

SERVIZIO SANITARIO REGIONALE
EMILIA-ROMAGNA
Azienda Ospedaliero - Universitaria di Bologna

POLICLINICO DI
SANT'ORSOLA



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Extravascular ICD: option or alternative ?

Mauro Biffi



Contemporary TV ICD therapy



> 80% Ventricular Arrhythmias terminated by ATP !



AHRE/AF detected



INAPPROPRIATE therapy delivery < 2% yearly

Comparison with Strik et al (up to 6 attempts with bursts/ ramps in 155-200 bpm)

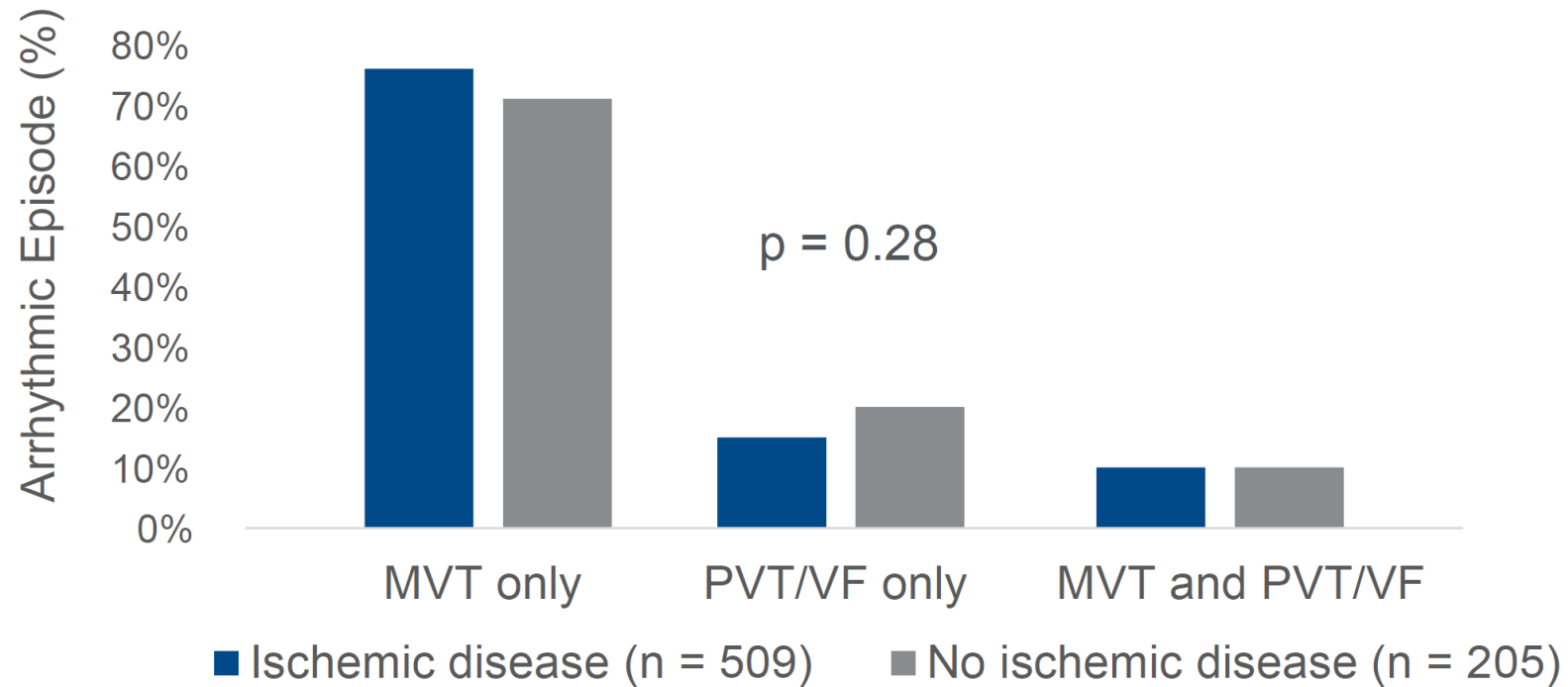
	EFFICACY		Overall acceleration leading to Shock	
	Strik et al.	iATP	Strik et al.	iATP
	1126 episodes	1722 episodes	1126 episodes	1722 episodes
VT 155-200 bpm	89% *	93%		
VT 200-230 bpm	64% *	91%	6.6%	1.6%
VF zone	NA	76%		

* A single ATP attempt had the same 64% efficacy either in VT or FVT zone

False Myths : «ICM has more MVT»

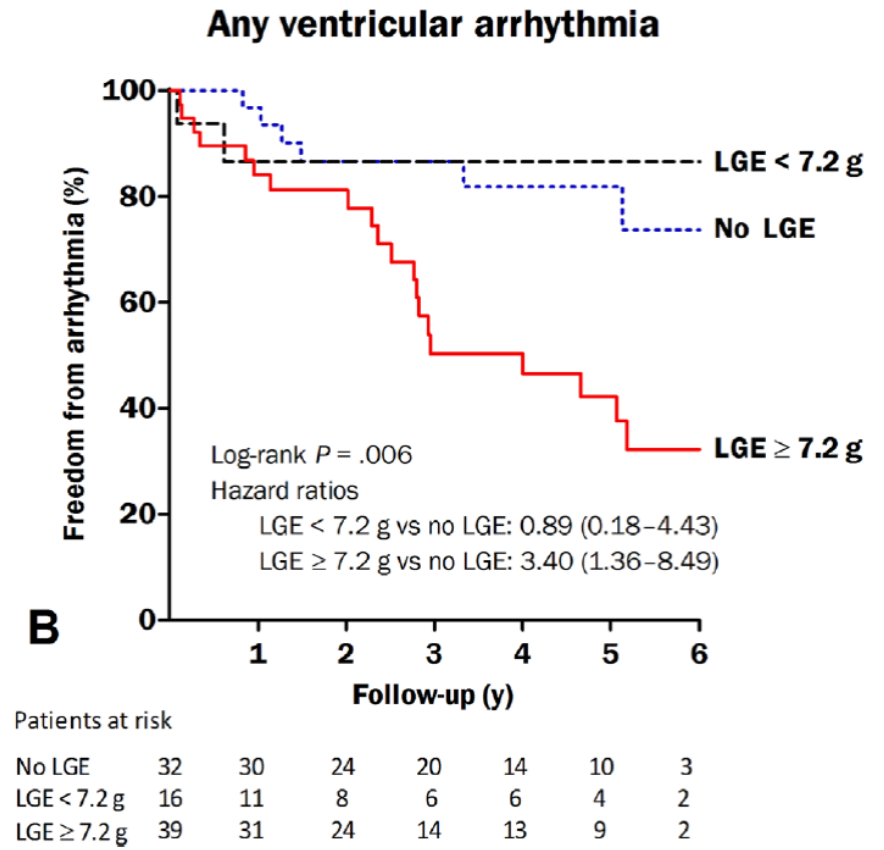
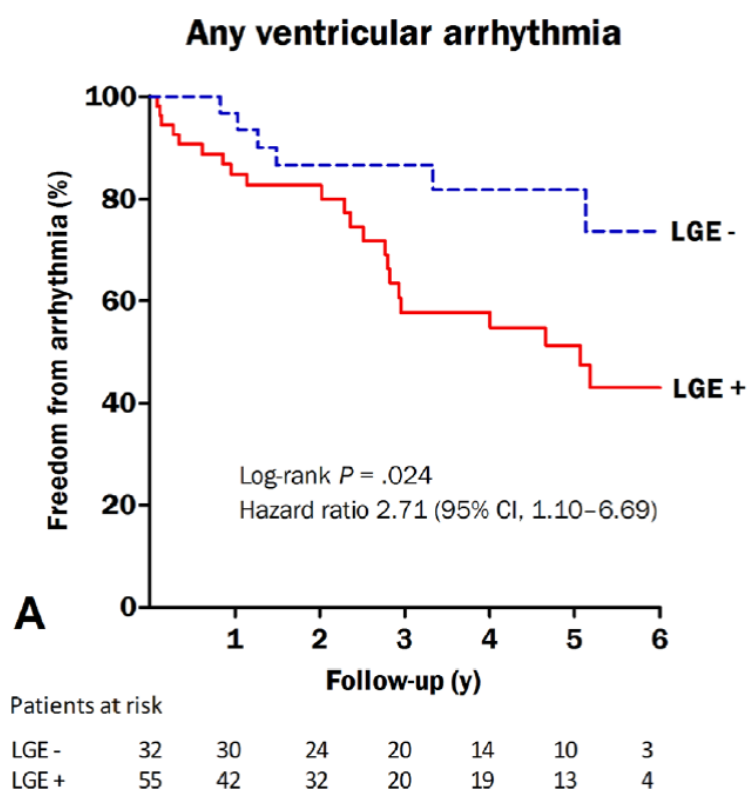
Ischemic cardiomyopathy (ICM) and non-ischemic cardiomyopathy (NICM) ICD patients have **similar monomorphic ventricular tachycardia (MVT) and polymorphic ventricular tachycardia/ventricular fibrillation (PVT/VF) episode proportions.**¹

Meta-analysis from three prospective trials: Shock-Less, PainFreeSST, and PREPARE

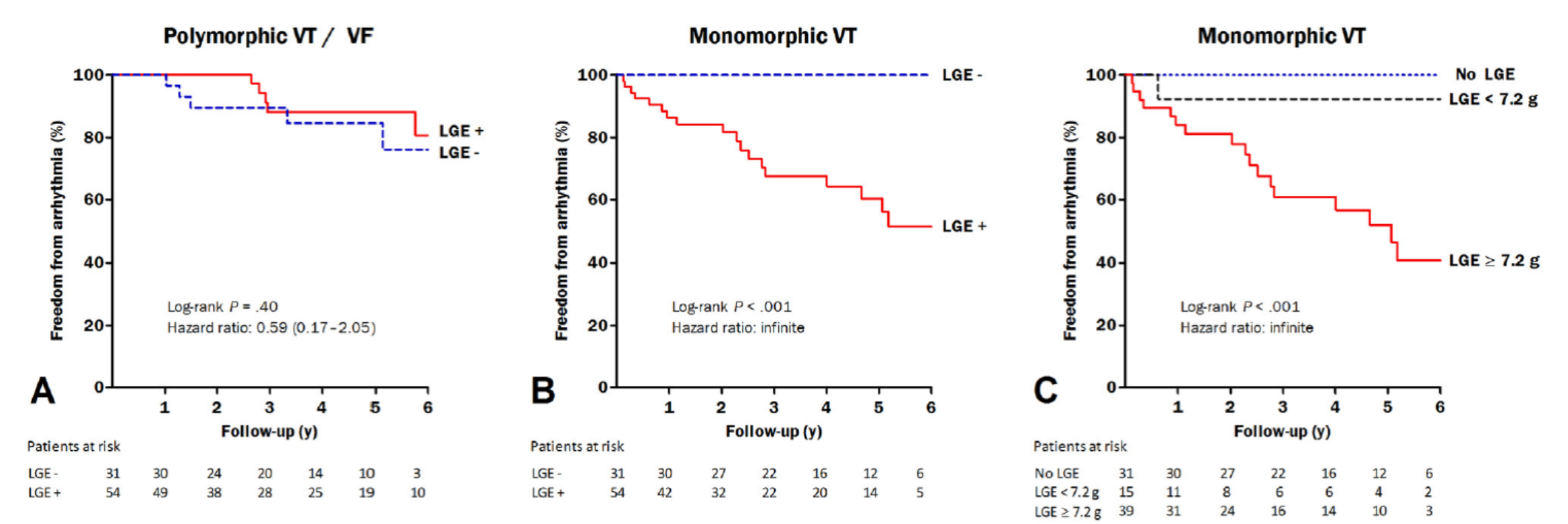


Characteristics Of Ventricular Tachyarrhythmias AND Their Susceptibility To ATP Termination In Patients With Ischemic And Nonischemic Cardiomyopathy: A Meta-analysis Of 3 Large Clinical Trials. Heart Rhythm 2018 15:5 Supplement 1 (S178-S283).

Effect of scar size on occurrence of VTA in patients with NICM



Effect of myocardial scar on occurrence and type of VTA in patients with NICM



Extravascular ICDs: The Twins are not Alike

face to face (heart to heart)

>75000 implants worldwide



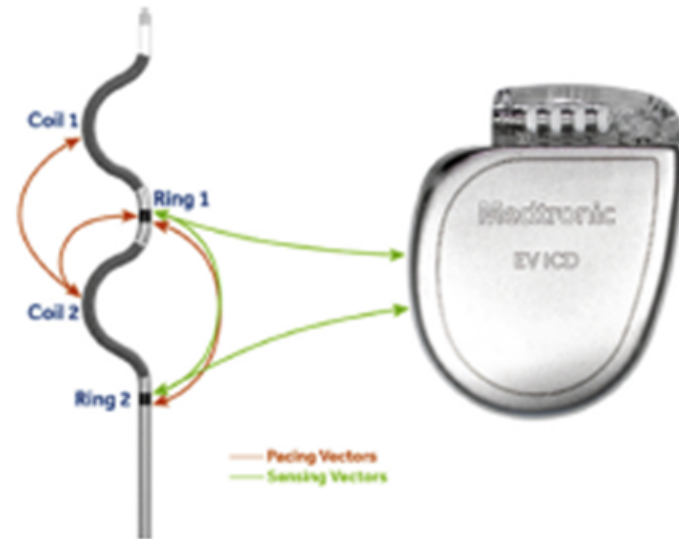
Extrathoracic lead

No ATP

Longevity 8 years

130 g, 59.5 cc

>5000 implants worldwide



Intrathoracic lead

ATP

Longevity 11 years

79 g, 33 cc

ORIGINAL ARTICLE

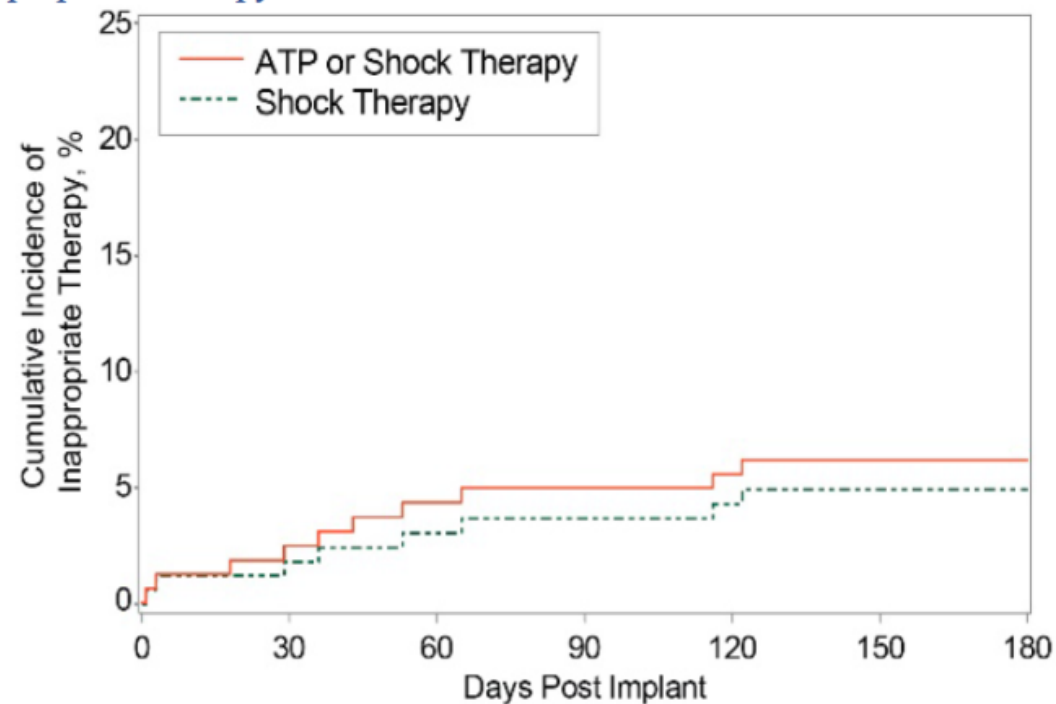
A Modular Communicative Leadless Pacing–Defibrillator System

N Engl J Med 2024;391:1402-12

5% IAS at 6 months



Figure S11 Inappropriate Therapy



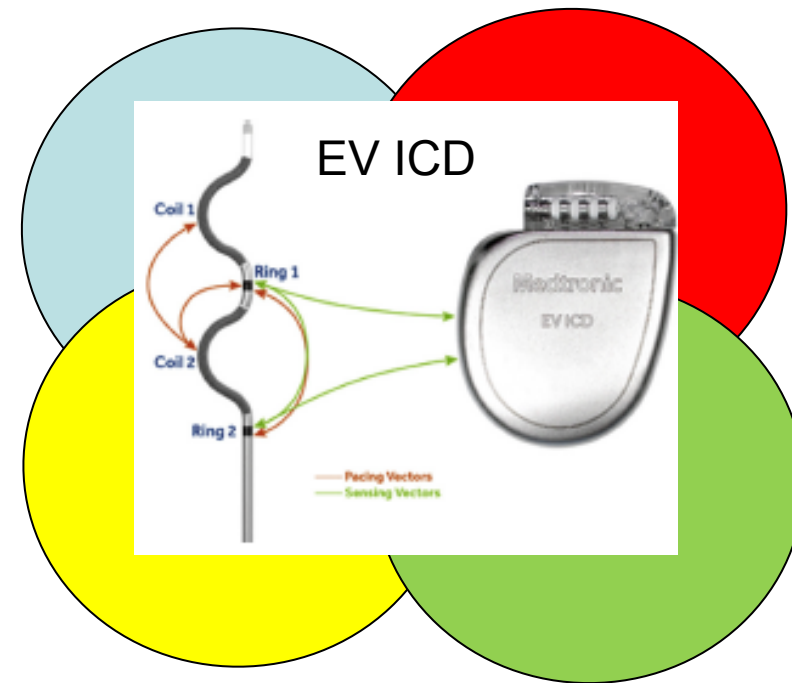
Inappropriate Shock

Subjects at Risk

162	156	153	151
Inappropriate Shock Rate, %			
0.0	3.1	4.3	4.9
95% Confidence Interval,			
(0,0)	(1.2,6.6)	(1.9,8.3)	(2.3,9.1)

The unmet ICD needs :

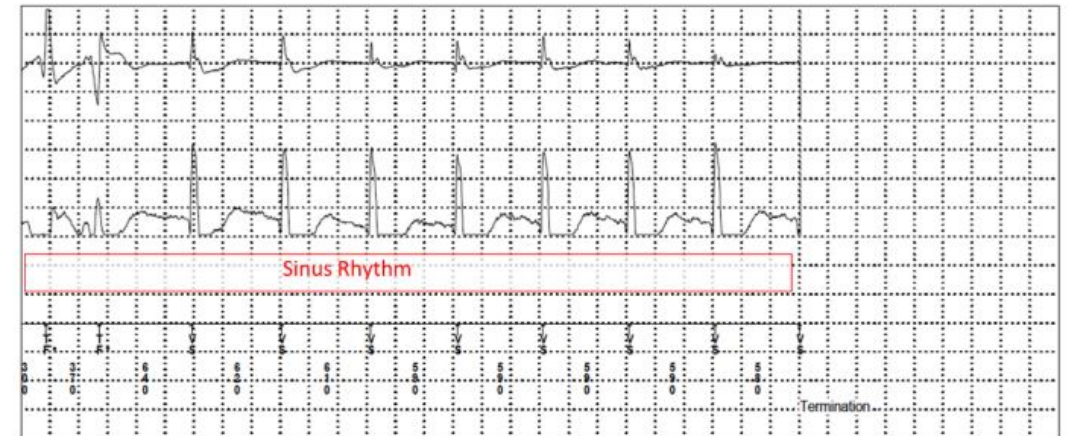
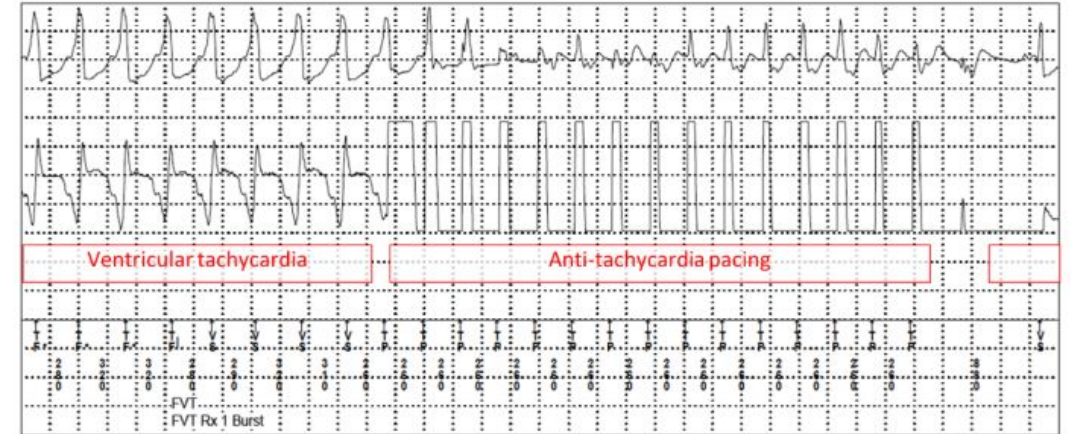
- Extracardiac device
- Longevity
- Small size
- ATP & <rarely>Pacing



Characterization of ATP

- **77.1 % ATP success (37/48 episodes)**
- **Shocks avoided in 10 patients**
- **ATP was tolerable:**
 - Significant increase in ATP 'on' from discharge (66.8%) to last available follow-up (**81.2%**) ($P < 0.0001$)
 - No instances of ATP programmed 'off' after receiving successful ambulatory therapy

Successful ATP Example

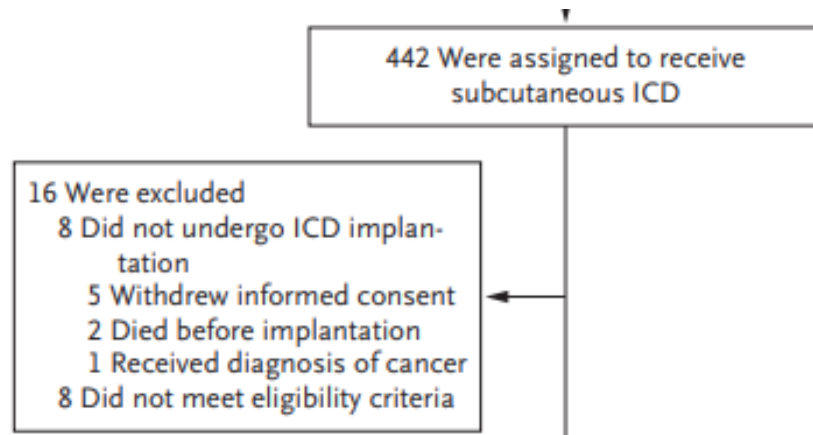


S-ICD

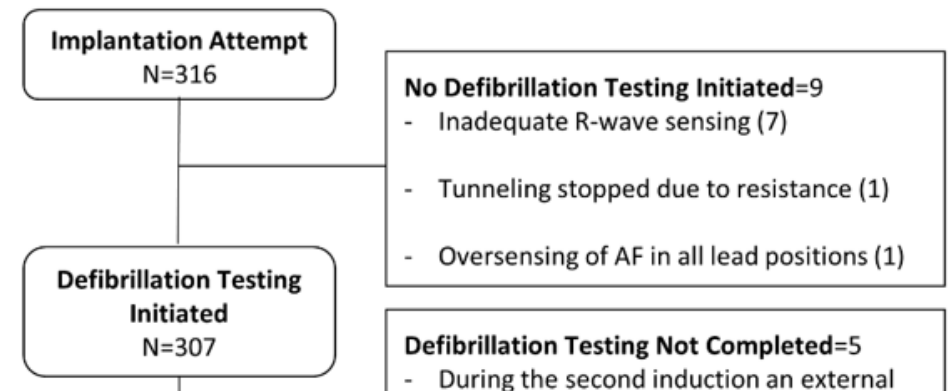
Extravascular ICD

OVERALL APPLICABILITY: Failure to implant due to signal quality

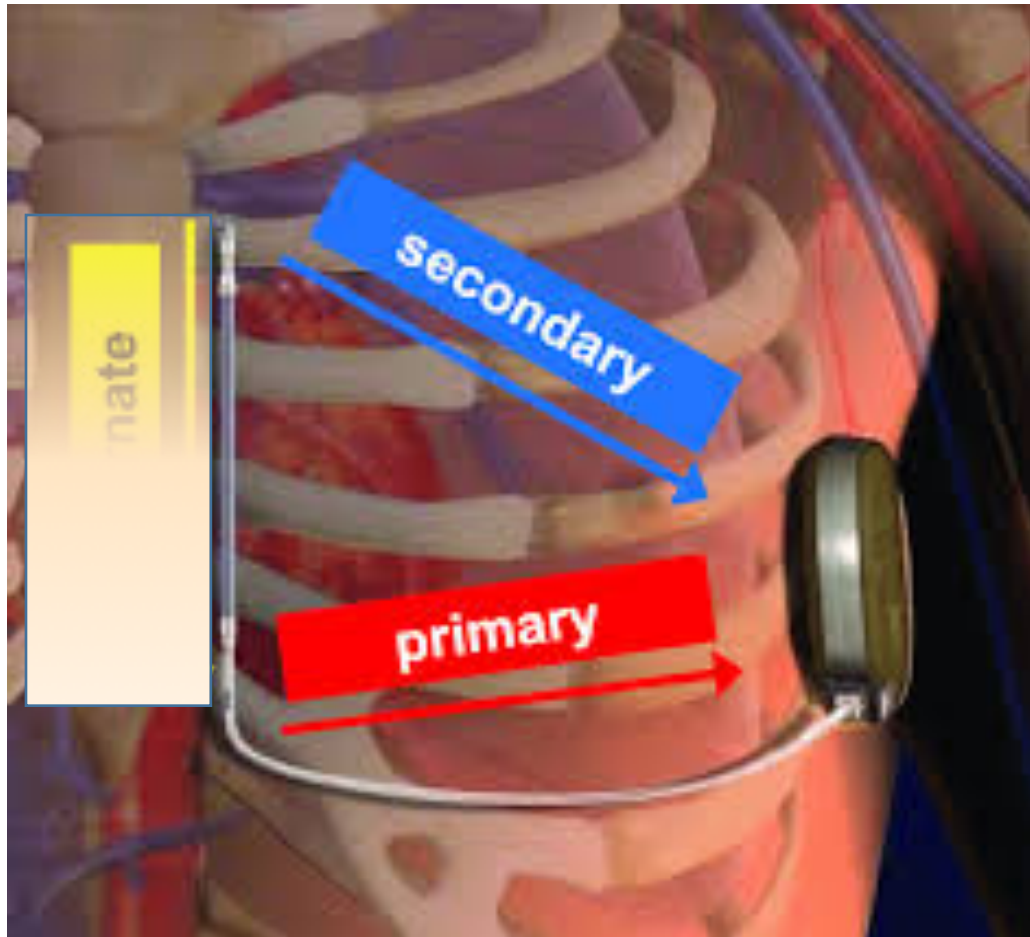
2%, Known before implant owing to screening test



