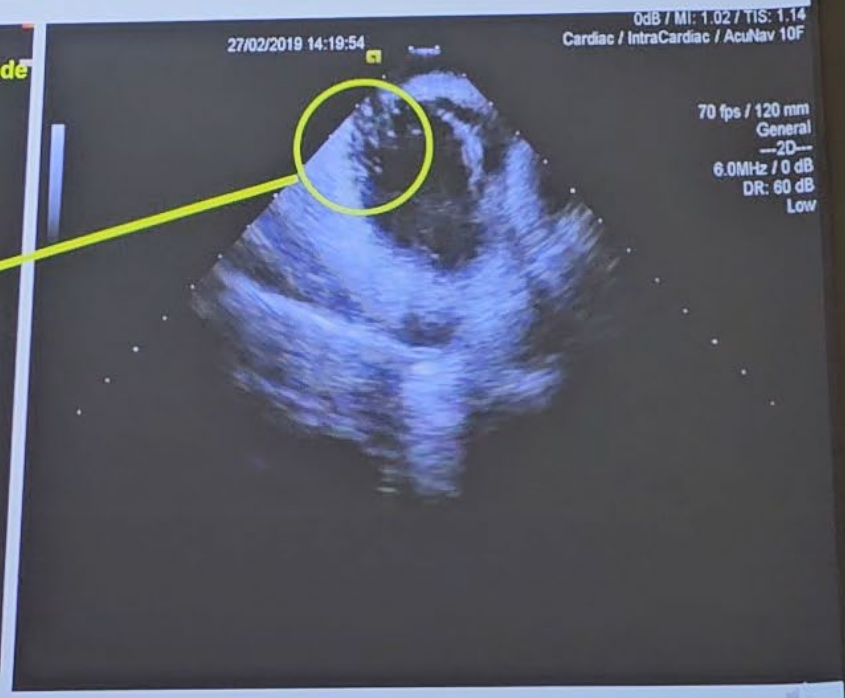

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Loc.
Cath.
Map
Mapping
Ablation
Verification
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OA1-2
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LAT
Tag Idx
Force
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R
L
LAT
CL
BI
Imp
Force
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N/A
0%
AP PA LAO RAO LL RL INF SUP

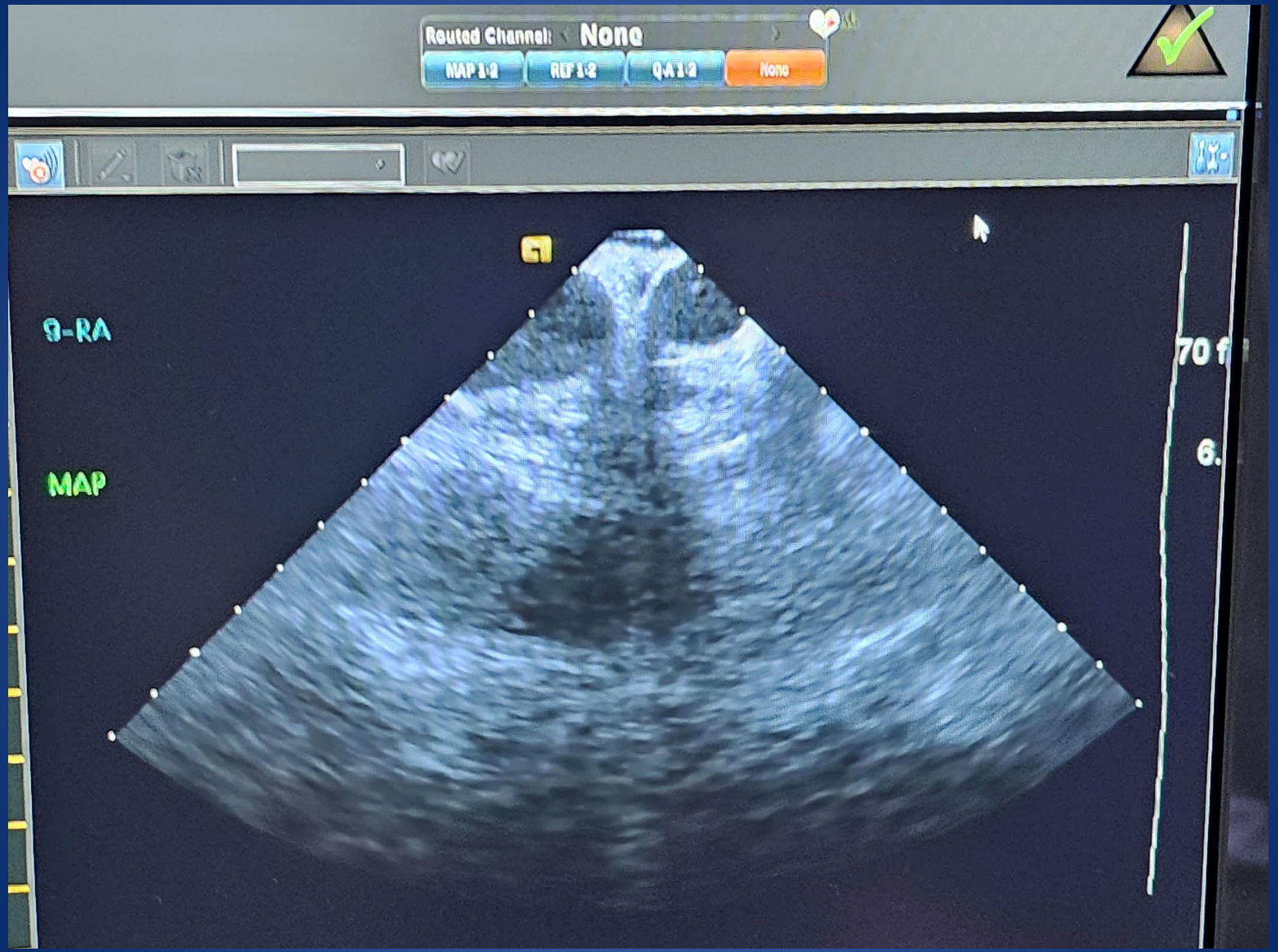

ICE for visualisation of presumed GP area
27/02/2019 14:19:55
Cardiac / IntraCardiac / AcuNav 10F
70 fps / 120 mm
General
RIGP/
PMIGP
RIPV
PA
PA


ICE for visualisation of presumed GP
0dB / MI: 1.02 / TIS: 1.14
Cardiac / IntraCardiac / AcuNav 10F
10/12/2021 10:18:25
70 fps / 120 mm
General
---2D---
RIGP/P
MIGP
Store
RIPV
R
PA
PA

Our approach






Routed Channel:
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REF 1:2
Q-A 1:2
None
9-RA
MAP
70 f
6.