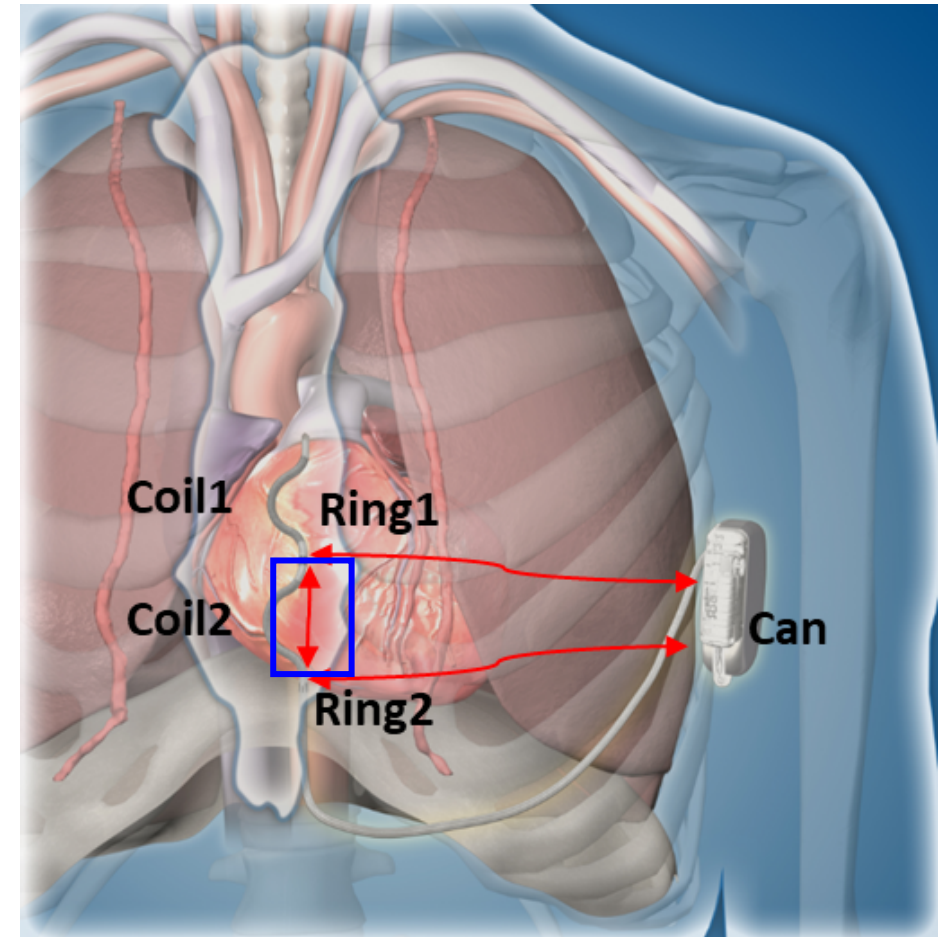
2.5%, During implantation, NO screening available



S-ICD



EV-ICD



Experience on 85 patients - R wave



8 with R wave $< 0.6-1.3\text{mV}$ →

7 implanted, no issues at FU

Small R wave minor issue if

- NO P wave detectable**
- Noise negligible**
- VF detection immaculate during testing**



SUBOPTIMAL S-ICD Patient Profile



Small QRS/T ratio, abnormal T waves



Brugada , LONG QT Syndrome



HUGE T waves, Huge QRS



HCM



Low-Voltage QRS



ACM, HCM, LAMIN A/C

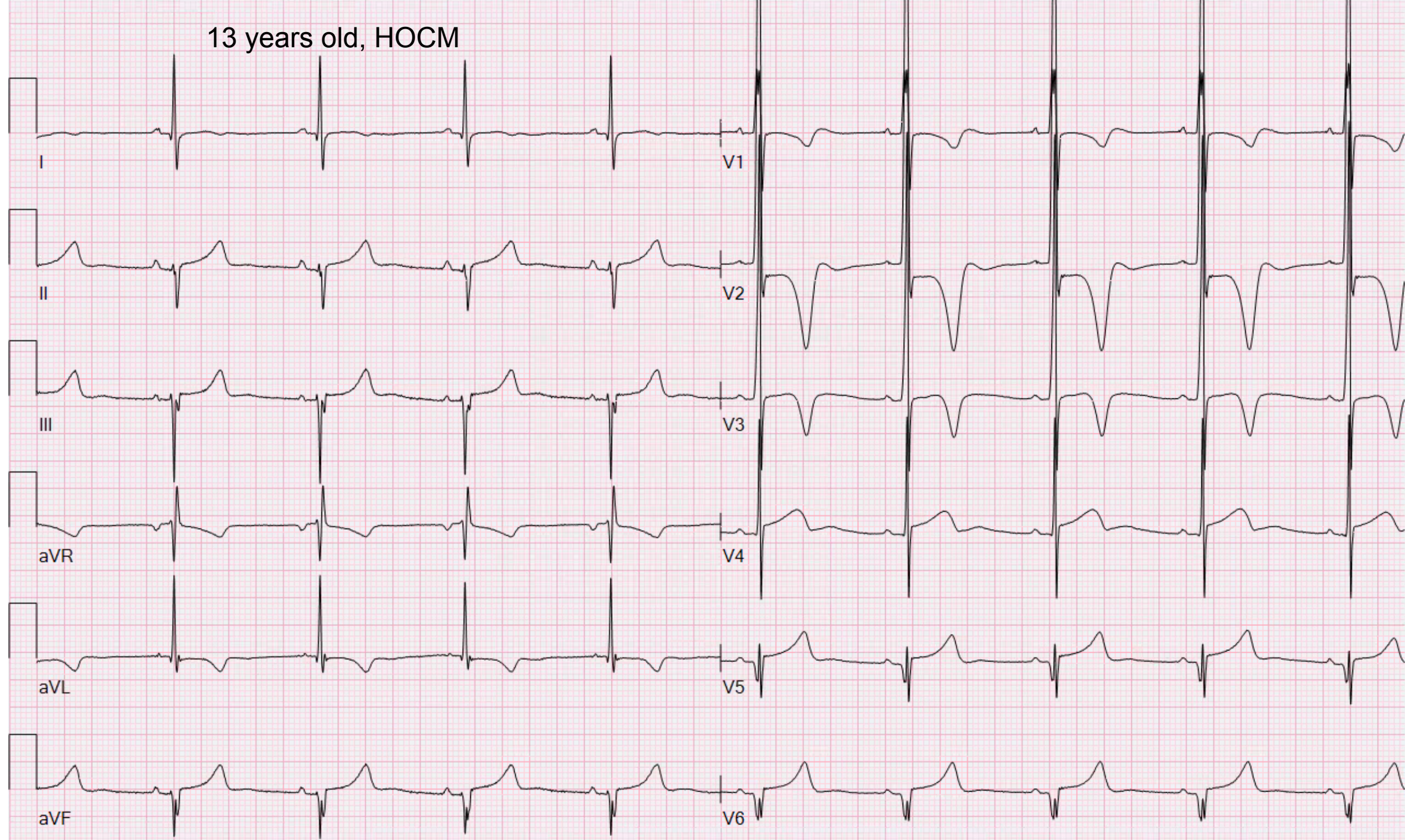


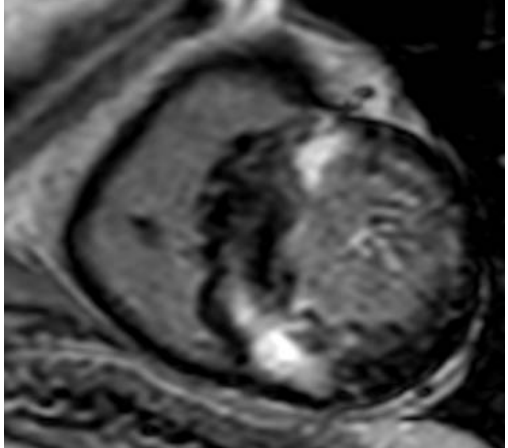
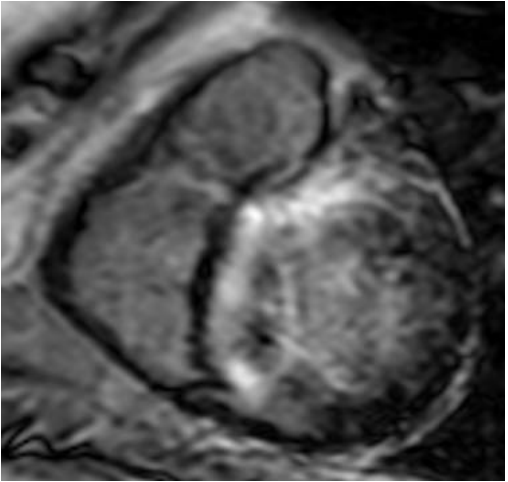
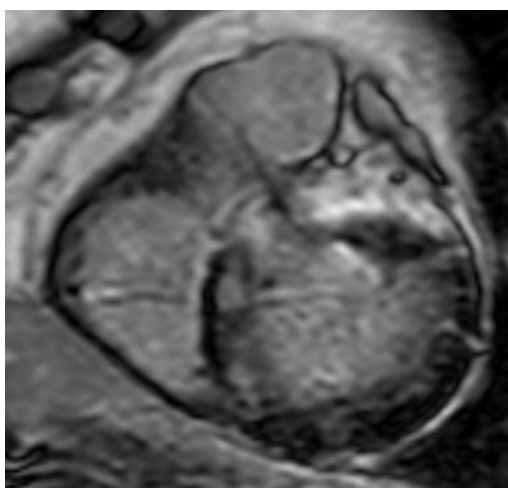
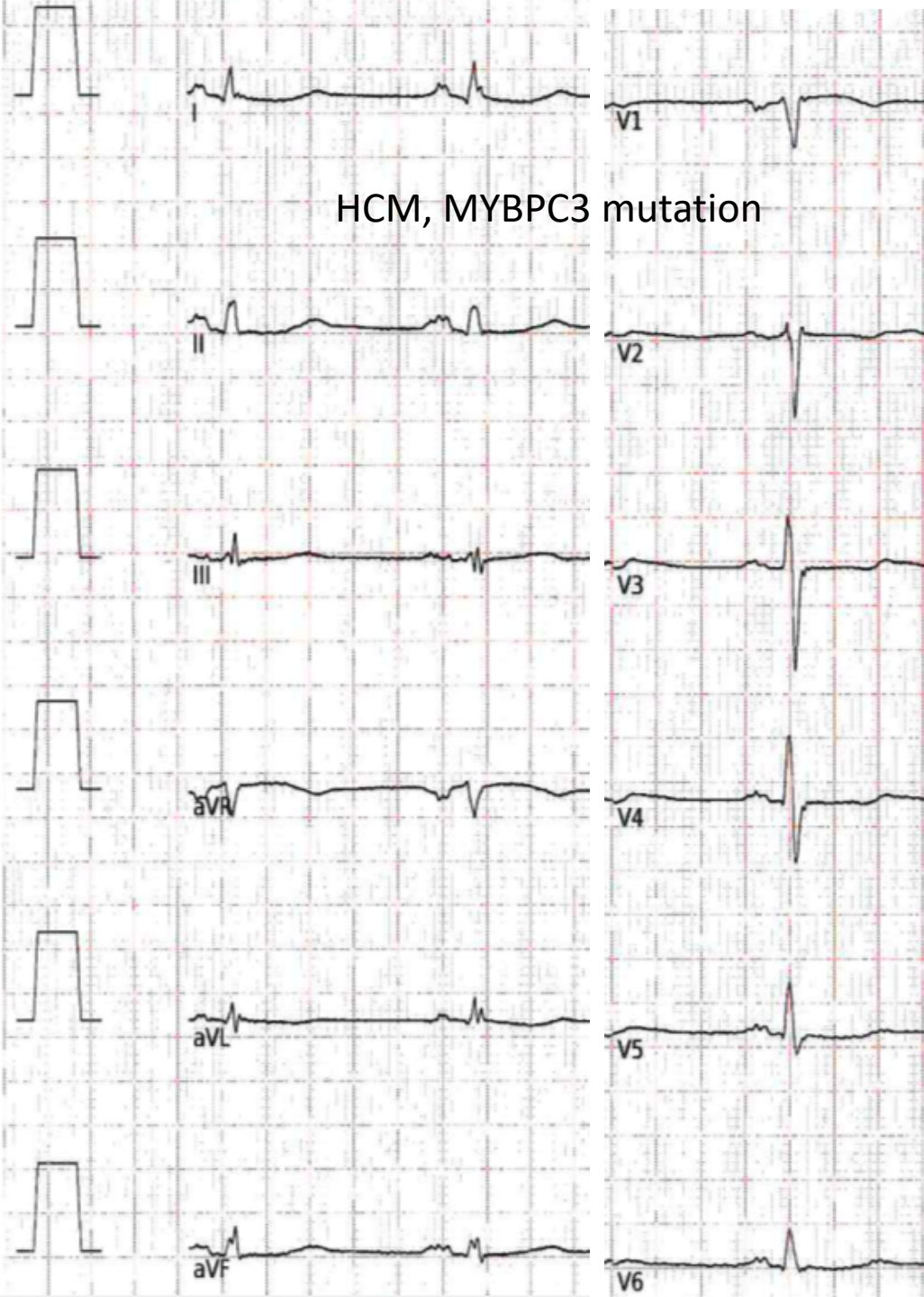
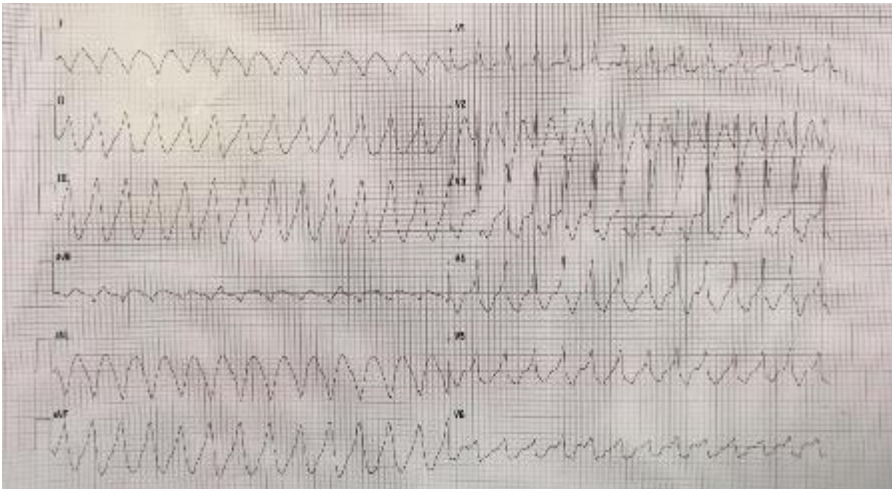
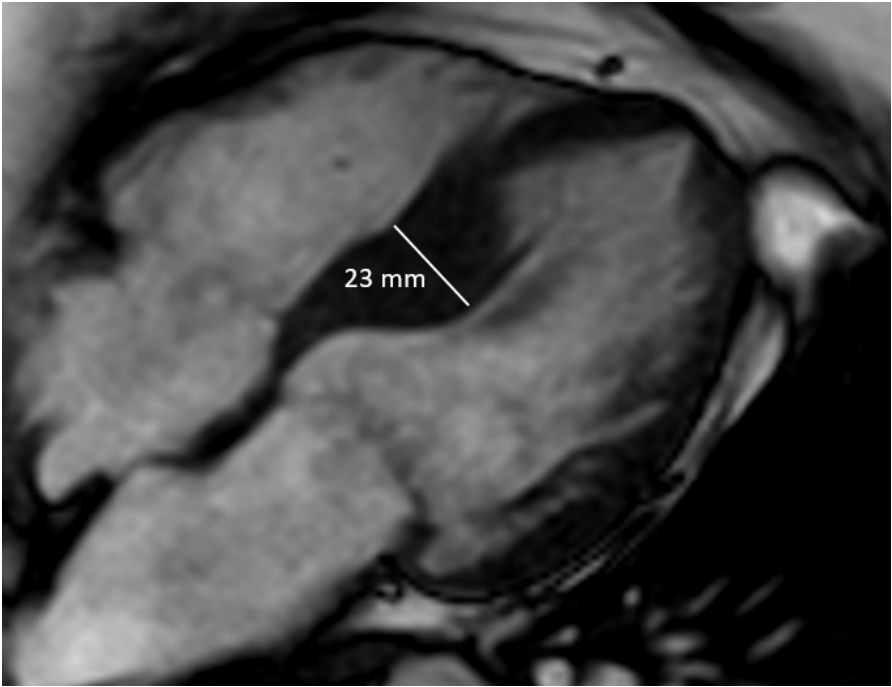
Evolving Cardiomyopathies



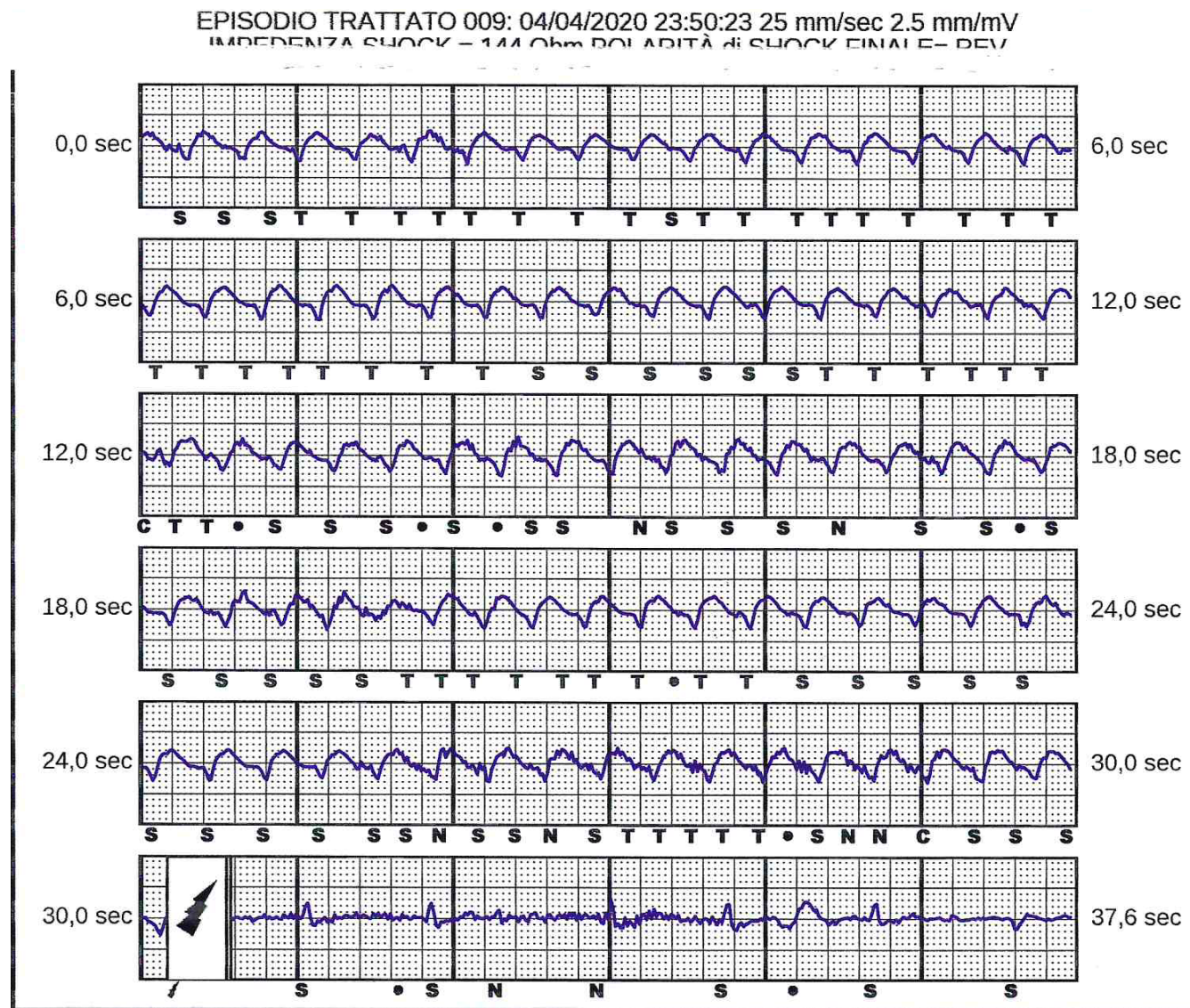
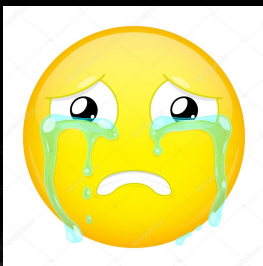
ACM, HCM, Neuromuscular
Diseases

13 years old, HOCM





The larger the substrate, the slower the arrhythmia

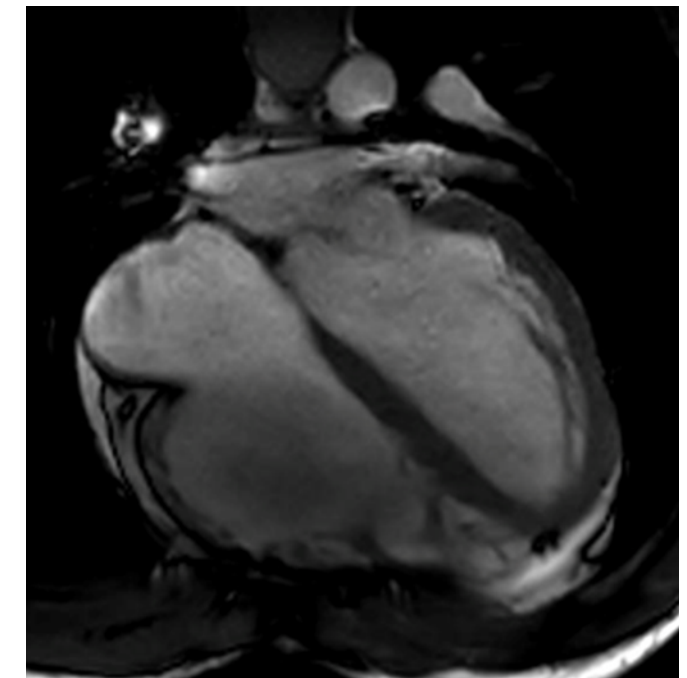
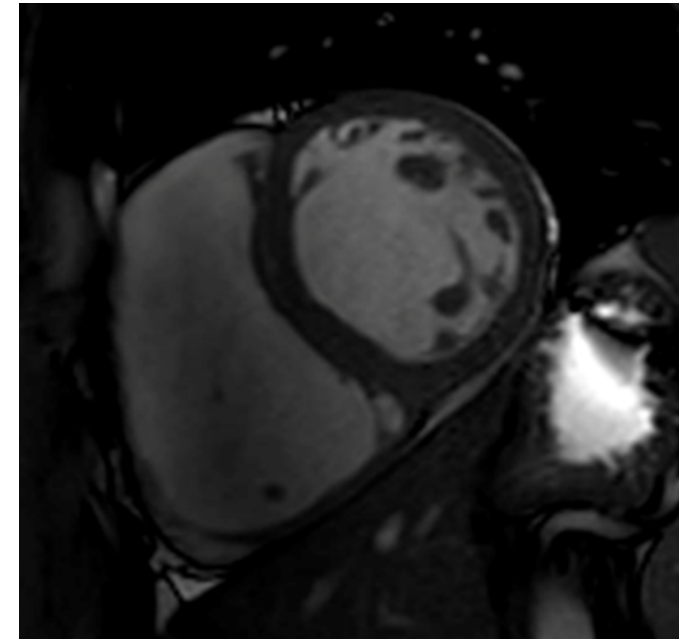
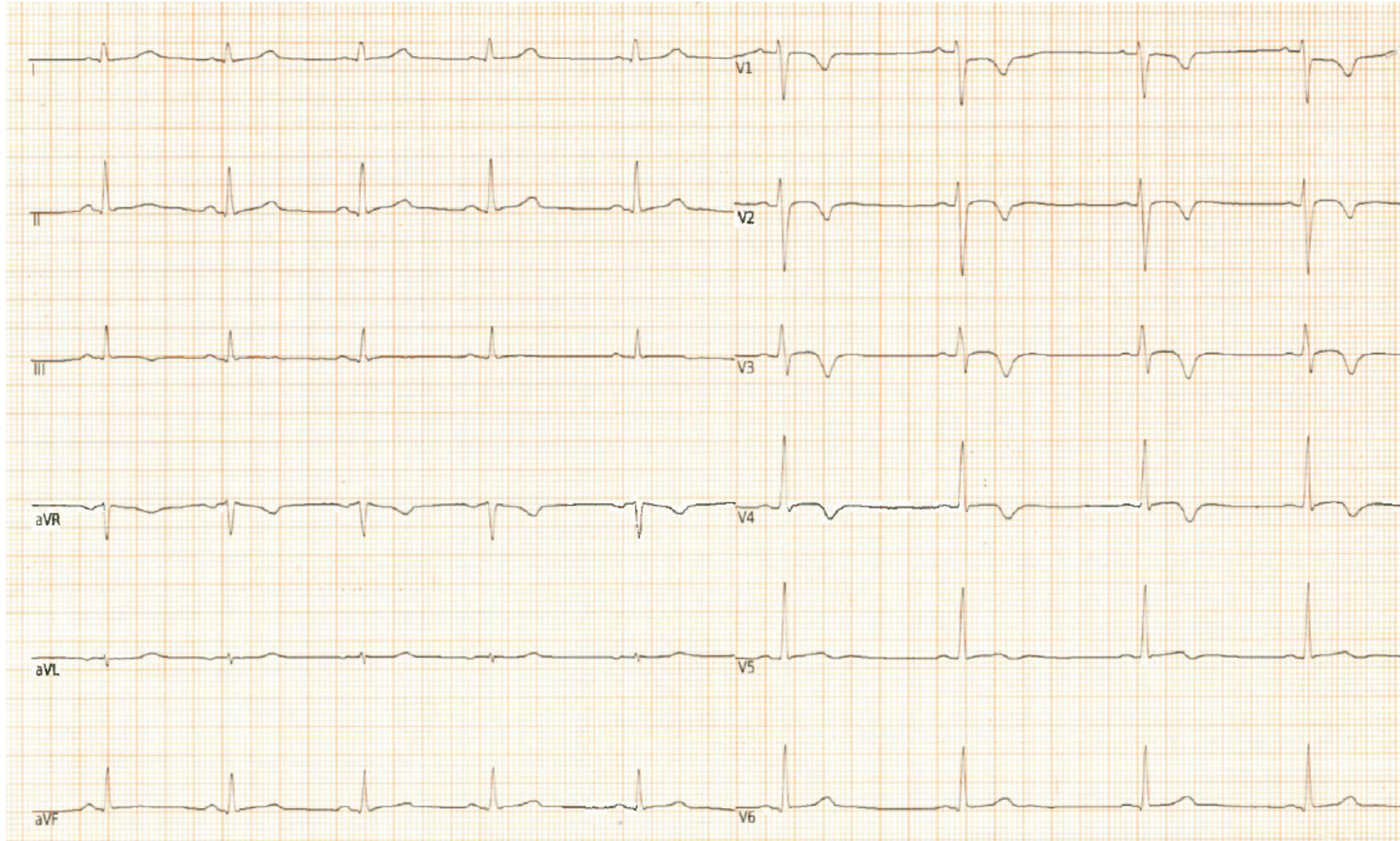


EV ICD in any disease etiology, 89 pts

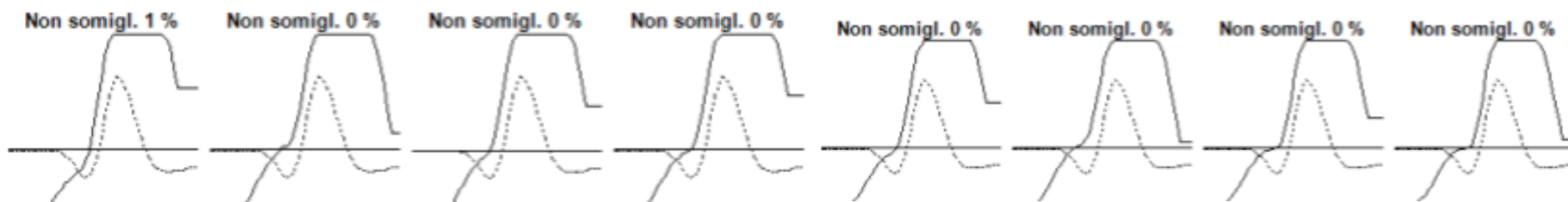
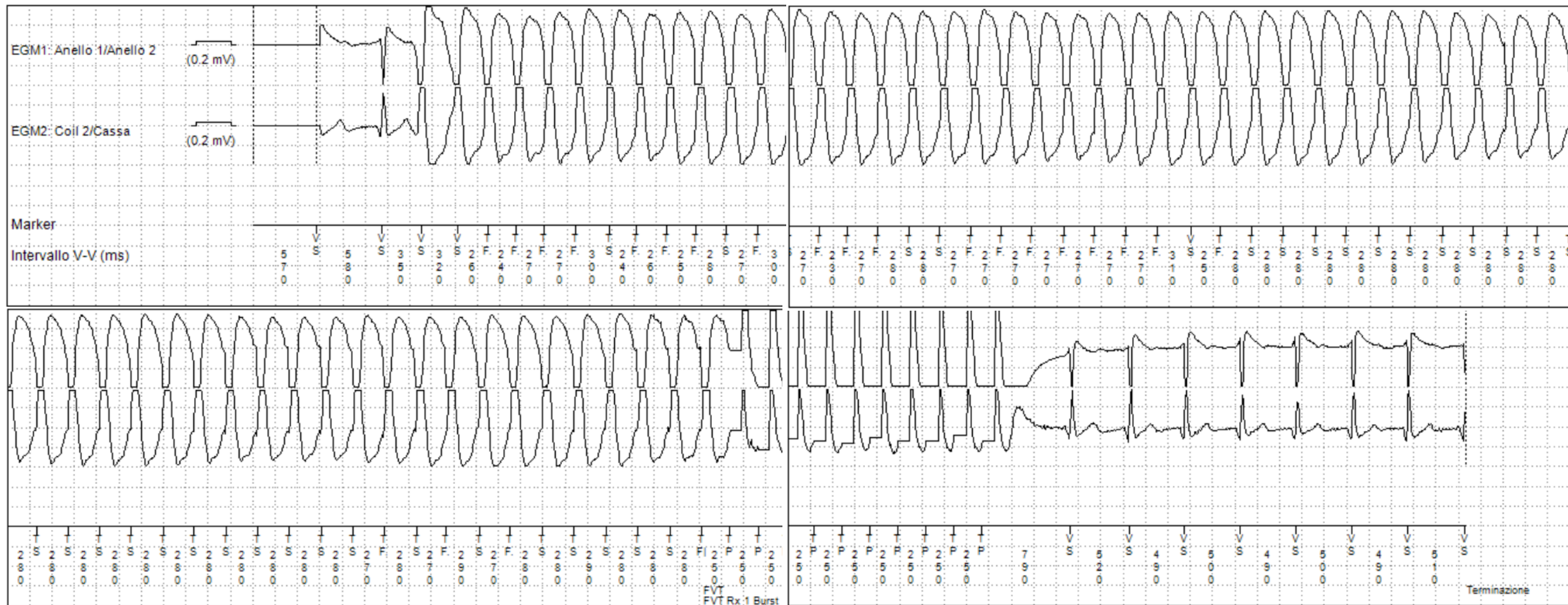
✓ Ischemic Heart disease	→	12 patients
✓ Dilated Cardiomyopathy	→	11 patients
✓ ALVC & ARVC	→	32 patients
✓ Hypertrophic CM	→	15 patients
✓ Idiopathic VF	→	7 patients
✓ Brugada Syndrome	→	3 patients
✓ Duchenne Cardiomyopathy	→	2 patients
✓ Previous Myocarditis	→	2 patients

21 yrs old professional football player, Palpitation & dizziness during training

NSVT max 8 beats at holter. Plakophilin P2 pathogenic mutation



3 months later: palpitation and near syncope during exercise



Wavelet analysis

Experience on 89 patients



11 not suitable for S-ICD



9 Failed Screening TEST

2 loss of signal



6 with ALVC, 4 with HCM, 1 Dilated

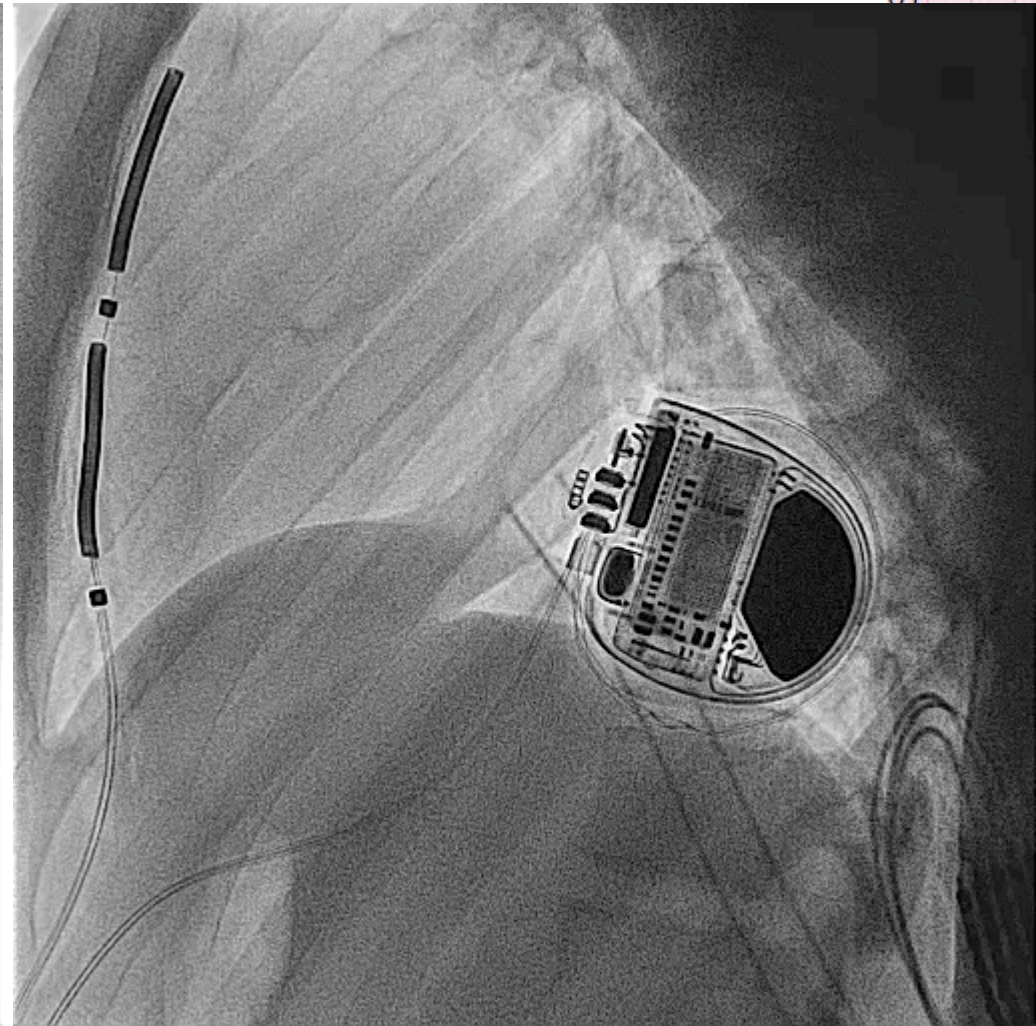
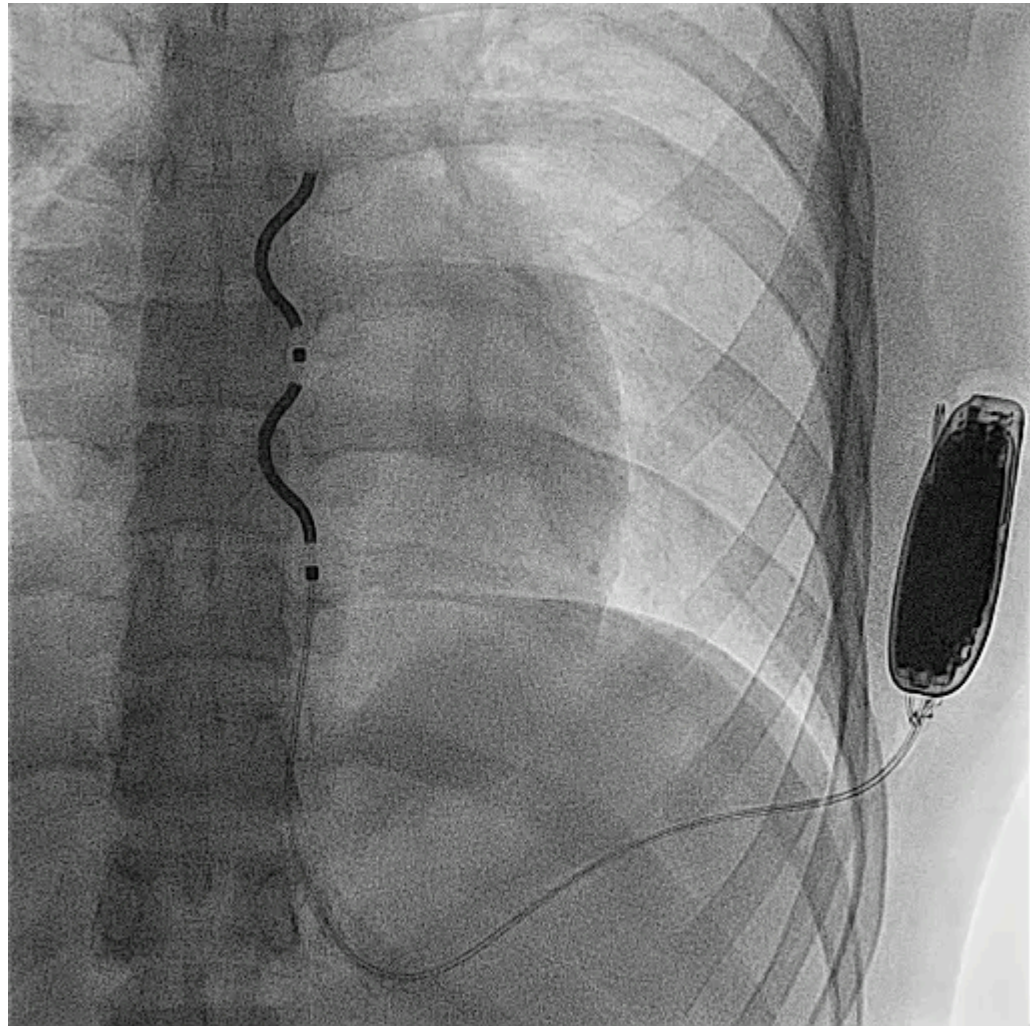
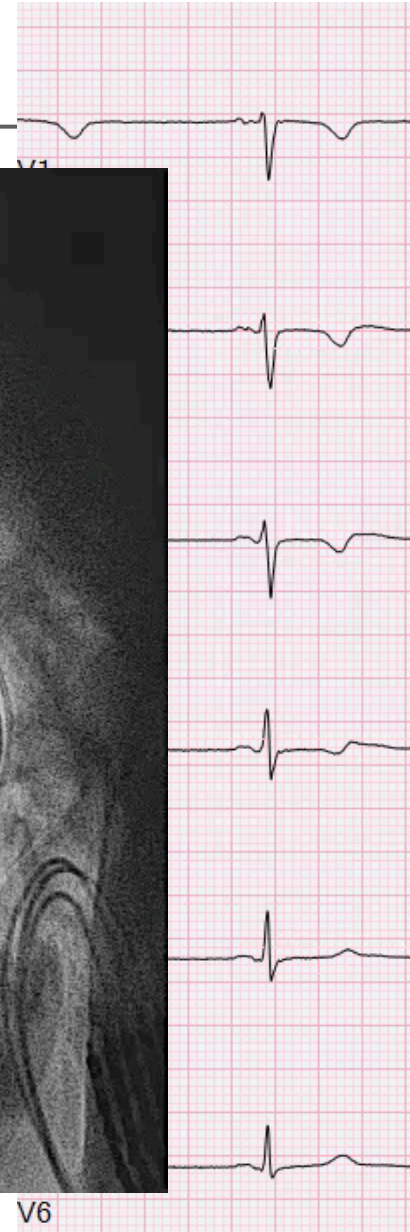


Implanted, NO IAS at FU

EV ICD SUITABLE for S-ICD FAILURE/FAILED SCREENING

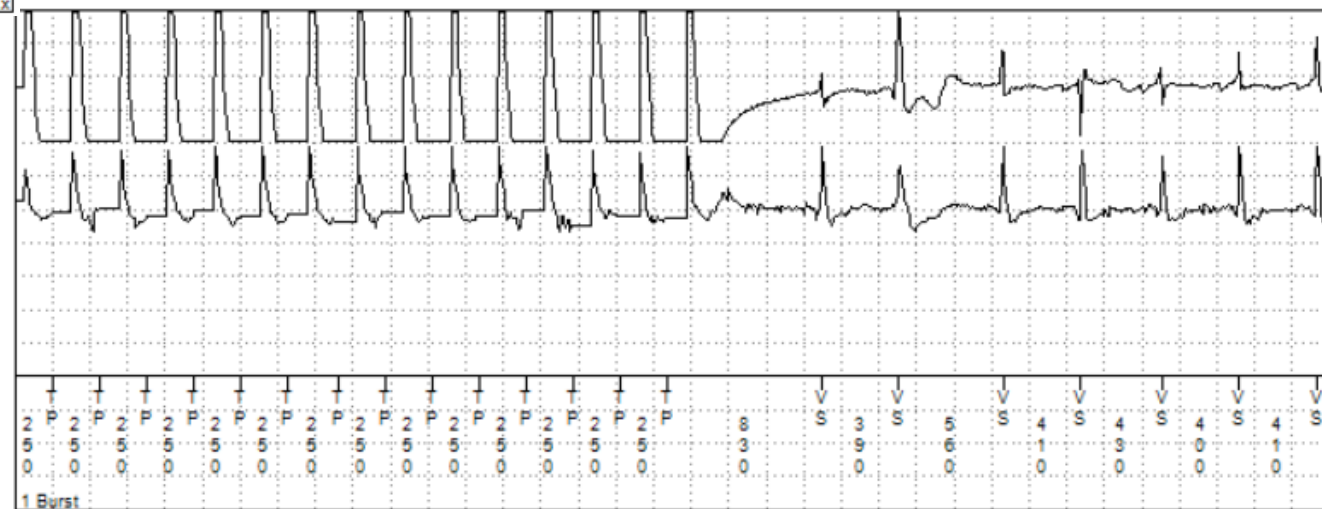


16yrs old, Resuscitated VF (3 AED shocks) , competitive swimmer
Normal MR, DSP pathogenic mutation



RATHER Have it ON BOARD ...

5 ATP interventions in 3 years
Precisely on dropping propranolol



EV ICD in any setting



Previous S-ICD failure with IAS



2 patients, working Smoothly



Previous TV infection



6 patients, no issues



Pediatric patients



10 patients, range 11-16, no issues



Co-existing Micra or CRTP



1 patient each, no issues



ESC

European Society
of Cardiology

Europace (2025) 27, euaf128

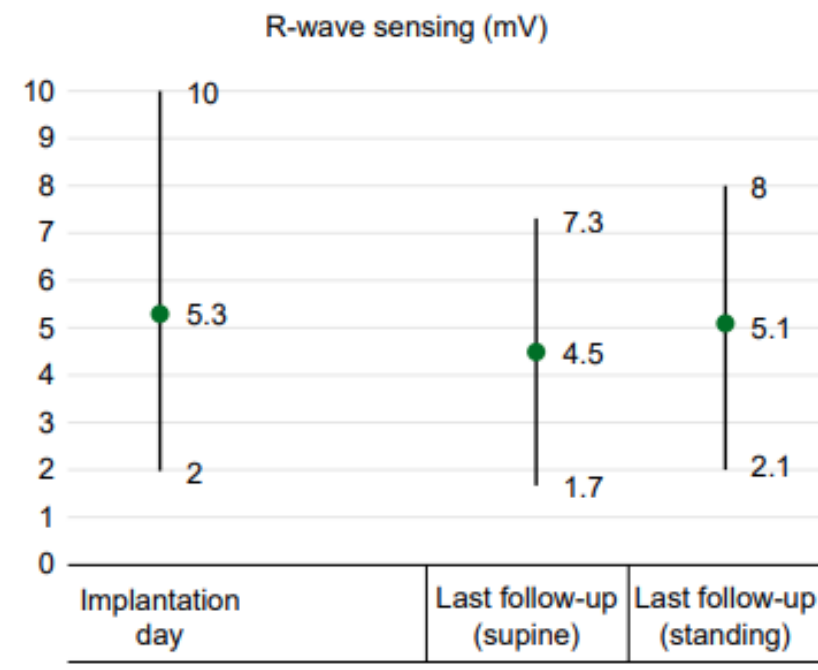
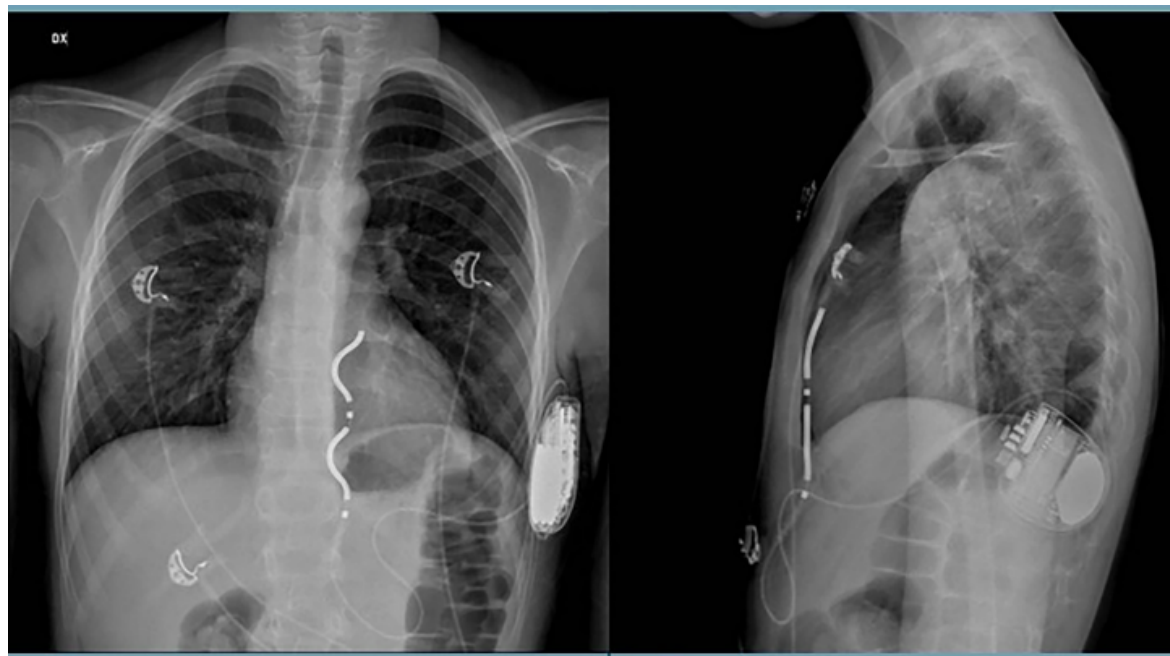
<https://doi.org/10.1093/europace/euaf128>

RAPID COMMUNICATION

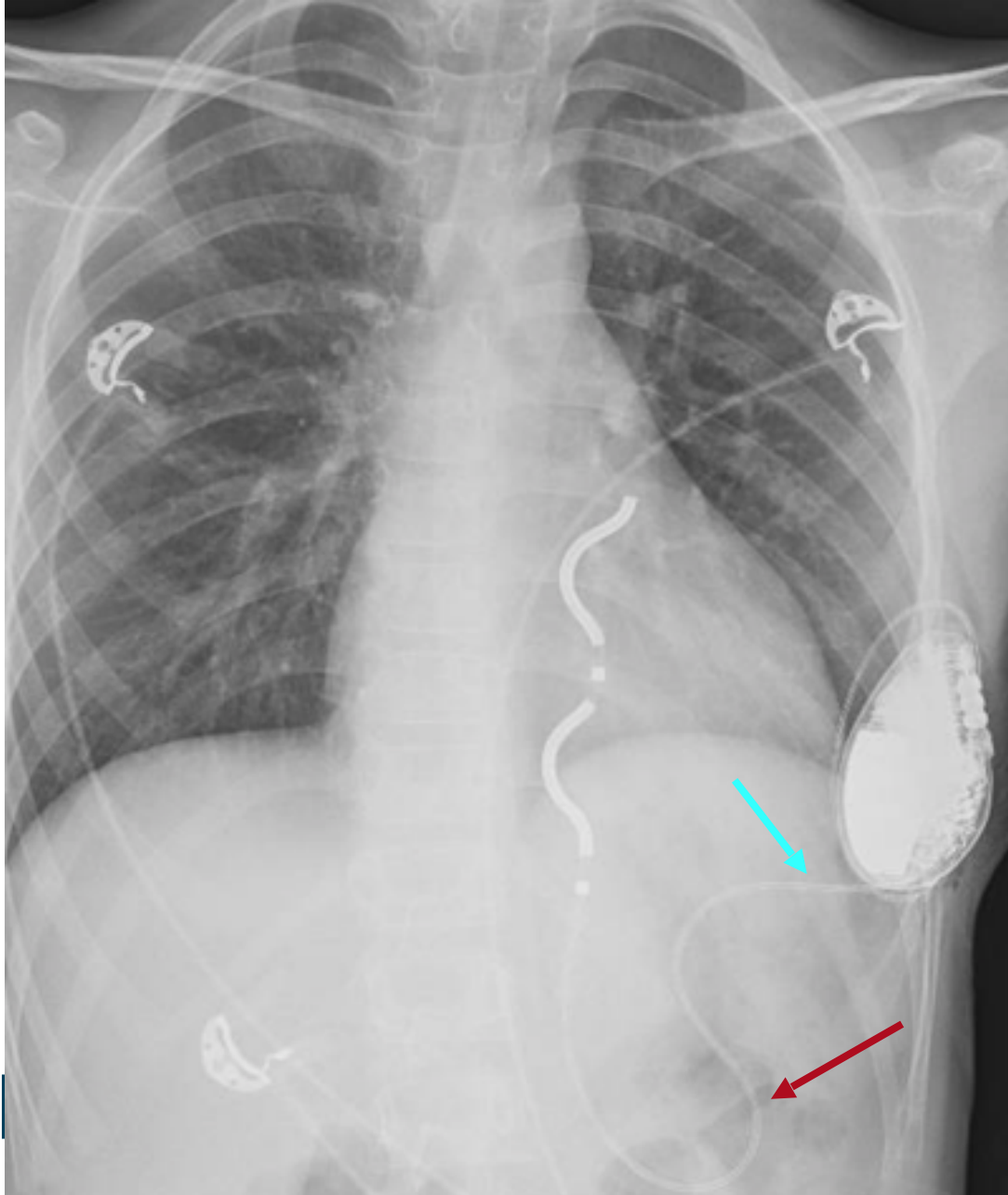
The extravascular implantable defibrillator: a novel opportunity for the paediatric population

Mauro Biffi ¹, Andrea Quaranta ^{2*}, Alessandro Carecci ², Luca Ragni ¹,
Andrea Donti ¹, Cristian Martignani ¹, Igor Diemberger ²,
Andrea Angeletti ¹, and Matteo Ziacchi ¹

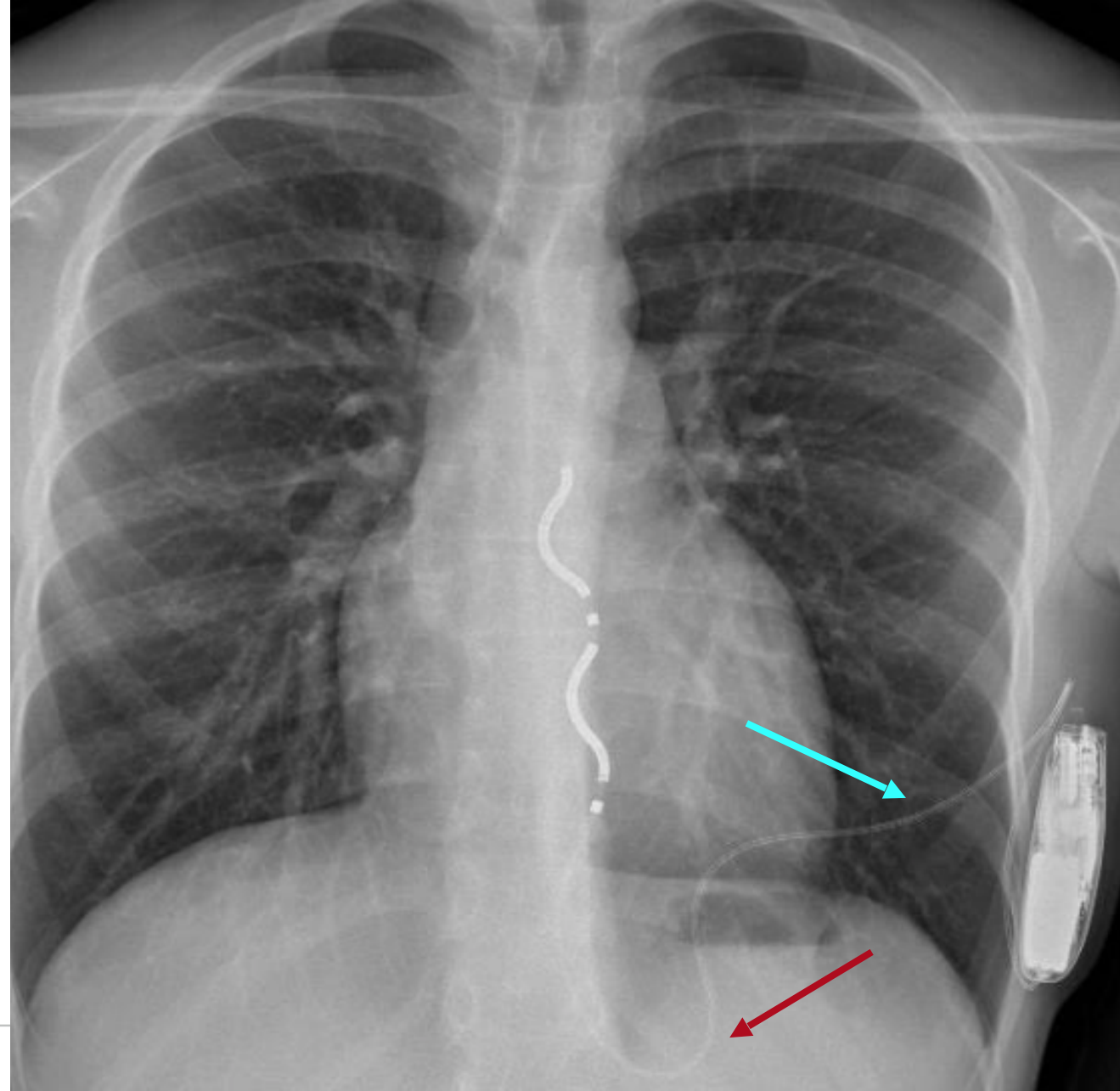
10 patients in the range 10-16 yrs



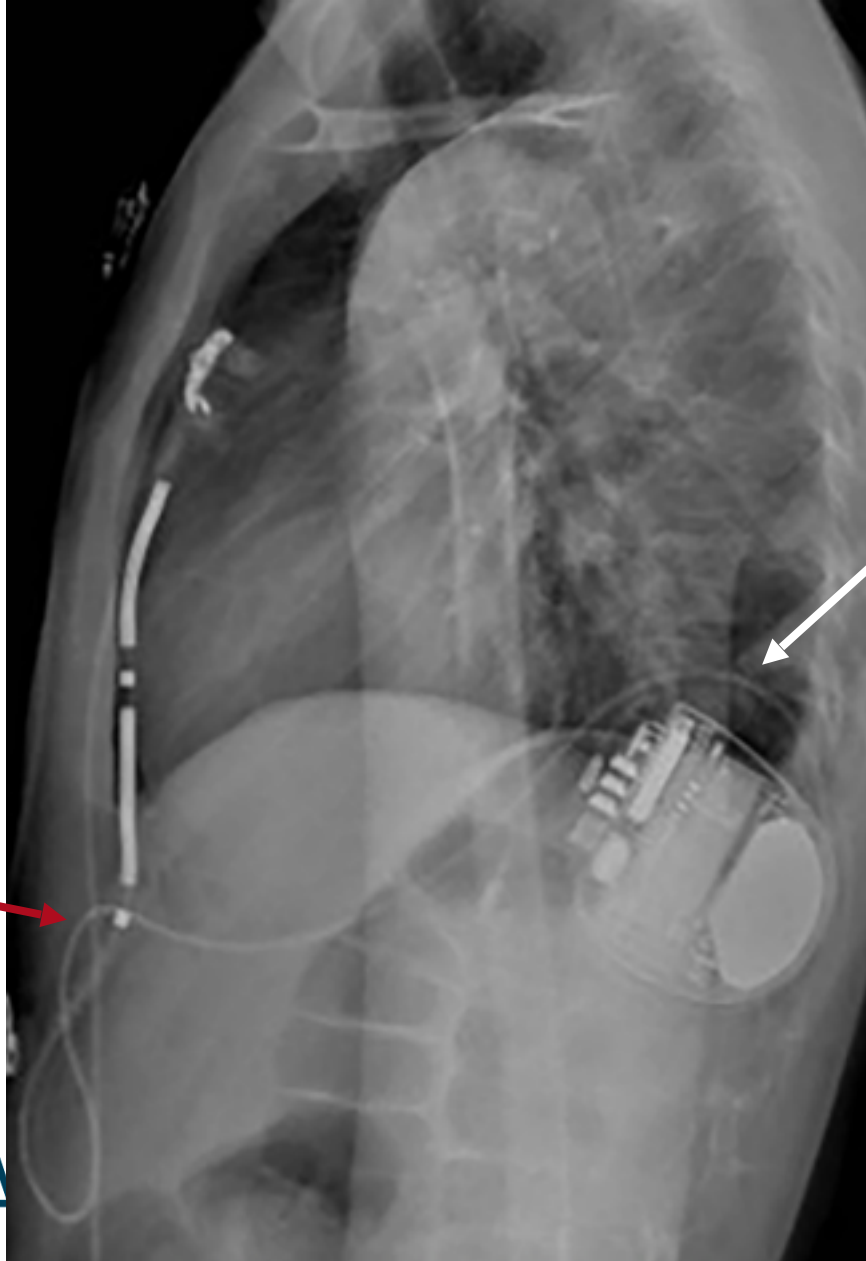
12 years, mild scoliosis



14 years, 25 cm growth, kinesiotherapy

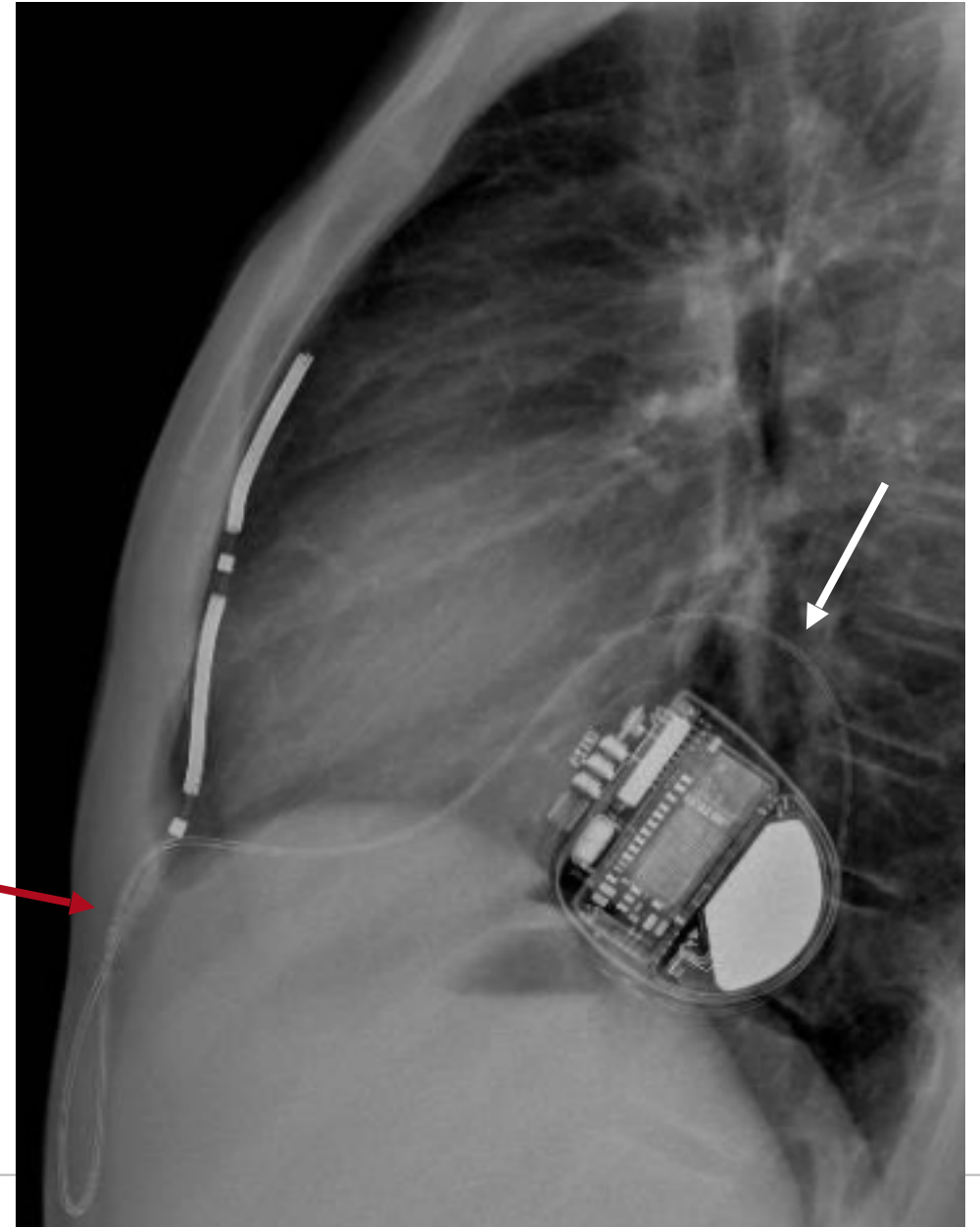


12 years, mild scoliosis



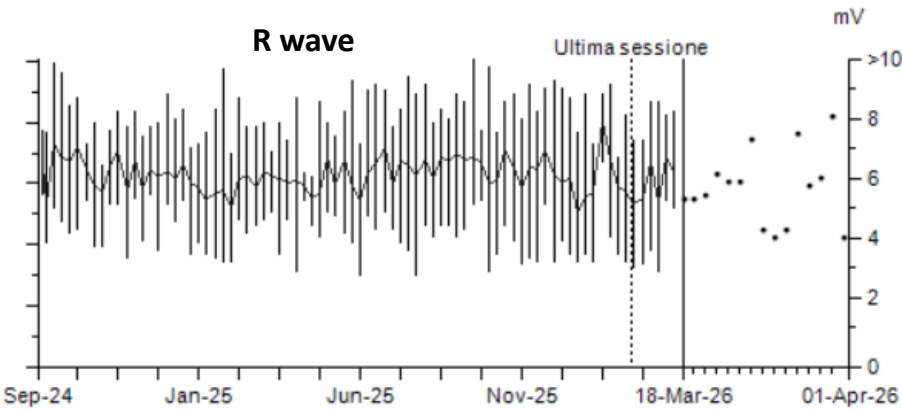
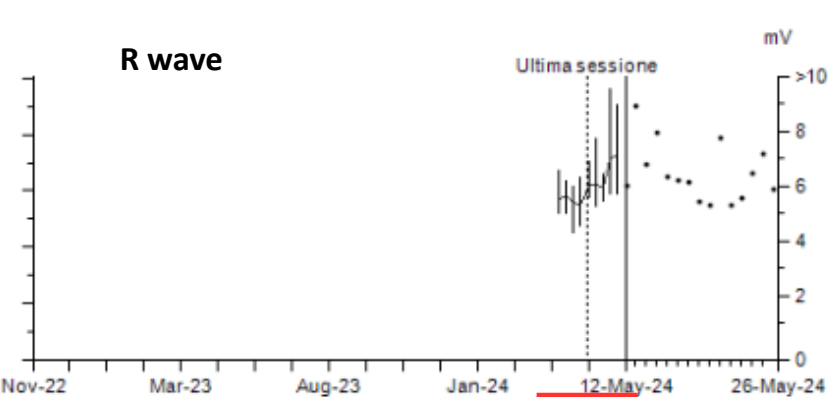
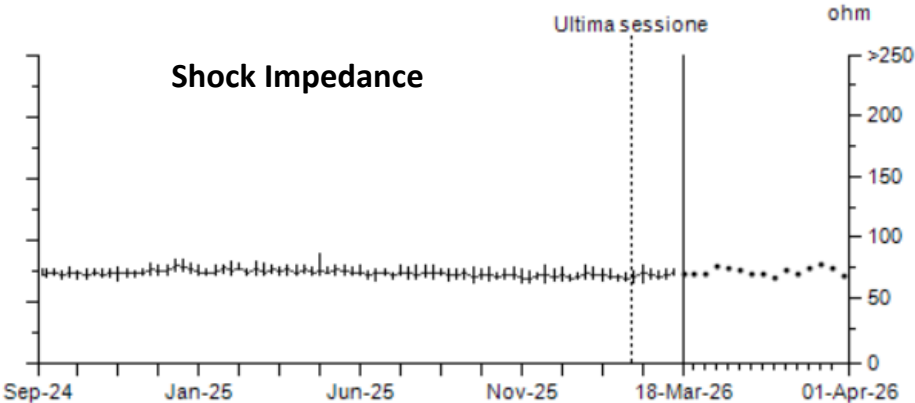
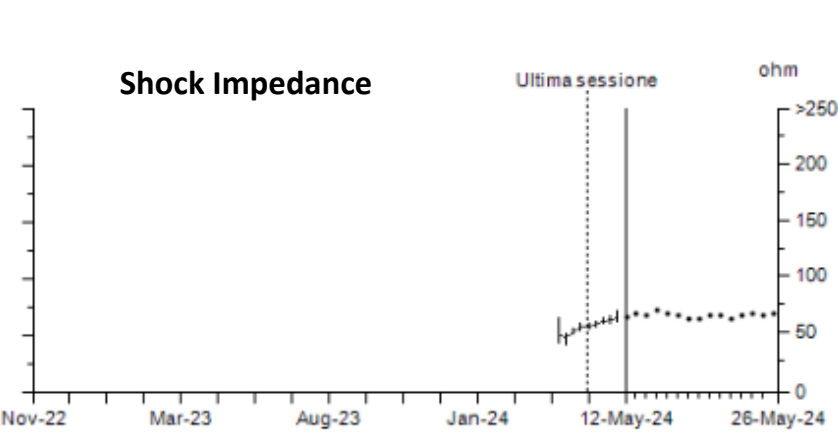
**Ring 1&2
Are in
front of
the RV**

14 years, 25 cm growth, kinesiotherapy



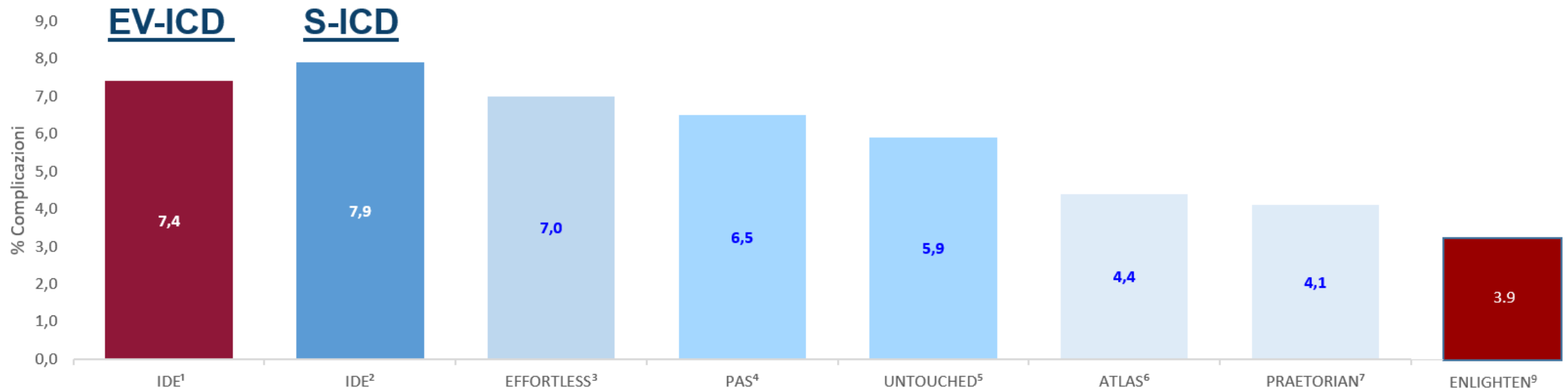
26 months after implant: height growth 25 cm

Implant FEB 2024



Patient Safety: 6- Month Follow-up

- The EV-ICD IDE study¹ met its primary safety endpoint: freedom from major system- or procedure-related complications through 6 months: 92.6%, 89% lower confidence limit, 79% performance goal.
- 22 ICDs were revised (7.4%) “mostly due to lead dislodgement, a significantly higher rate compared with transvenous or subcutaneous systems”⁸.
- Complication rate over 6 months, IS ANYWAY SIMILAR to the IDE S-ICD study, and the Enlighten registry paired with S-ICD best performance



1. Friedman F., et al., *N Engl J Med* 2022; 387(14):1292-1302.

2. Weiss R., et al., *Circulation*. 2013;128(9):944-53.

3. Lambiase P.L., et al., *European Heart Journal* 2022; 43(21):2037-2050.

4. Gold M.R., et al., *Circulation* 2022; 146(25): 18635

5. Gold M.R., et al., *Circulation* 2021; 143(1): 7-17

6. Healey J.S., et al. *Ann Intern Med* 2022;175(12):1658-1665.

7. Knops R.E., et al. *N Engl J Med* 2020; 383:526-536.

8. Elshazly M.B. and Gold, M.R, « Efficacy and Safety of an Extravascular ICD », PracticeUpdate, <https://www.practiceupdate.com/content/efficacy-and-safety-of-an-extravascular-icd/141120>

9. Crozier I, Heart Rhythm. 2025 Mar 17:S1547-5271(25)00127-4. doi: 10.1016/j.hrthm.2025.02.012

Tips and tricks for extravascular implantable cardioverter-defibrillator implantation: a single-centre experience

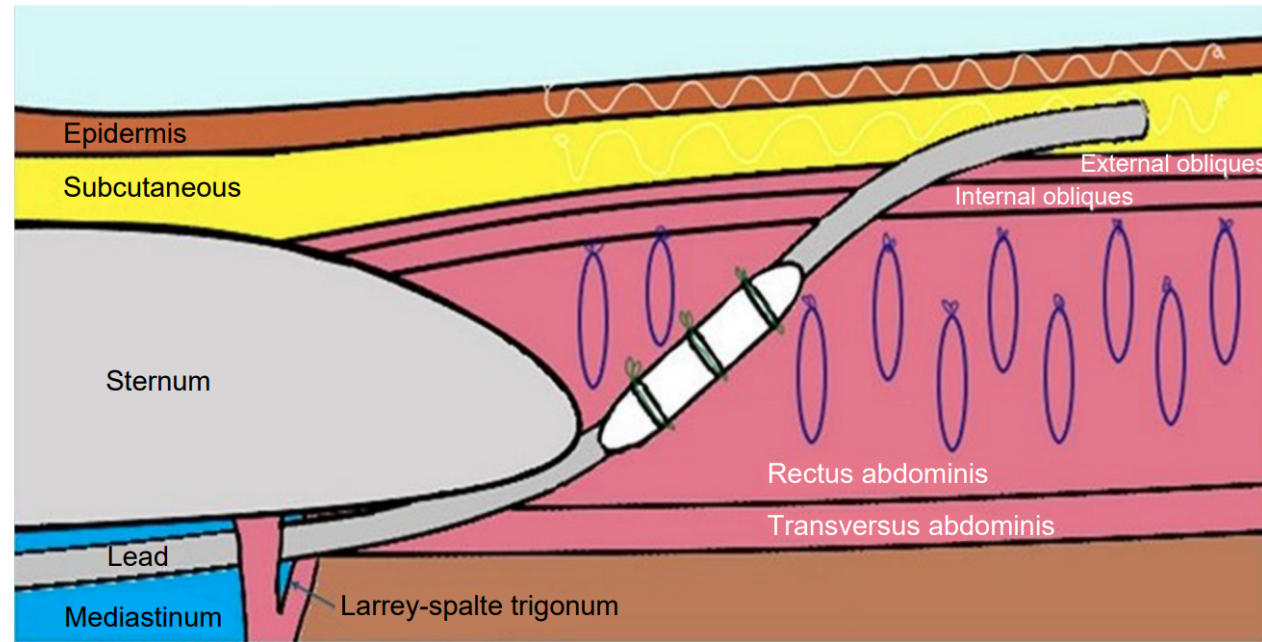
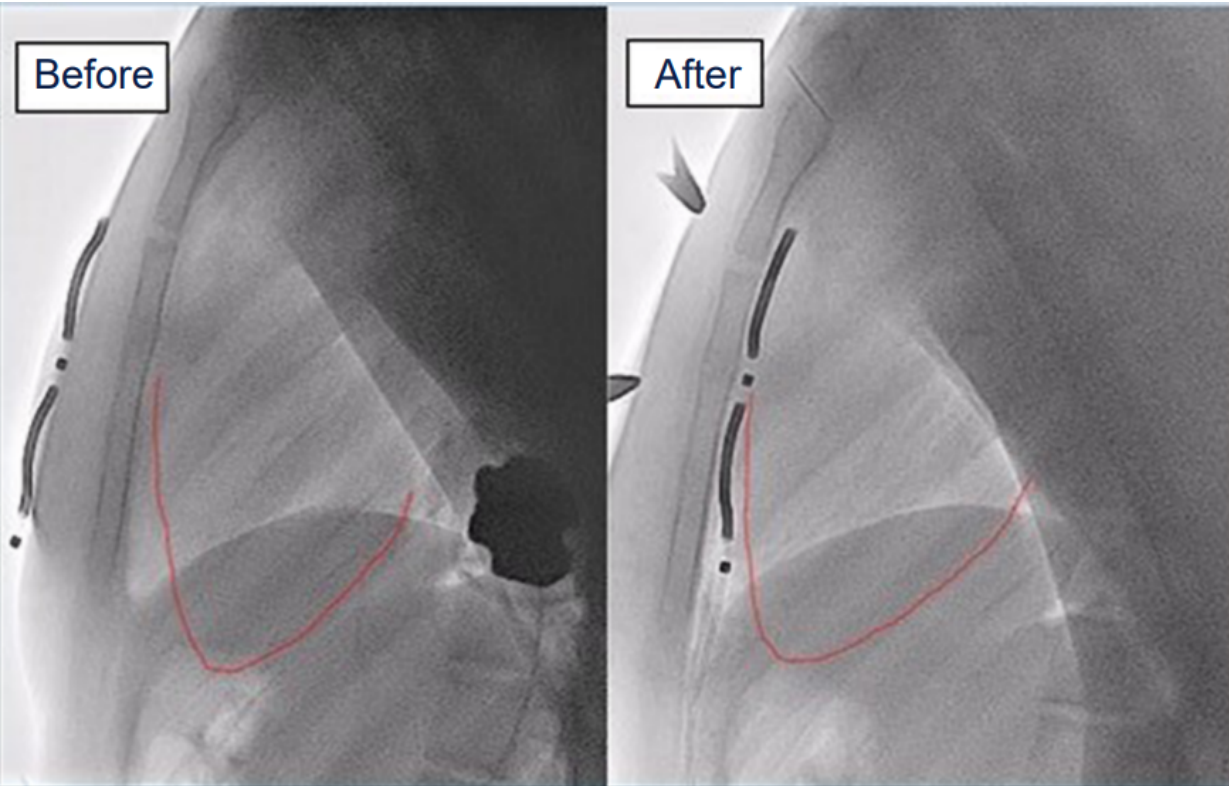


ESC

Europace (2026) 28, euag007

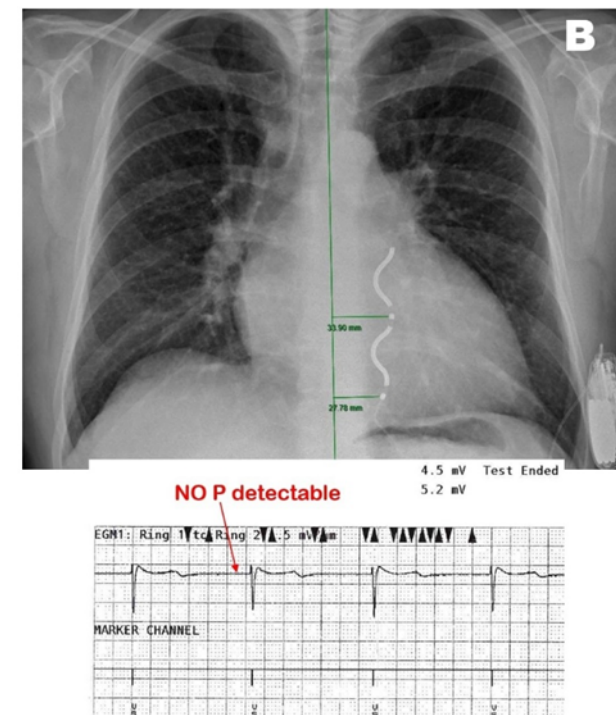
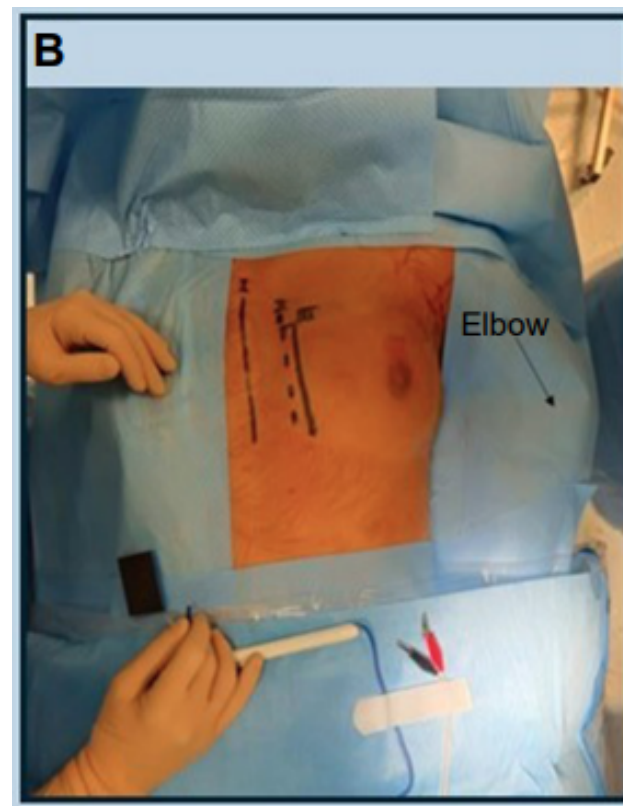
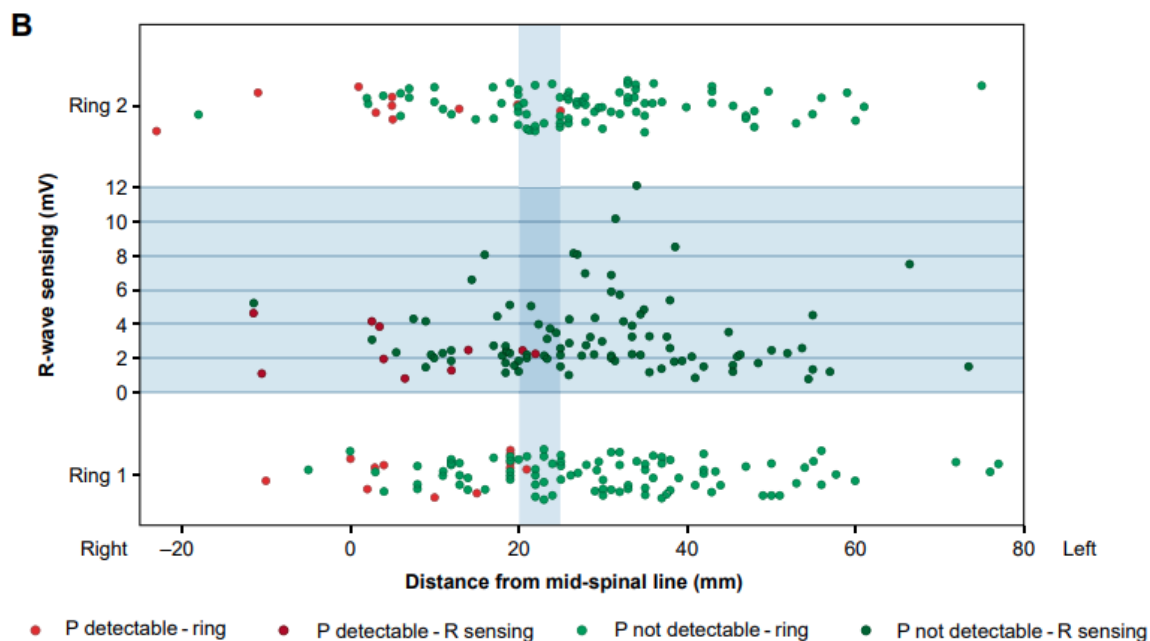
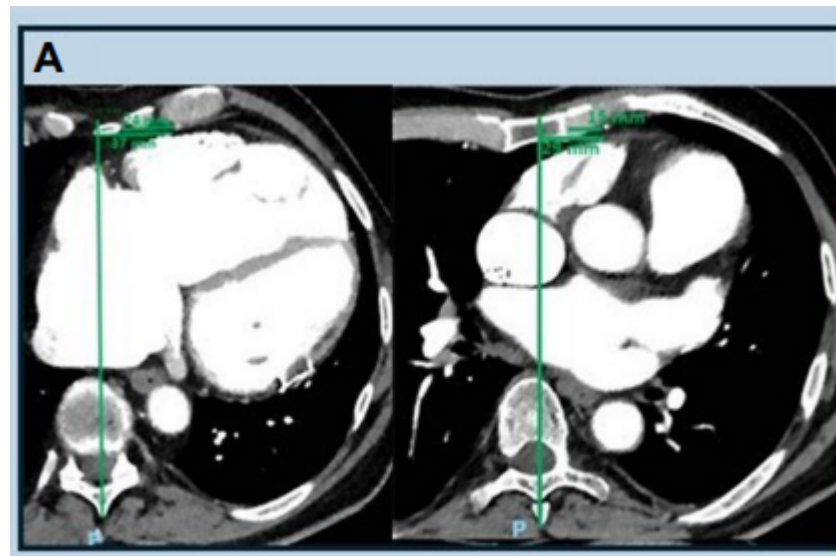
<https://doi.org/10.1093/europace/euag007>

Mauro Biffi ¹, Andrea Quaranta ^{2*}, Cristian Martignani ¹, Igor Diemberger ²,
Andrea Angeletti ¹, Carmine Verde ², Jessica Frisoni ², Antonio Nicolò Izzo ²,
Alberto Spadotto ², and Matteo Ziacchi ¹



CT-guided lead placement prevents P-wave oversensing in extravascular ICD

Andrea Quaranta ^{1*}, Matteo Baroni ^{2†}, Raffaele Falco ², Cristian Martignani ³, Igor Diemberger ¹, Andrea Angeletti ³, Carmine Verde ¹, Antonio Nicolò Izzo ¹, Alberto Spadotto ¹, Matteo Ziacchi ³, Patrizio Mazzone ², and Mauro Biffi ³



The PRICE of ATP and Asystole prevention

S-ICD much **EASIER** procedure than **EV ICD**



NO Surgical BACK-UP

Only learning Phase



NO severe complications

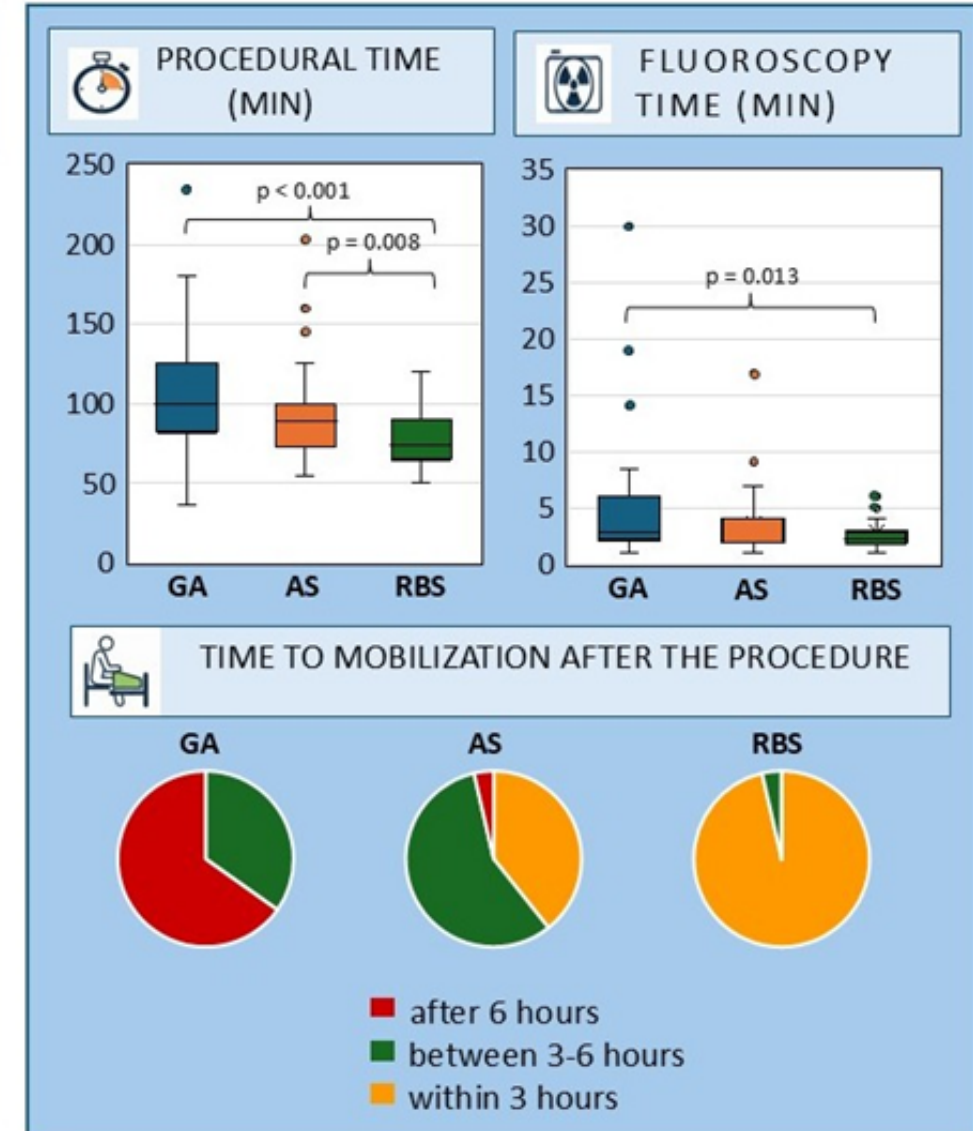
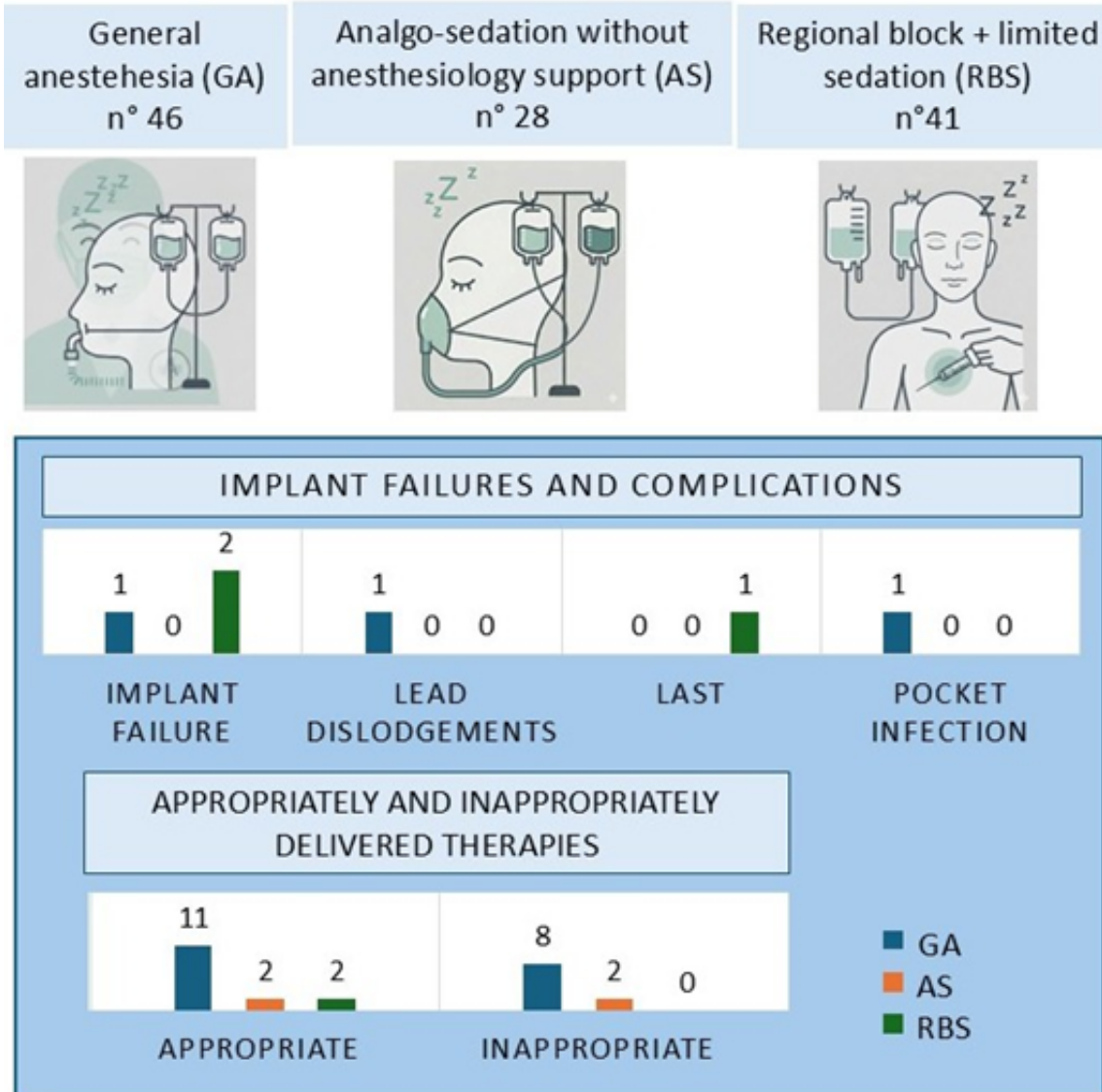
Thoracic arteries trauma possible



NO CT scan, NO fluoroscopy

Mandatory to ensure efficacy and safety

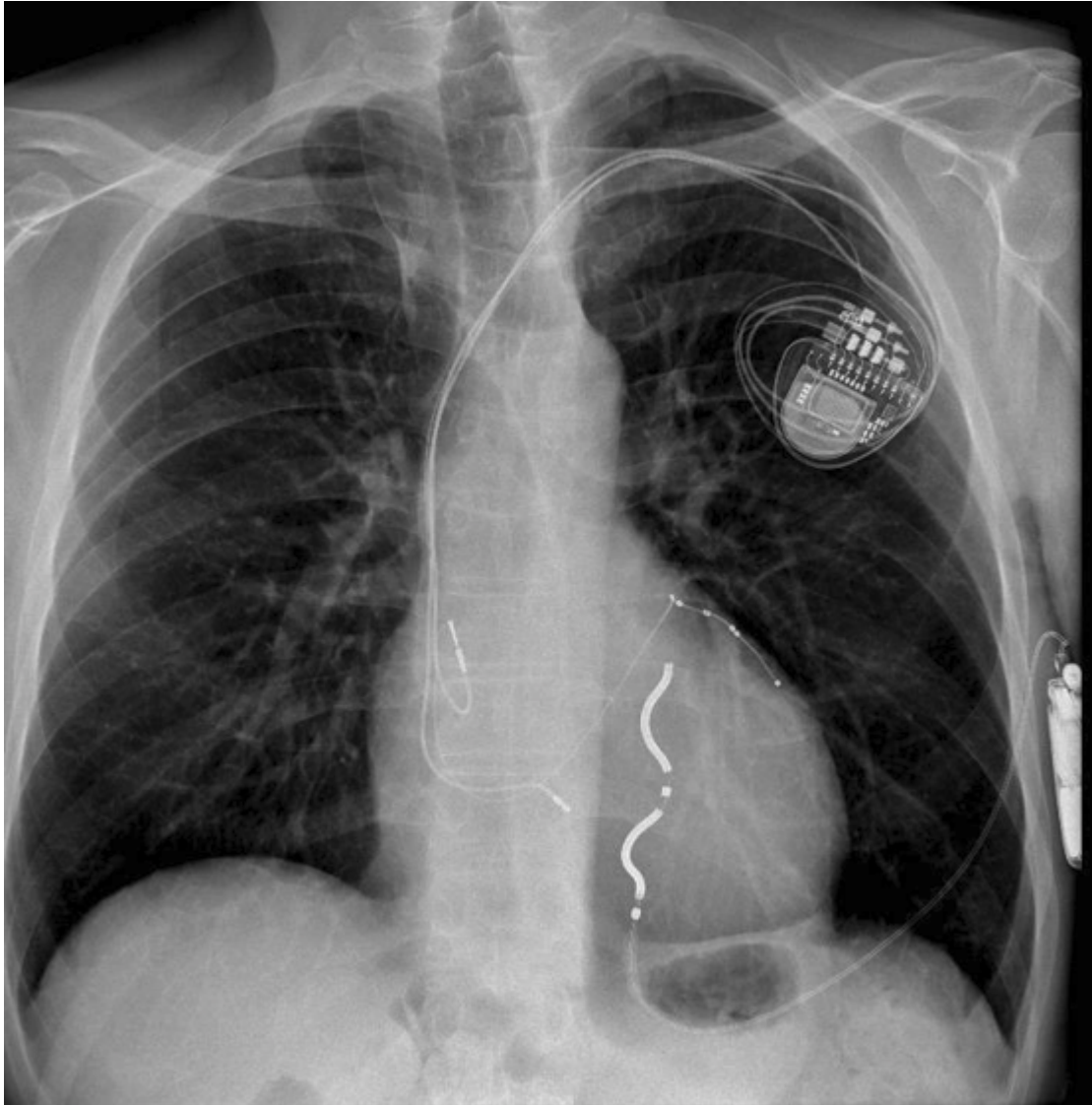
EV-ICD implant without GA: Bologna and Nieuwegein experience



**NON-TV ICDs are perfectly suited
for NON-communicating co-
implanted devices**

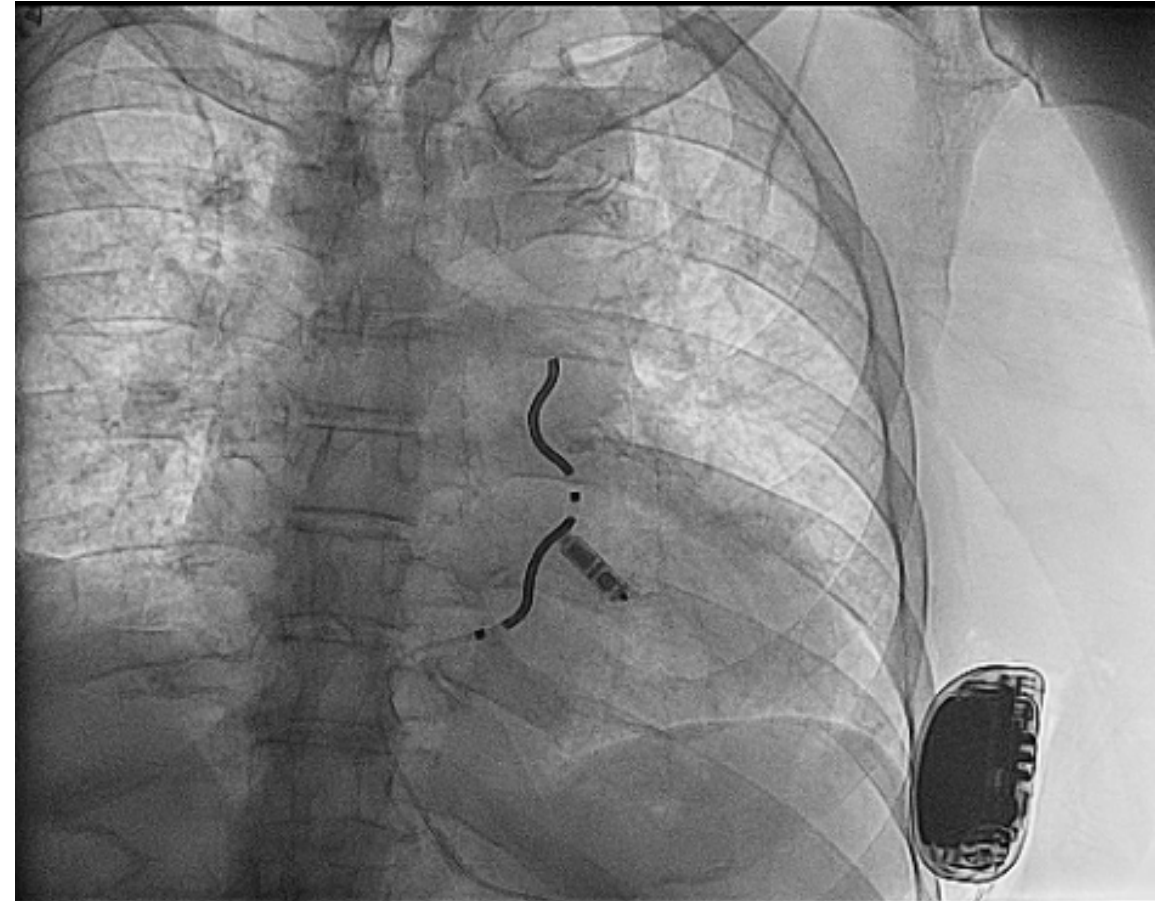


EV + LOT-CRTP



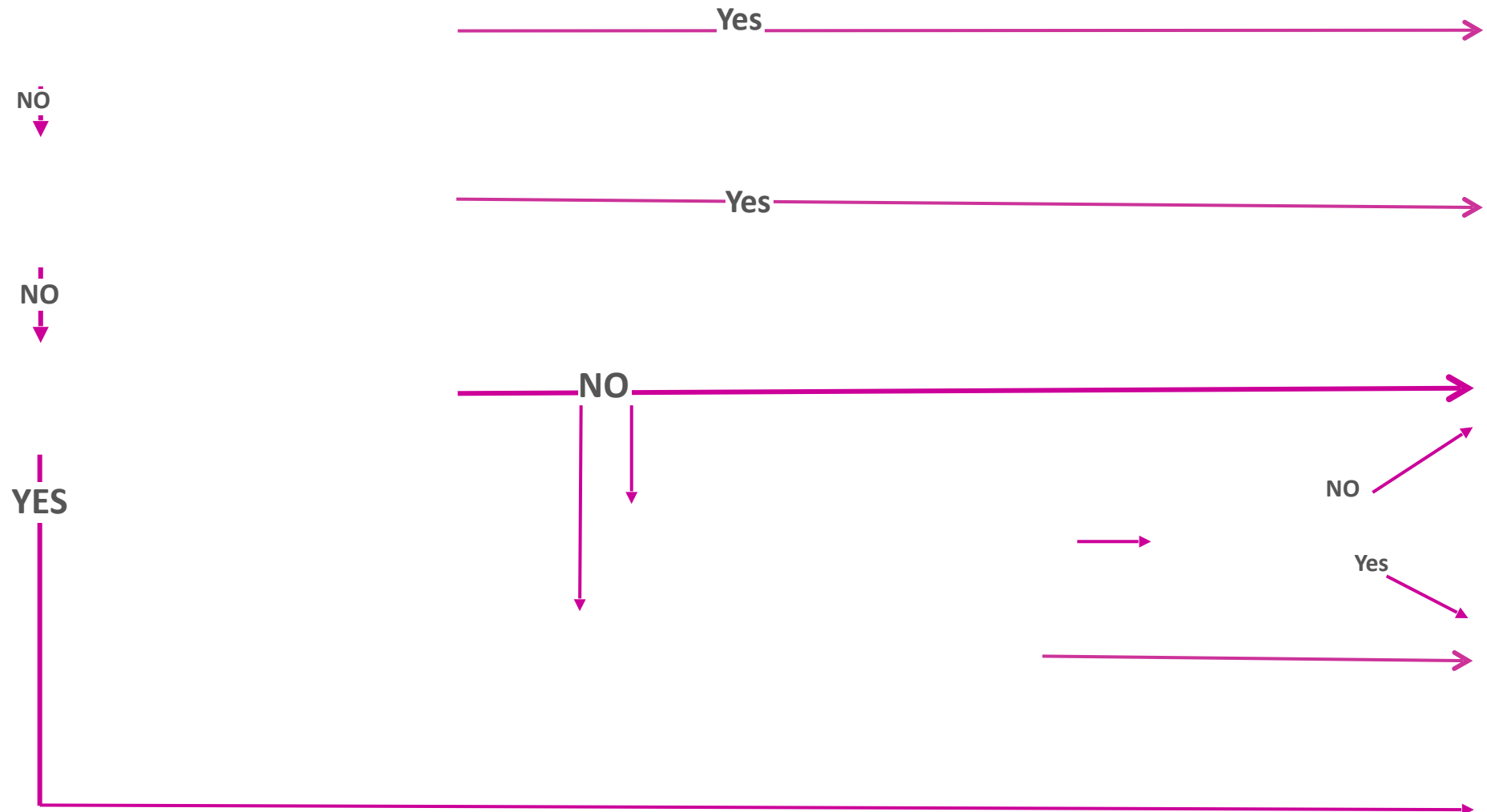
Desmoplakin mutation

EV + Micra



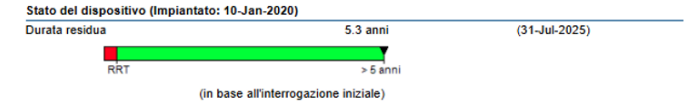
ICM, permanent AF

ICD indication



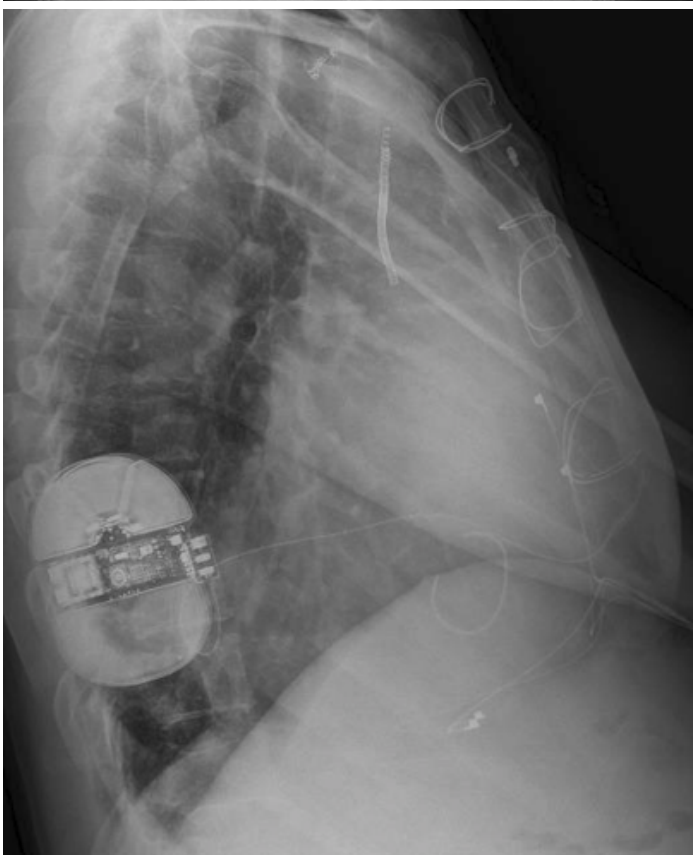
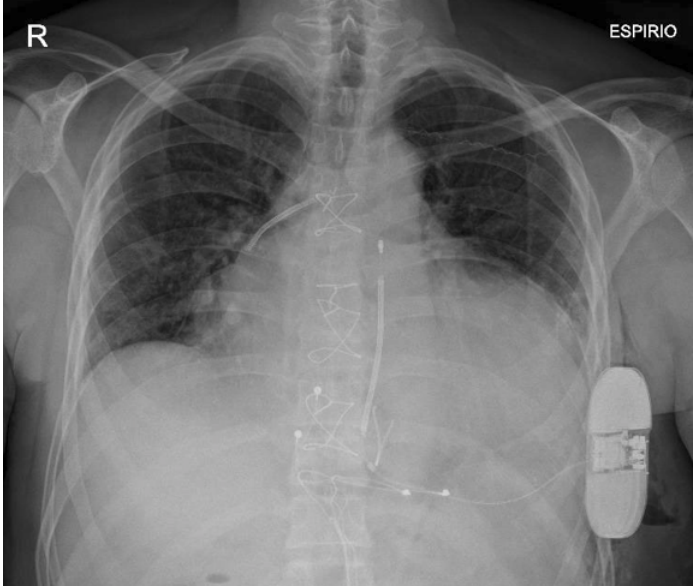
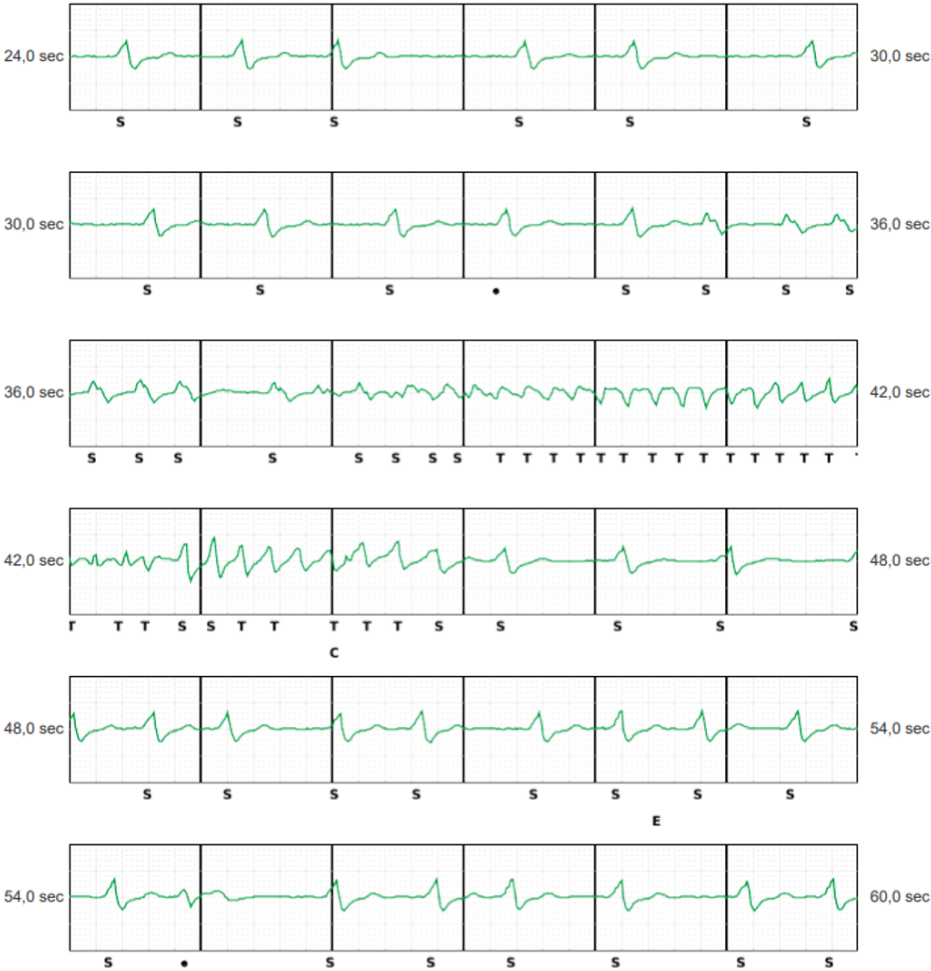
S-ICD with coexistent non-communicating pacemakers

S-ECG visualizzato a 25 mm/sec 2,5 mm/mV



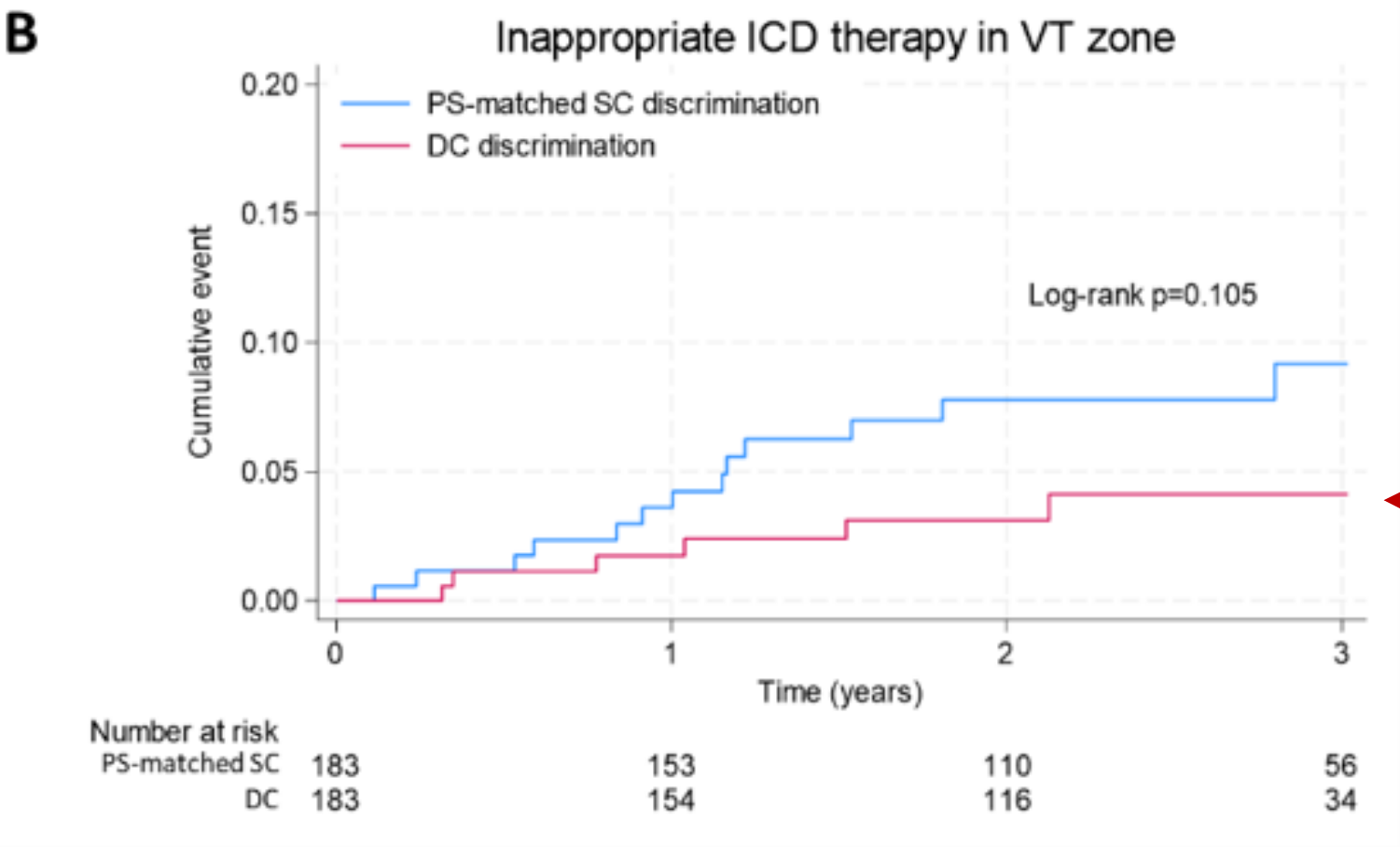
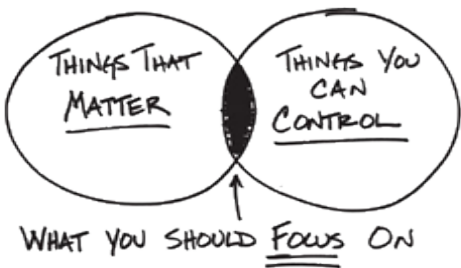
Impedenza elettrocateteri	Atriale 513 ohm	RV 646 ohm
Soglia di cattura	0.750 V a 0.40 ms	2.000 V a 0.40 ms
Data misurazione	26-Jun-2025	31-Jul-2025
Ampiezza/durata impulso programmata	1.50 V / 0.40 ms	5.00 V / 0.40 ms

% Stim.	(% di tempo dal 20-Dec-2024)
VP	95.1% (MVP Off)
AP	10.0%



The sINgle lead reGiStry: THINGS

Propensity Score-matched Comparison of Inappropriate Therapies between Single- and Dual-Chamber Discriminators in Single-Chamber devices



The Value of Atrial signal

The role of atrial sensing for new-onset atrial arrhythmias diagnosis and management in single-chamber implantable cardioverter-defibrillator recipients: Results from the THINGS registry

TABLE 2 2-y incidence of new-onset atrial tachycardia/fibrillation diagnosis and oral anticoagulation onset for patients with ICD VR and ICD DX

2-y estimates	ICD VR	ICD DX
New-onset AT/AF diagnosis	3.6 (95% CI: 1.6%-9.6%)	11.4% (95% CI: 6.8%-18.9%)
OAC onset for AT/AF	3.6 (95% CI: 1.6%-9.6%)	6.3% (95% CI: 3.0%-12.7%)

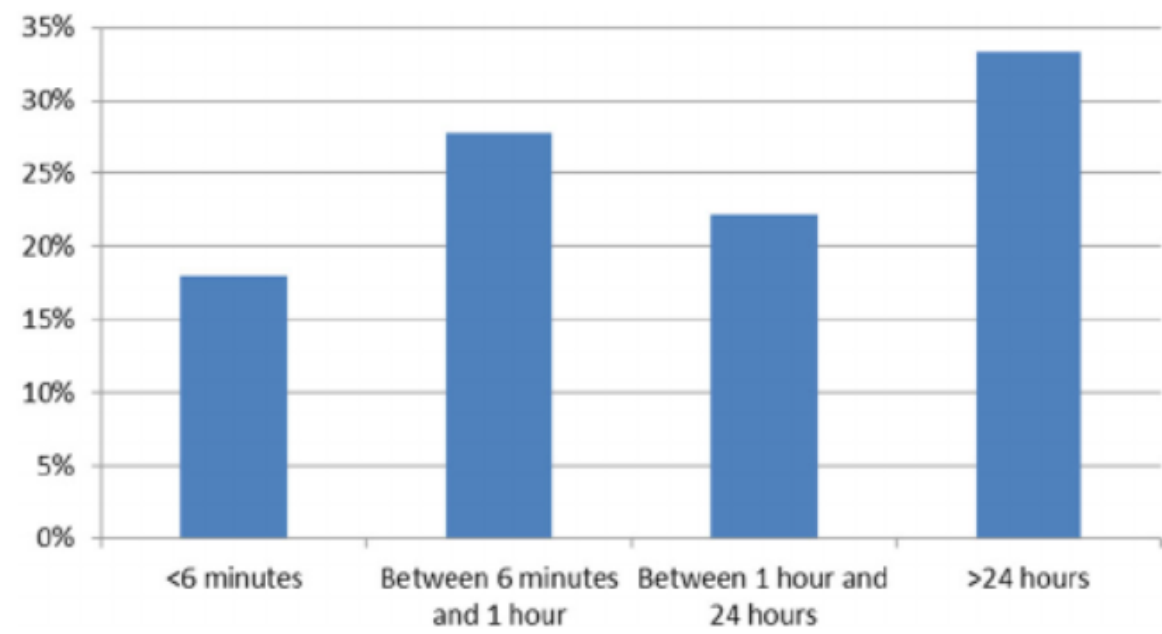
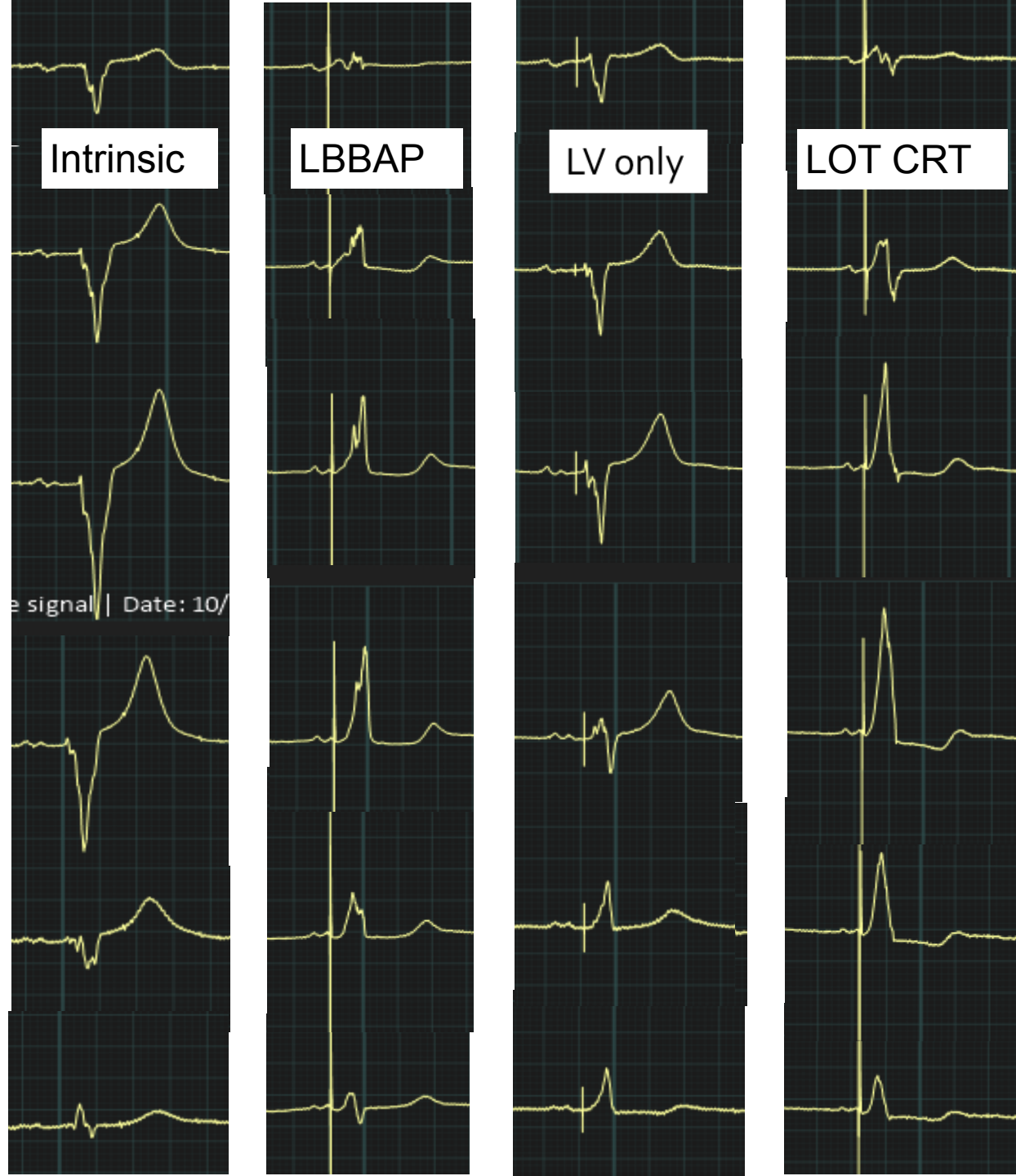


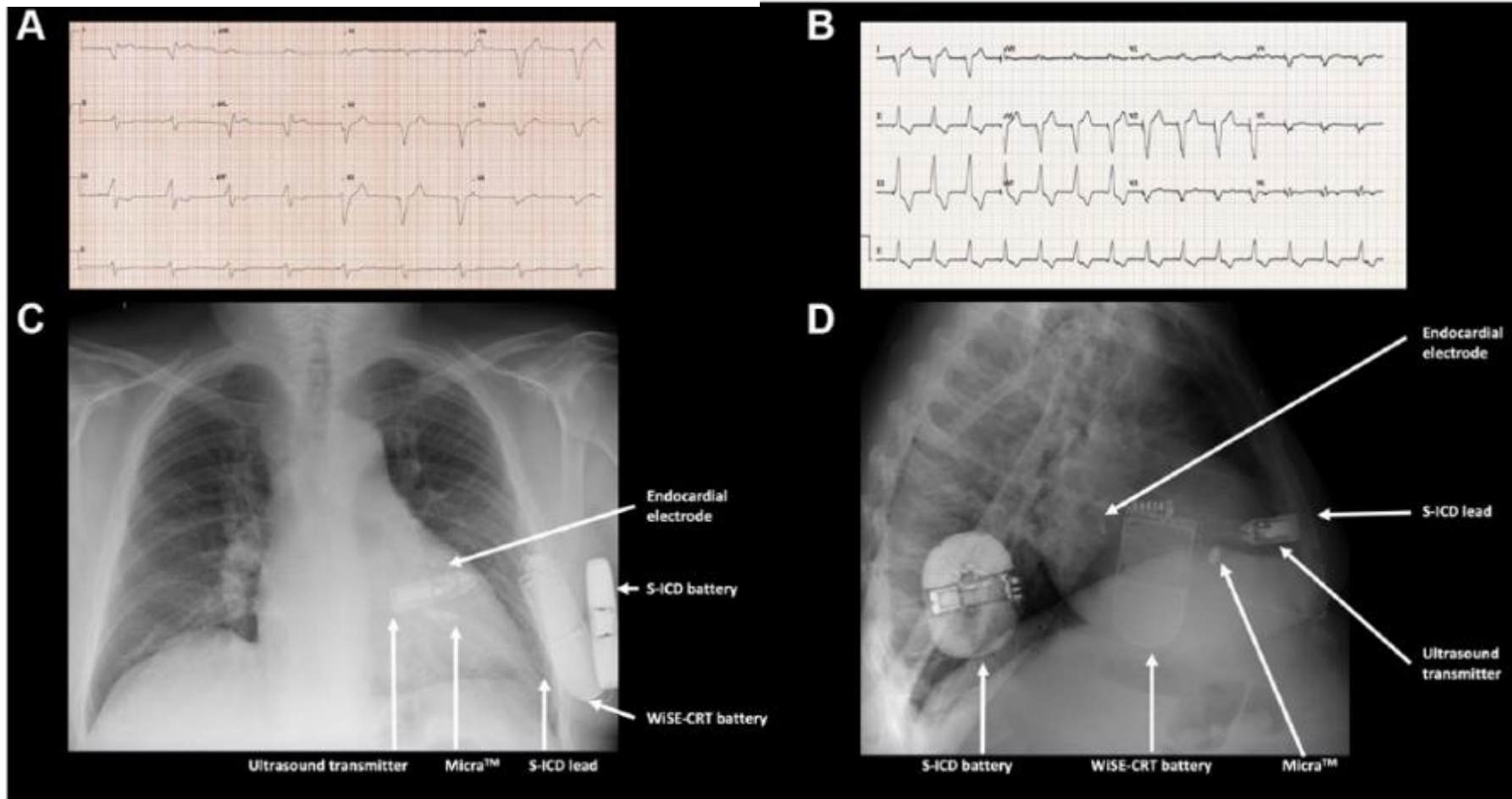
FIGURE 3 Distribution of the longest atrial tachycardia/fibrillation (AT/AF) episode duration as provide by the ICD DX system in patients who experienced new-onset AT/AF diagnoses. ICD, implantable cardioverter-defibrillator



Next Steps: Totally Leadless CRT-D (WiSE + Micra + S-ICD)

Completely Leadless Cardiac Resynchronization Defibrillator System

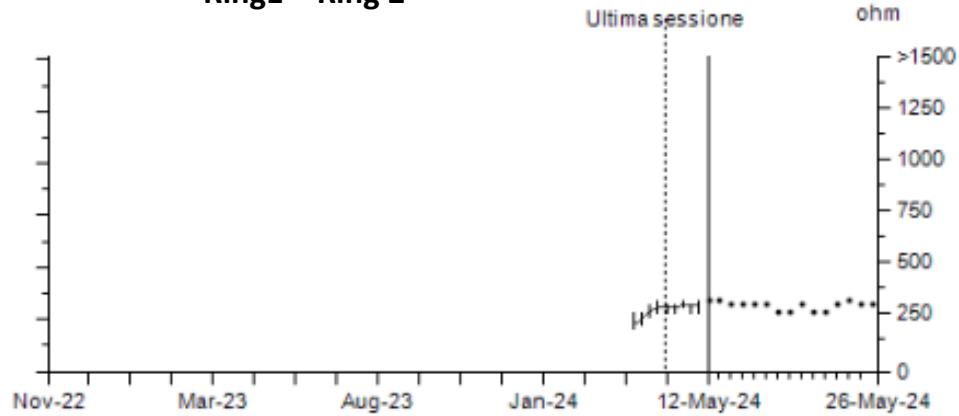
Baldeep S. Sidhu, BM,^{a,b} Justin Gould, MBBS, PhD,^{a,b} Bradley Porter, MBChB, PhD,^{a,b} Mark Elliott, MBBS,^{a,b} Vishal Mehta, MBBS,^{a,b} Steven Niederer, DPM,^a Christopher A. Rinaldi, MD^{a,b}



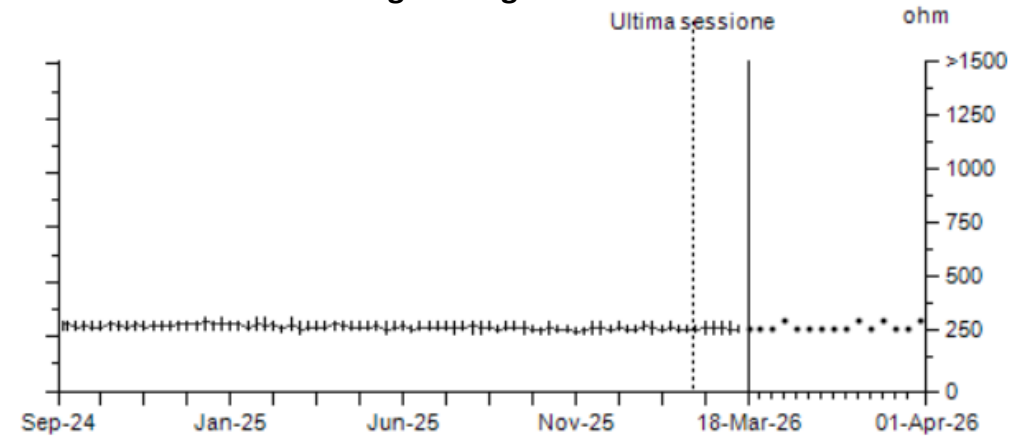
Stability of electrical parameters at follow-up

Implant FEB 2024

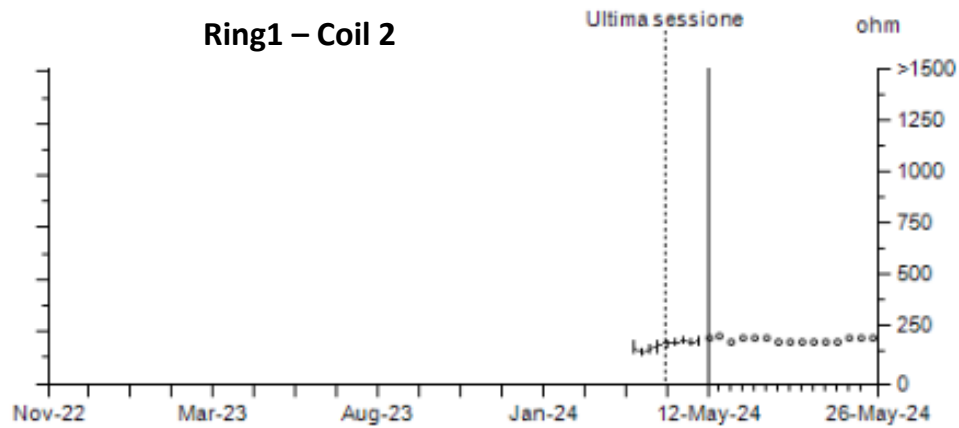
Ring1 – Ring 2



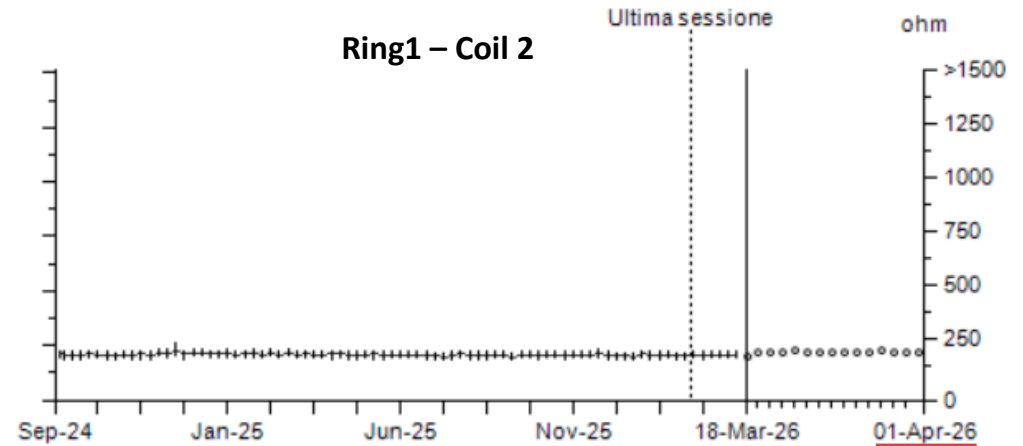
Ring1 – Ring 2



Ring1 – Coil 2



Ring1 – Coil 2



The need for a subsequent transvenous system in patients implanted with subcutaneous implantable cardioverter-defibrillator

Heart Rhythm 2022;19:1958–1964

VT in about 10 % of patients

VT ablation in 50%

Drugs

Only 2% shifted to a TV ICD

> [Heart Rhythm](#). 2026 May 25:S1547-5271(26)02401-X. doi: 10.1016/j.hrthm.2026.05.034.

Online ahead of print.

Subcutaneous ICD Therapy in Patients with Monomorphic Ventricular Tachycardia: Arrhythmia Recurrence, Shock Rate, and Management Strategies

Giovanni Luca Botto ¹, Federico Migliore ², Paolo Pieragnoli ³, Stefano Viani ⁴, Antonio Bisignani ⁵, Matteo Ziacchi ⁶, Massimo Stefano Silvetti ⁷, Gerardo Nigro ⁸, Valter Bianchi ⁹, Marco Valerio Mariani ¹⁰, Gianluca Savarese ¹¹, Raimondo Pittorru ², Gabriele Bambagioni ³, Mariolina Lovecchio ¹², Sergio Valsecchi ¹², Mauro Biffi ⁶, Maria Carla Casale ¹³; "S-ICD Rhythm Detect" Investigators

SAFE PED

EV-ICD Registry

Alexander Breitenstein*, Karim Saleh*, Ferran Roses, Margaux Pontailier, Carsten Lennerz, Florian Reinke, Georgia Spentzou, Palash Barman, Mark Walsh, Julian Ormerod, Matthew Ginks, Jasveer Mangat, Greg Mellor, Eyal Nof, Wim Huybrechts, Ammar Taha, Miroslav Krpan, Christophe Vo, Sebastian Marchandise, Davide Castagno, Francis Murgatroyd, Maciej Sterlinksi, Christian Balmer, Christian Scheckenbach, Michiel Rienstra, Gonçalo Pestana, David Duncker, Mauro Biffi

EHRA 2026 Meeting, Paris, 13th of April 2026

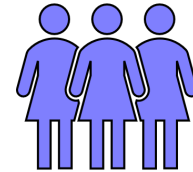
Underlying cardiac conditions and demographic profile



13.7 ± 3.1 years



54.9% male
45.1% female



19.4 ± 4.2 kg/m²



Primary 40.8 %
Secondary 59.2 %

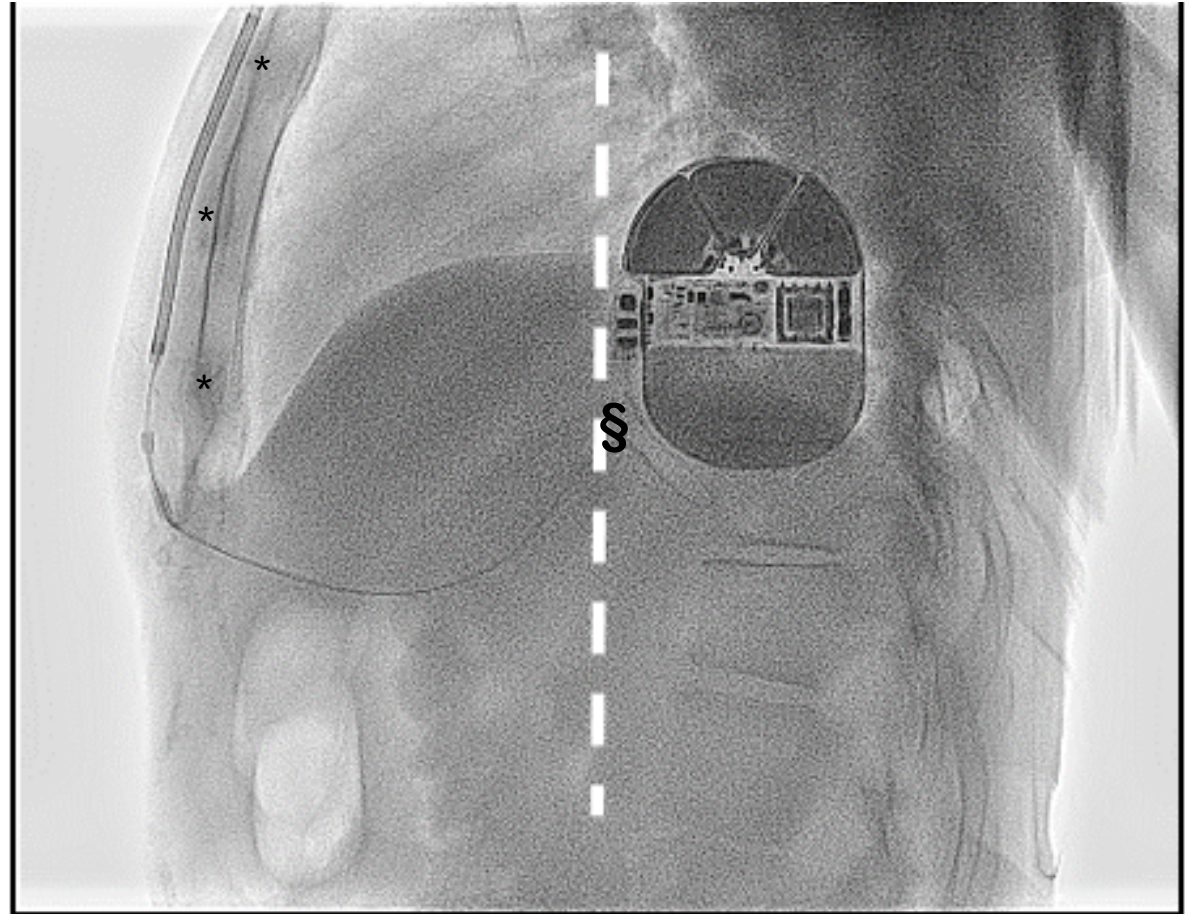
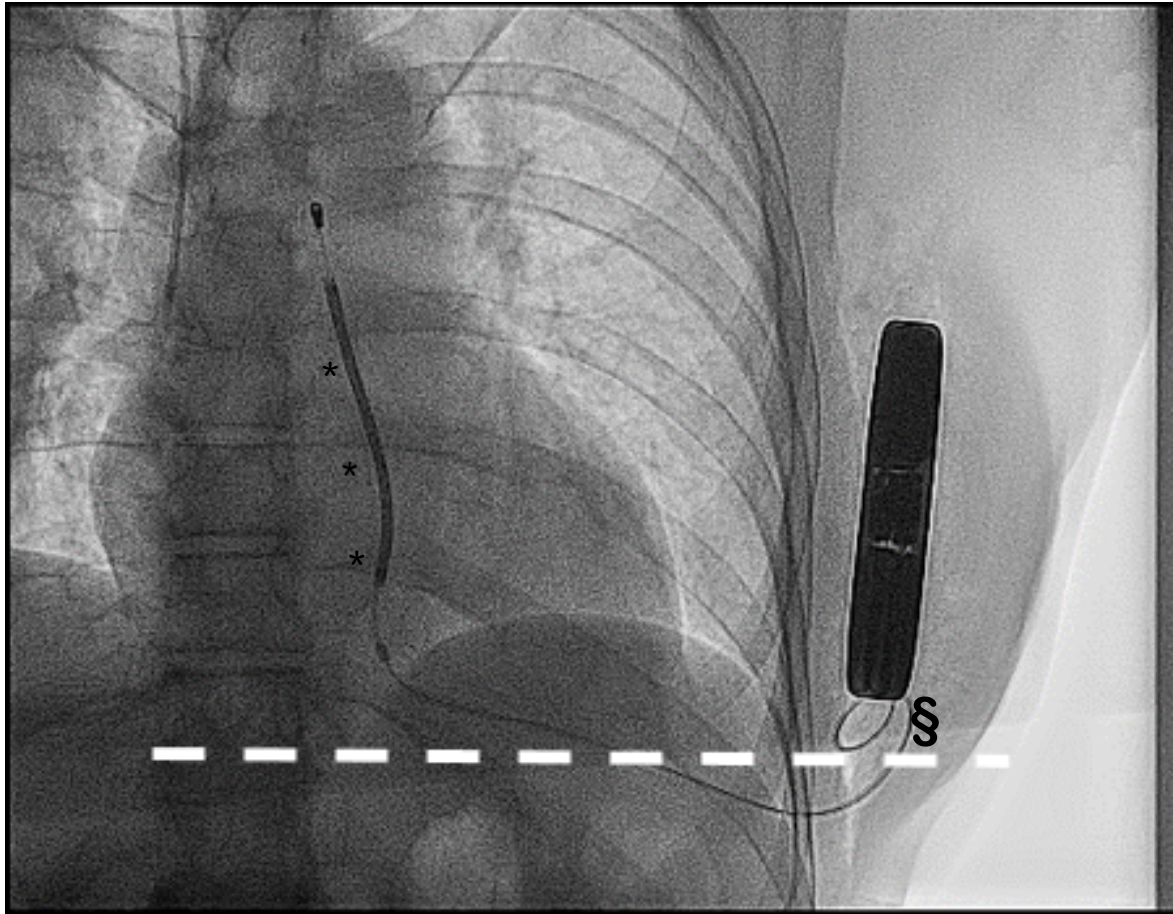
Implantation procedure characteristics

Operating theatre

Type of sedation

Primary operator

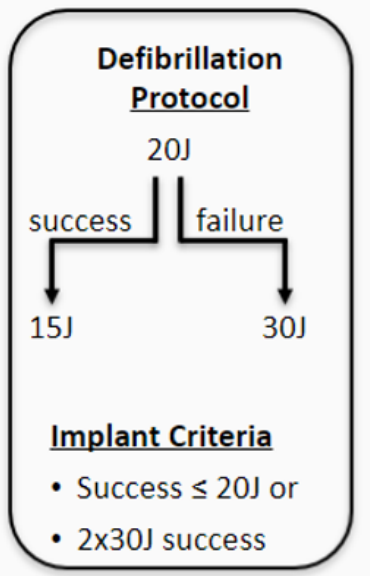
Optimal S-ICD placement: see COIL in close contact to rib.sternum junction over the left sternal border (*), Can intermuscular , posterior to the mid-axillary (LL view) and above the diaphragm (PA view) (§).



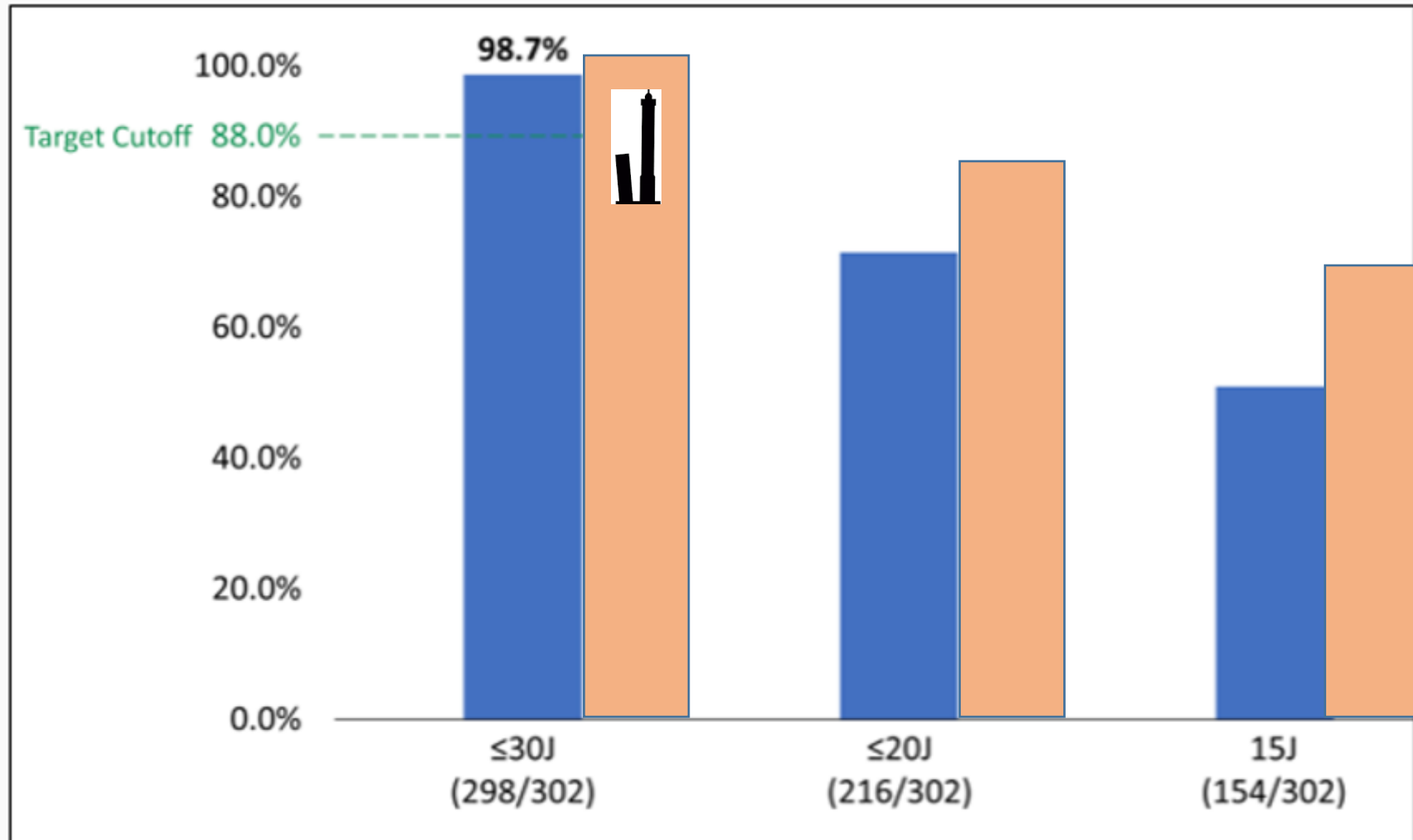
This configuration yielded effective VF termination at $\leq 40\text{J}$ in 54 consecutive patients, half of which successfully terminated with $\leq 30\text{J}$ (subanalysis of *JACC Clin Electrophysiol* 2021;7:767-776).

Evaluation of defibrillation thresholds: CT guidance and intermuscular pocket

PIVOTAL TRIAL



ESC CONGRESS 2022
Barcelona & Online



Performance and Safety of the Extravascular Implantable Cardioverter Defibrillator Through Long-Term Follow-Up: Final Results From the Pivotal Study

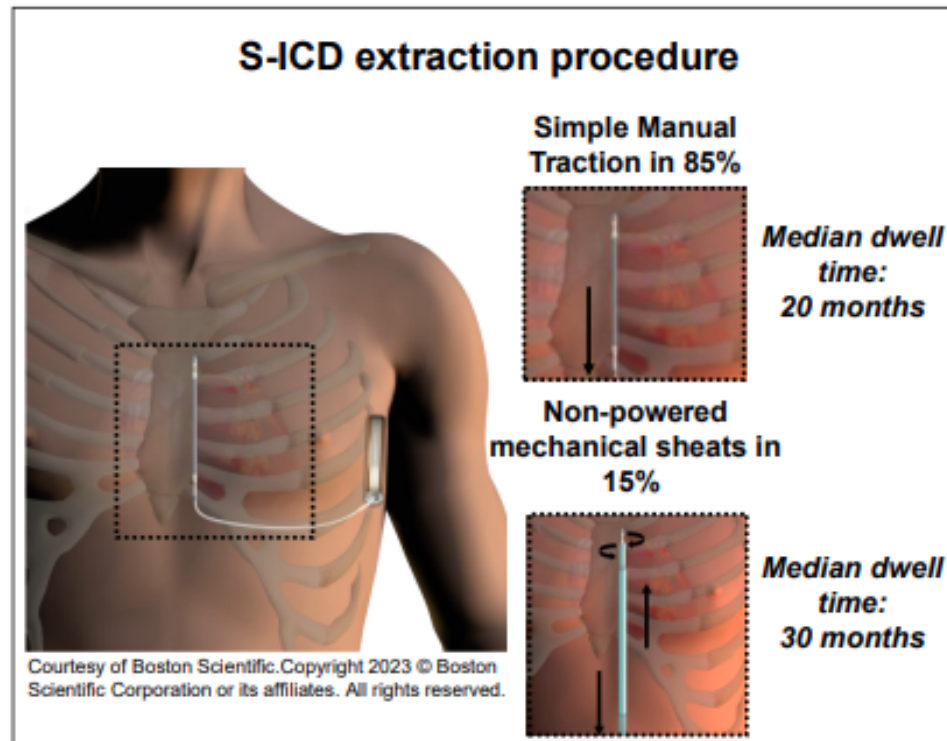
Circulation. 2025;151:322–332.

- **299 Patients, mean LEF = $38.9 \pm 15.4\%$, 82% Primary Prevention**
- **Minimum Follow-up 2 years , maximum 4.6 years**
- **24 patients had VAs, total of 82 VAs**
- **46% treated by ATP, 42% by Shock, 12% both ATP and Shock**



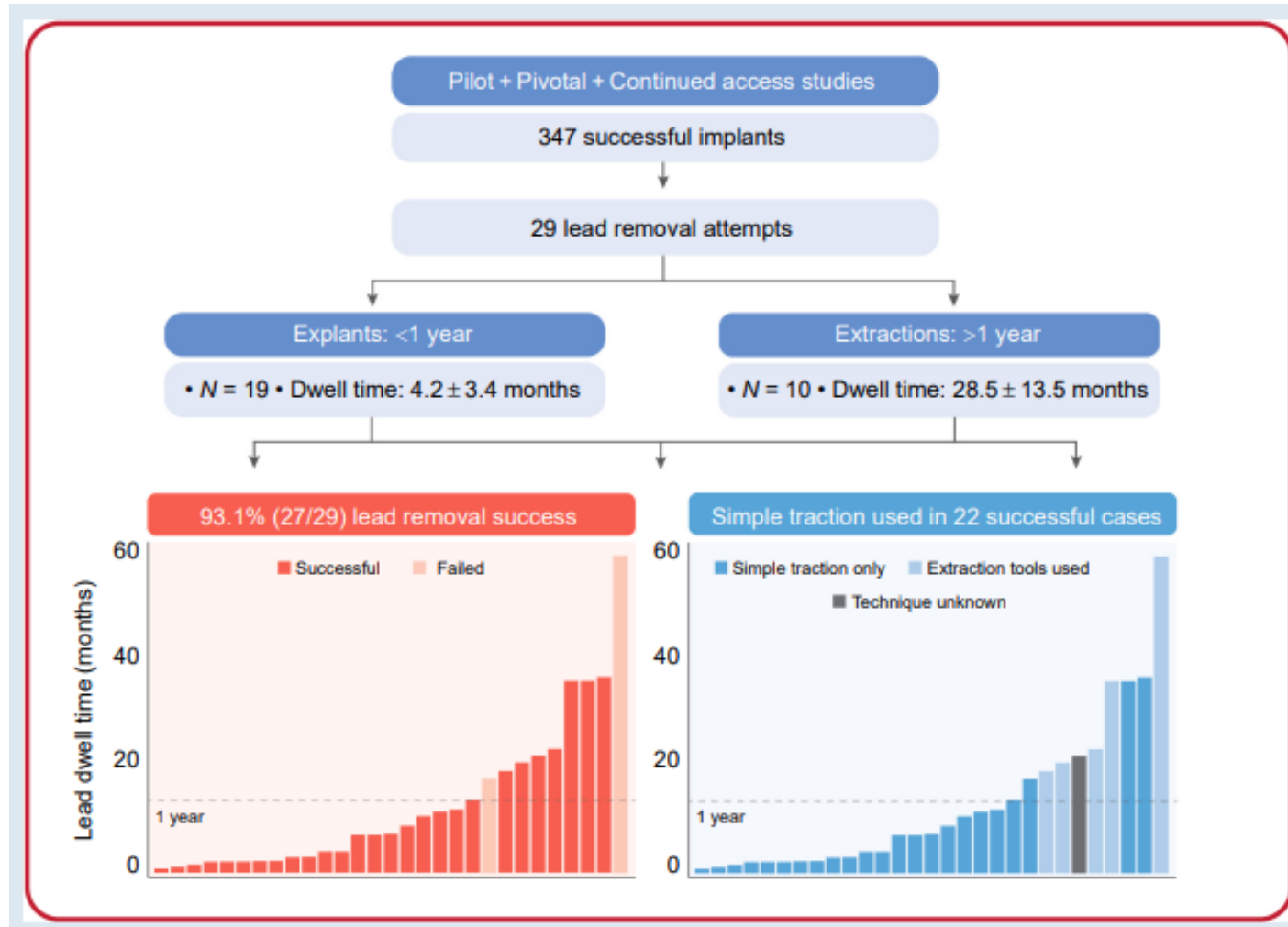
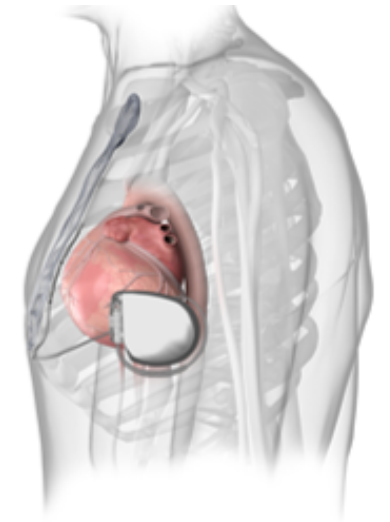
Procedure, management, and outcome of subcutaneous implantable cardioverter–defibrillator extraction in clinical practice

Management of S-ICD extraction



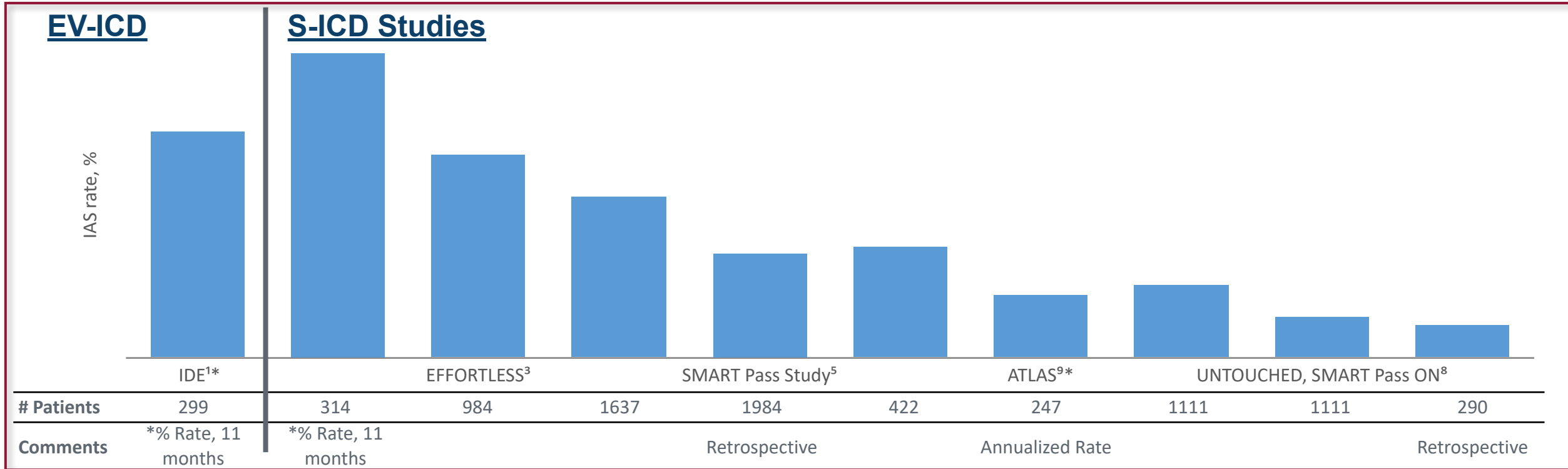
- S-ICD extraction is safe and easy to perform, with no intra-procedural complications.
- Simple manual traction of the lead is successful in most patients, but specific tools could be needed for systems implanted for a longer time.
- S-ICD extraction, even in the case of infection, is associated with short hospital stay, early re-implantation and no complications over follow-up.

Lead extraction in EV ICD recipients



Inappropriate Shock Rates: 10%, lower than the S-ICD IDE

not bad for a BEGINNER



- S-ICD rates have decreased over time with improved sensing, programming, and implantation techniques.
- One-Year IAS rates **lower than 2.0% for S-ICD** have been reported in 2 studies with the SMART Pass filter, 200/250 programming, and/or the intermuscular implantation technique (UNTOUCHED, RHYTHM DETECT).
- **Bologna EV.ICD experience is <2% IAS with BOTH the EV-ICD and the S-ICD**

1. Friedman F., et al, *N Engl J Med* 2022; 387(14):1292-1302
 2. Weiss R., et al., *Circulation*. 2013;128(9):944-53.
 3. Lambiase P.L., et al., *European Heart Journal* 2022; 43(21):2037-2050.

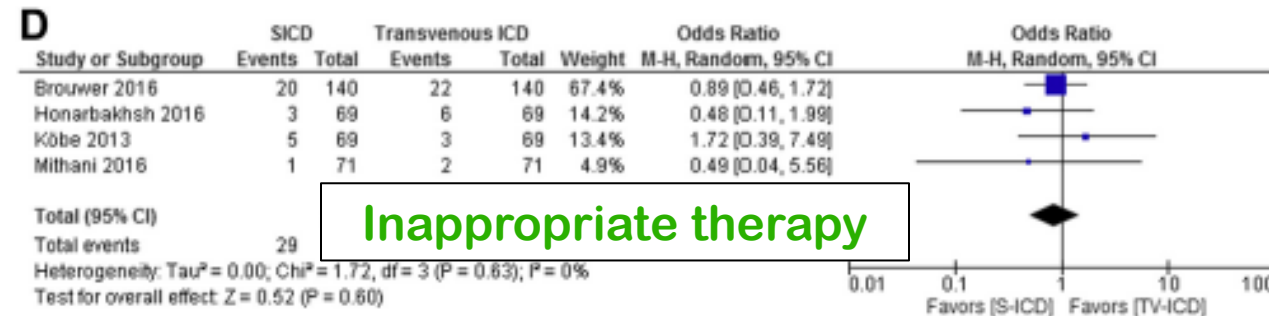
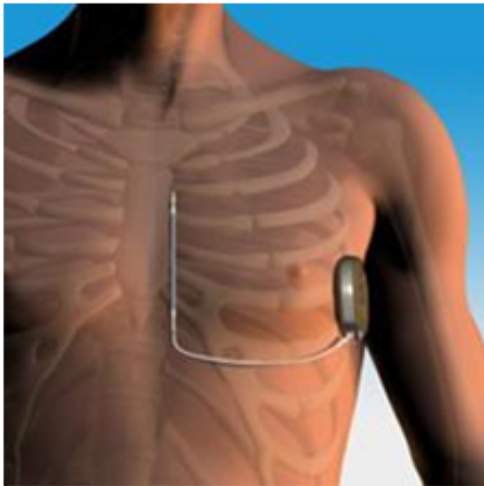
4. Gold M.R., et al., *Circulation* 2022; 146(25): 18635
 5. Lambiase P.L., et al., *European Heart Journal* 2022; 43(21):2037-2050.
 6. Knops R.E., et al. *N Engl J Med* 2020; 383:526-536.

7. Gold M.R., et al., *Circulation* 2021; 143(1): 7-17
 8. Boersma EHRA Congress 2022, Abstract #41073.
 9. Botto GL., et al., *Europace* 2023;00:1-9.

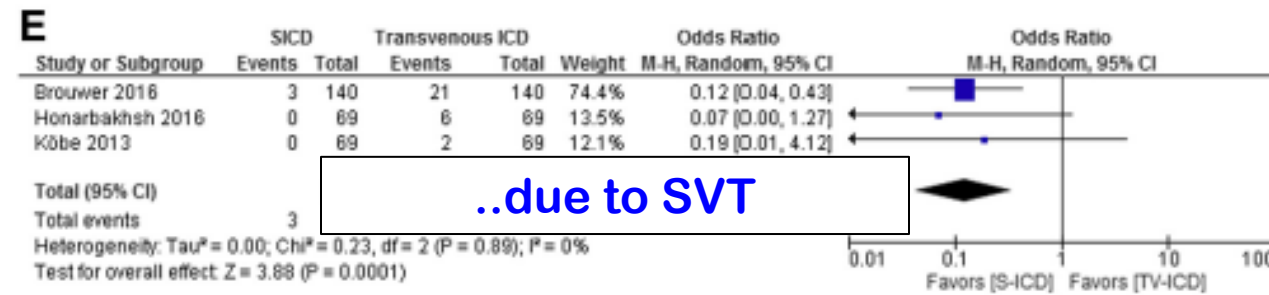
Subcutaneous Versus Transvenous Implantable Defibrillator Therapy

A Meta-Analysis of Case-Control Studies

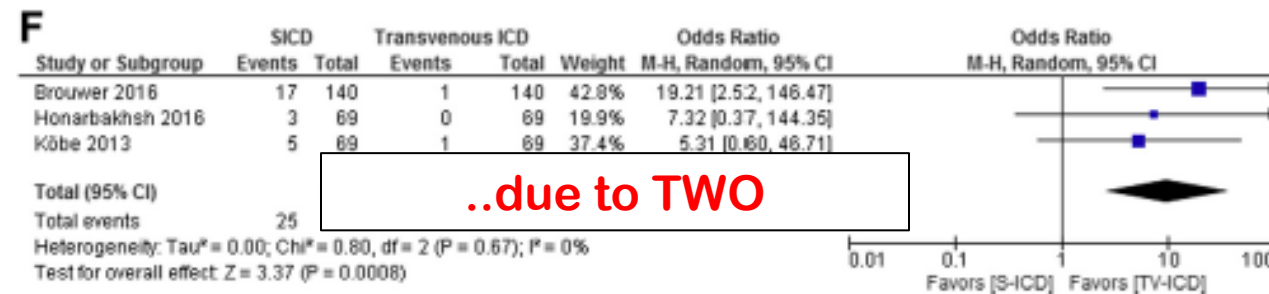
S-ICD



P=NS



P<0.05

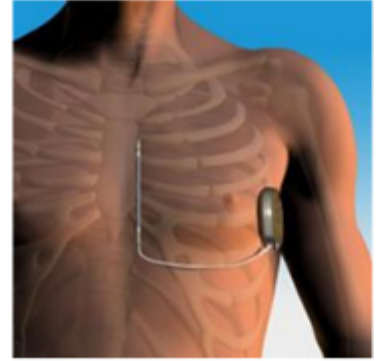


P<0.05

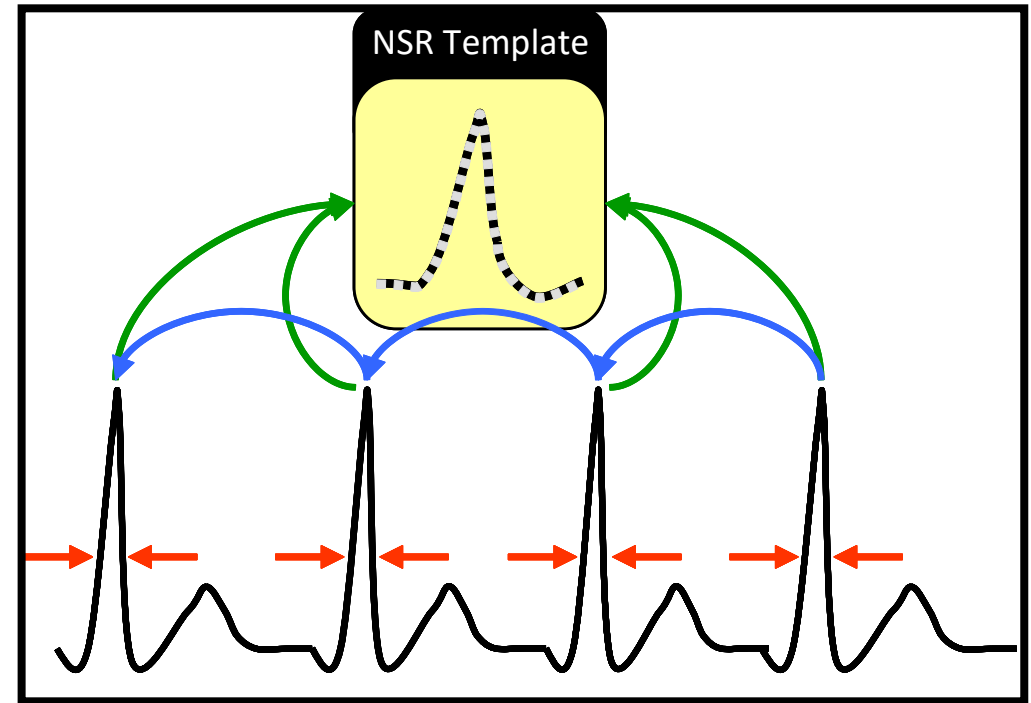
Algorithm Architecture

INSIGHT™ Algorithm

Utilizes 3 methods to identify and classify the S-ECG rhythm:



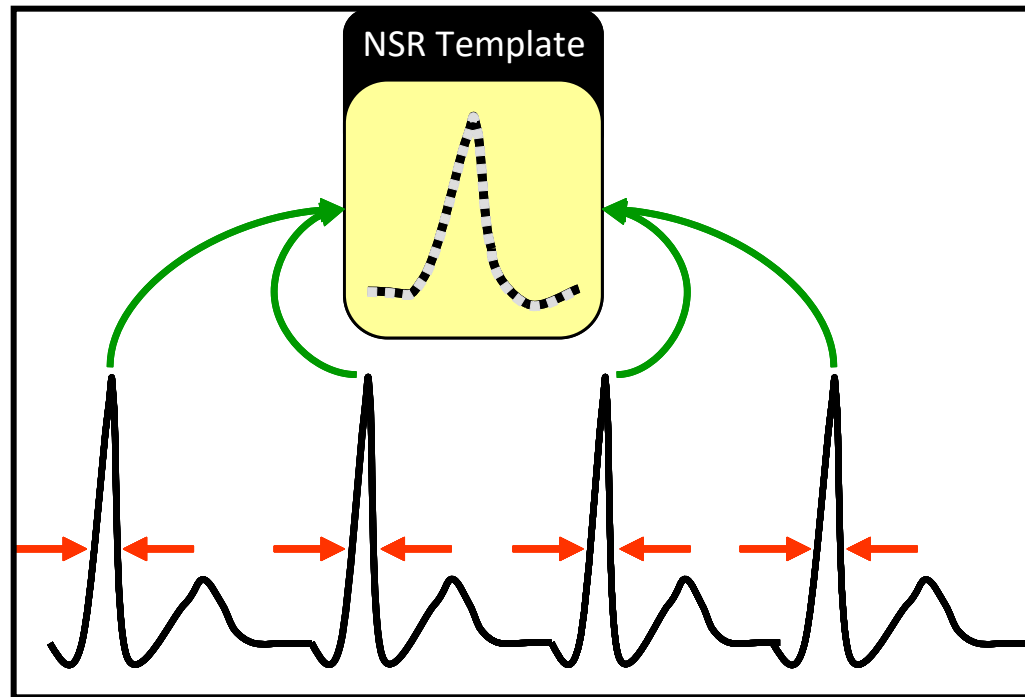
1. Static Morphology Analysis: NSR
2. Dynamic Morphology Analysis: SPR
3. QRS Width Analysis: SMR vs NR



Algorithm Architecture

INSIGHT™ Algorithm: Static CWA

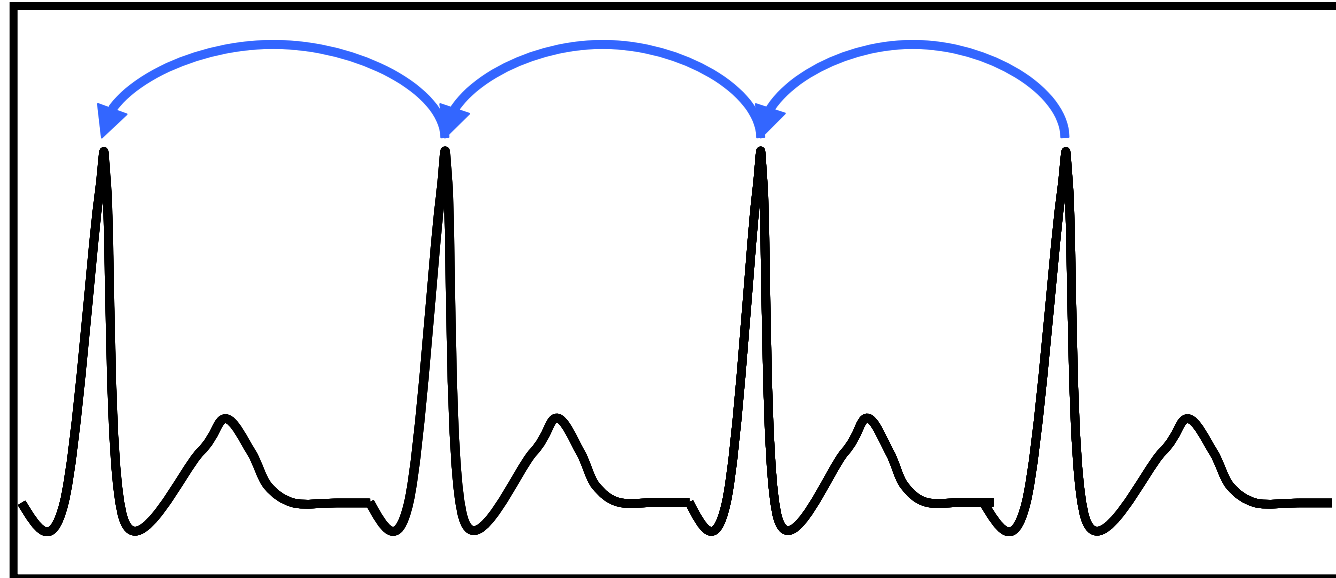
1. Static morphology analysis is used to identify *non-shockable* rhythms
 - NSR Template is used to determine if current rhythm is similar to the NSR morphology and width.



Algorithm Architecture

INSIGHT™ Algorithm: Dynamic CWA

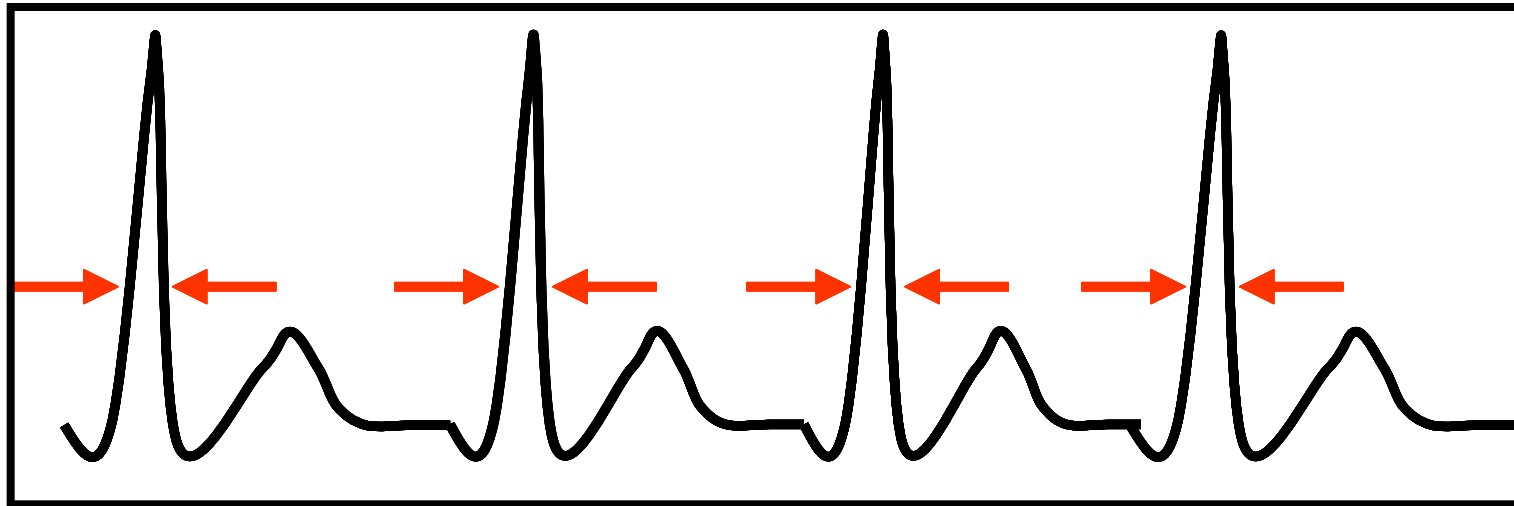
2. Dynamic CWA is used to quickly identify shockable polymorphic rhythms
 - Consecutive detections are compared to each other, not the NSR Template.



Algorithm Architecture

INSIGHT™ Algorithm: QRS Width

3. If Dynamic morphology analysis indicates similar beats, QRS **width** is used to label detections:
 - Normal: QRS Width narrower than the NSR Template
 - Tachy: QRS Width wider than the NSR Template



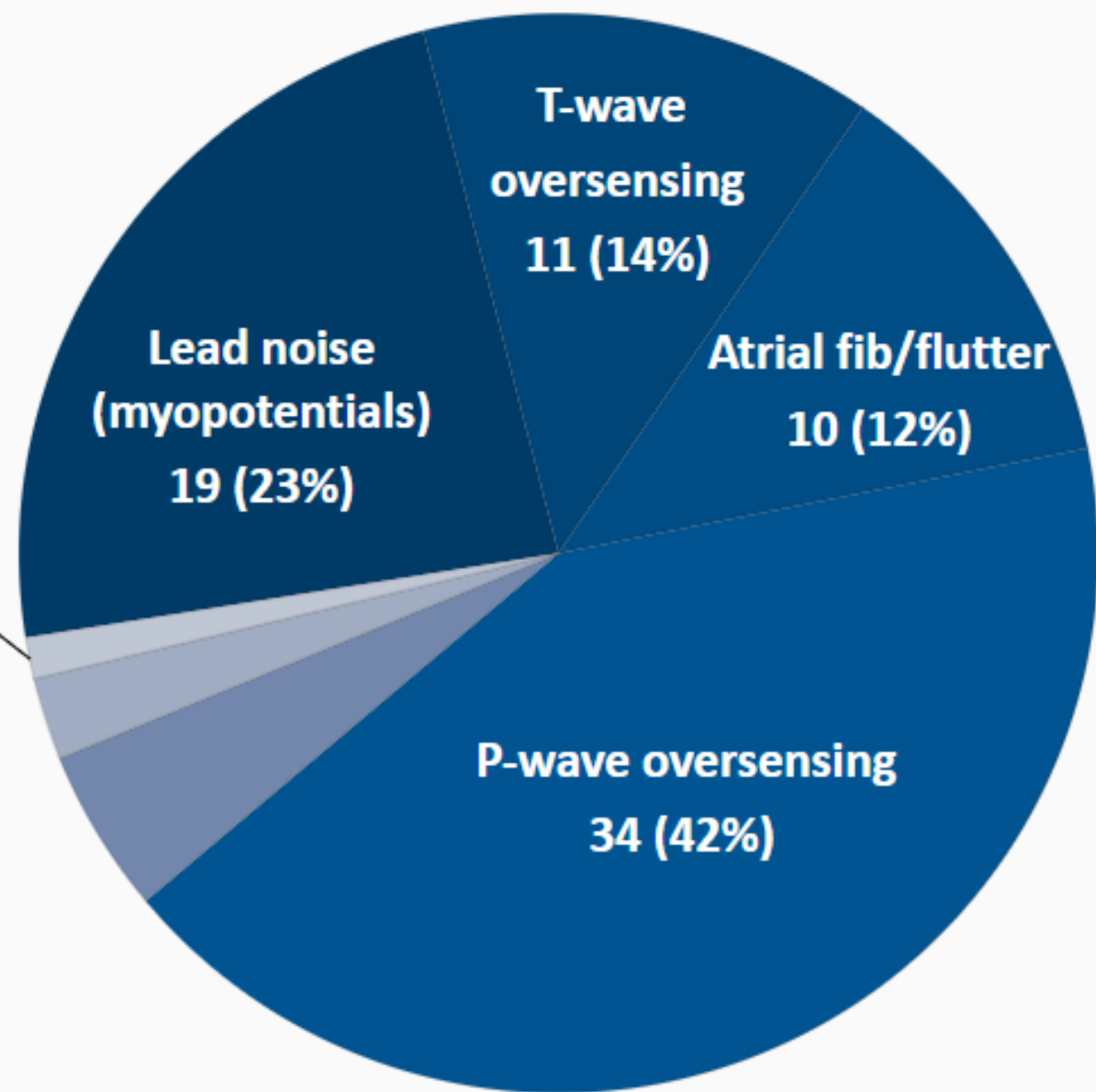
Inappropriate Shocks

- 29 patients at 10.6 months (9.7%)
- 81 episodes (118 shocks)

Non-sustained ventricular tachycardia
1 (1%)

Electromagnetic interference
4 (5%)

Other supraventricular/sinus tachycardia
2 (3%)



What in our center ?



1 PWOS, solved by reprogramming



1 lead dislodgement



2 myopotential oversensing, solved by programming



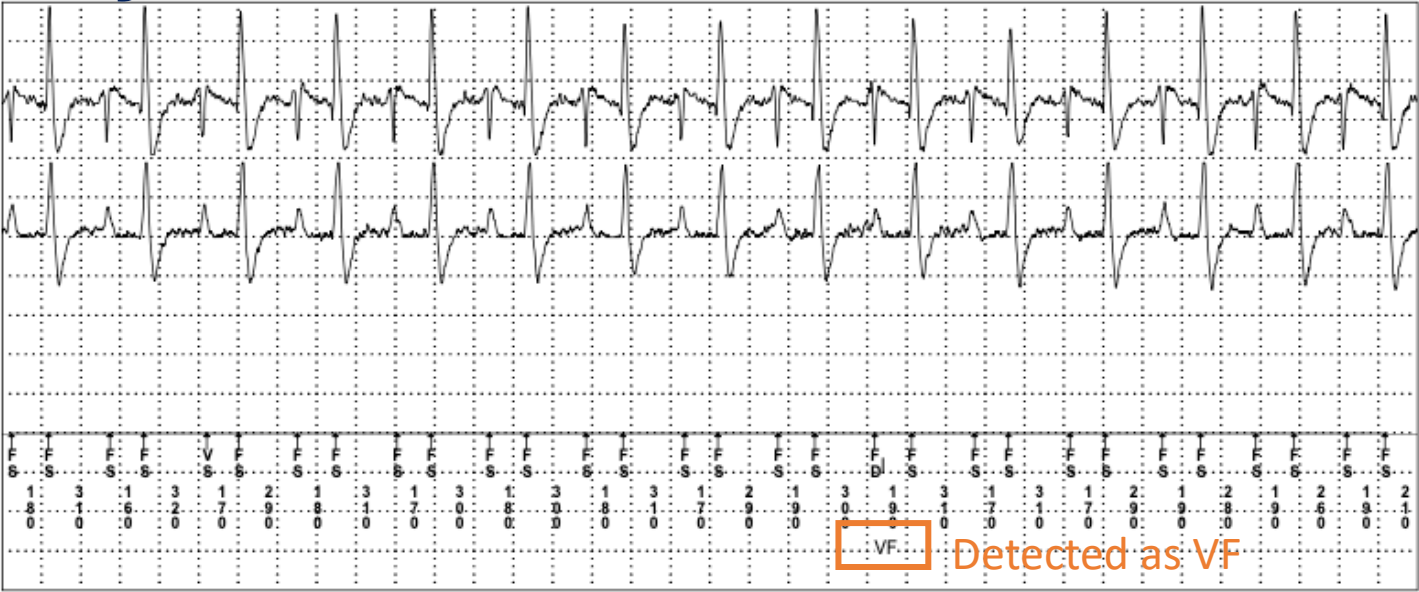
NO IAS since JAN 2024

Successful Rejection of PWOS

EV-ICD
Pivotal Study

Ring1Ring2

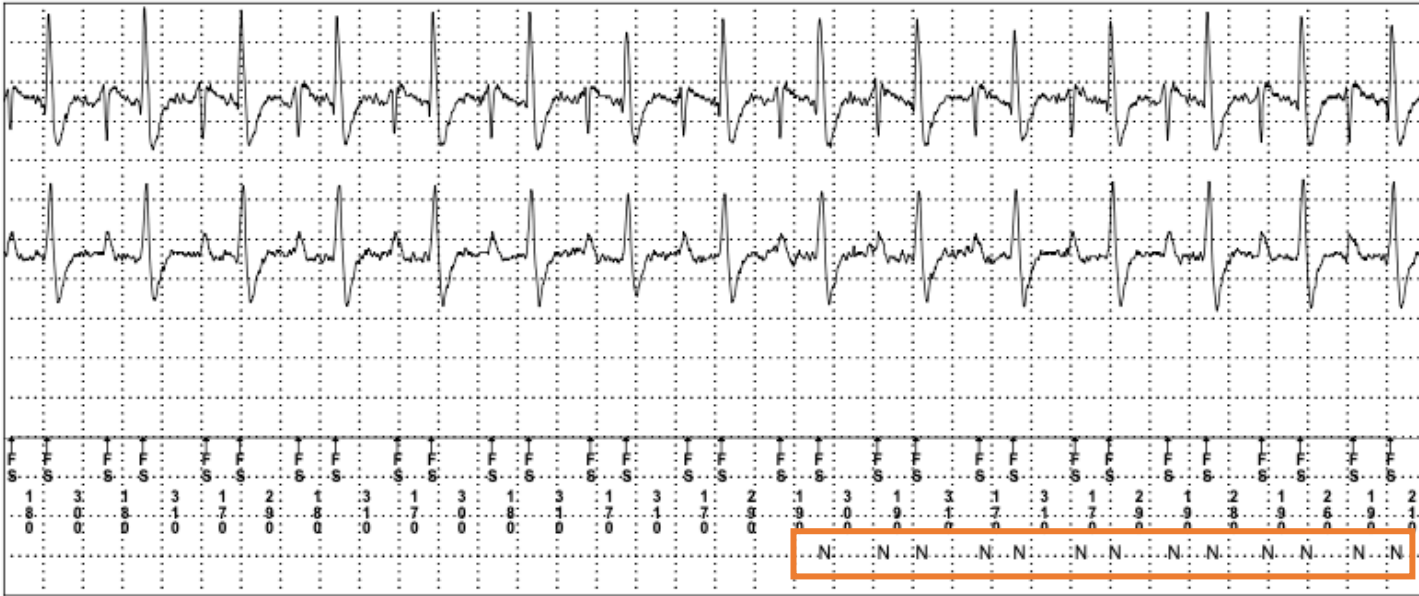
Coil2Coil1



EV-ICD with
PWOS Algorithm

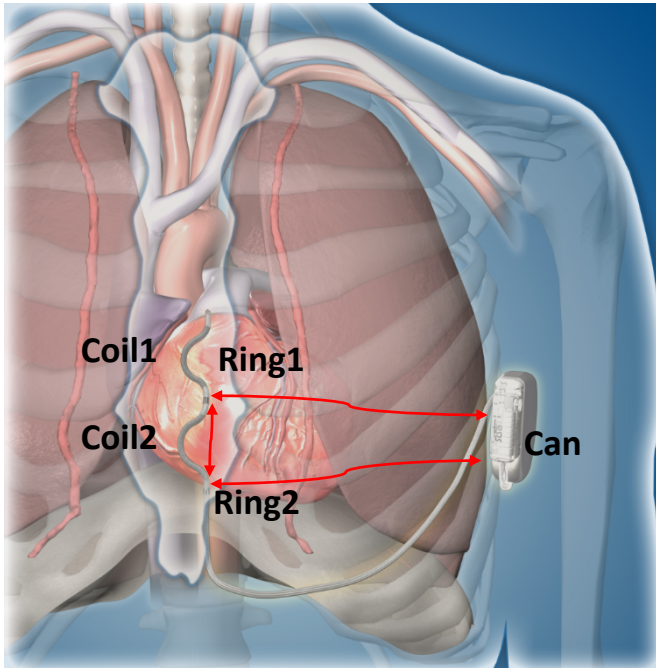
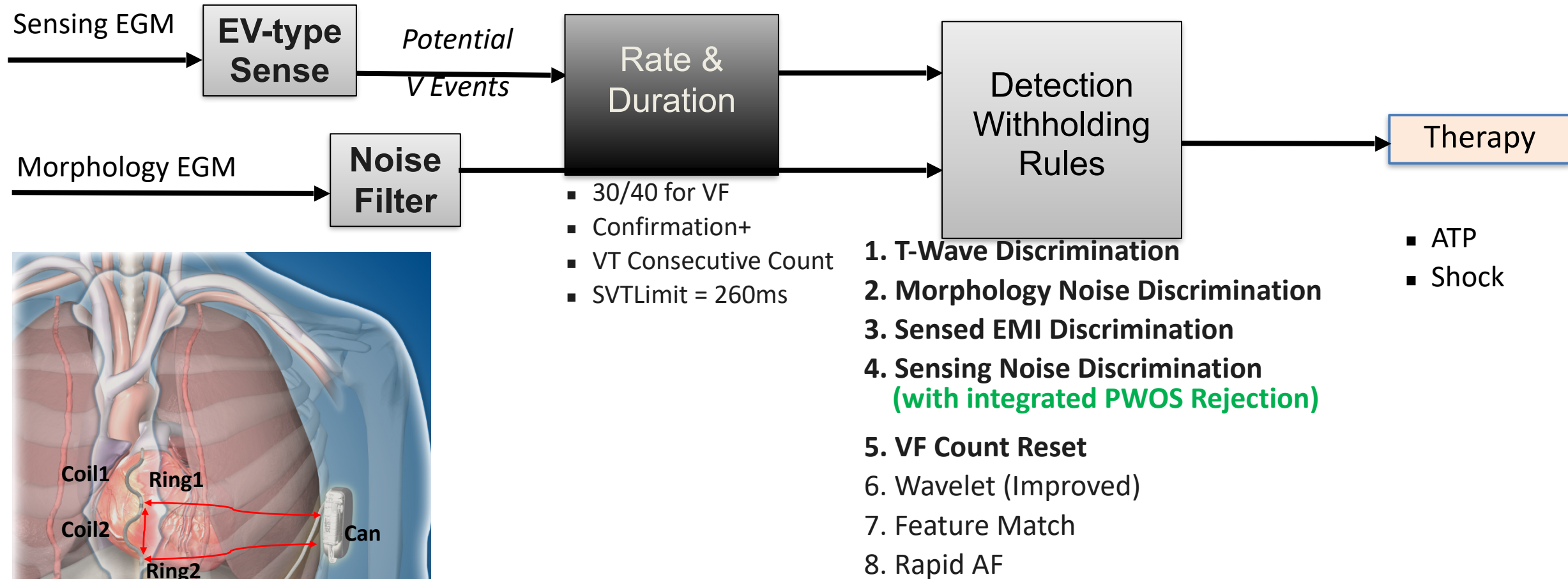
Ring1Ring2

Coil2Coil1



Withheld
as noise

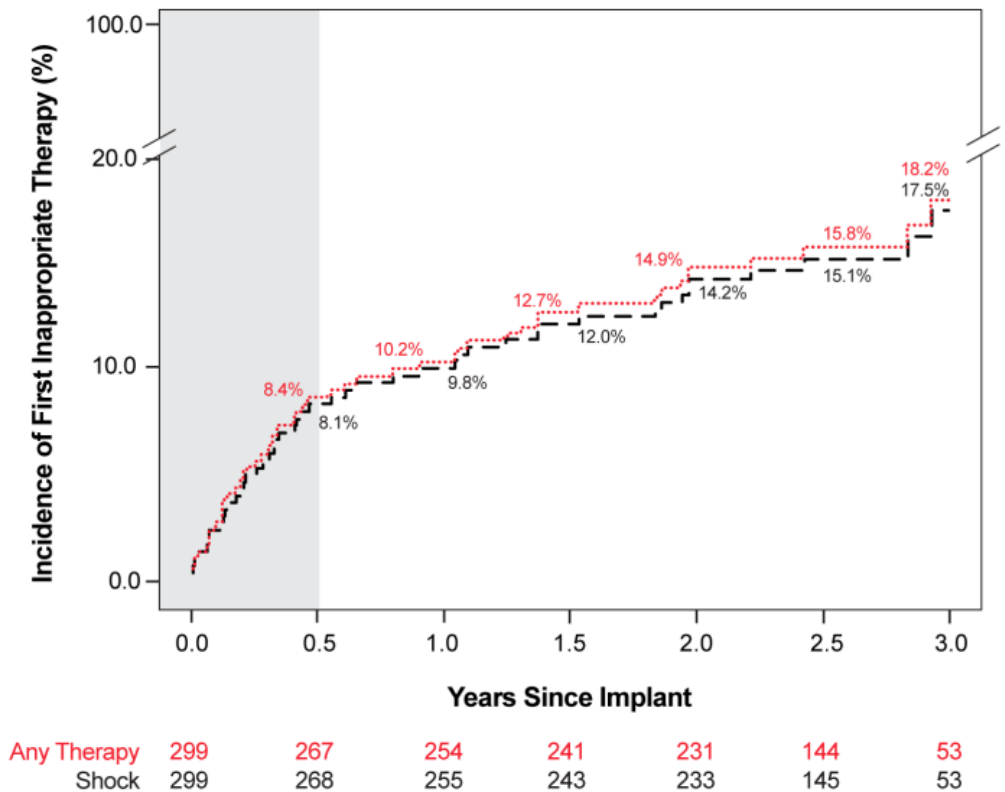
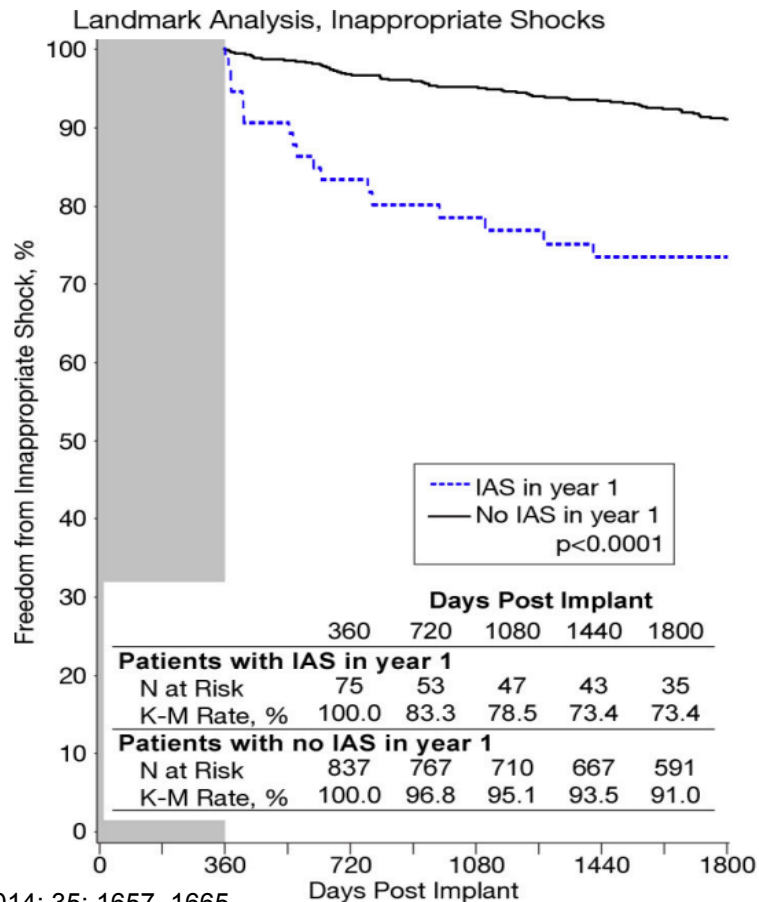
EV-ICD Sensing & Detection Architecture



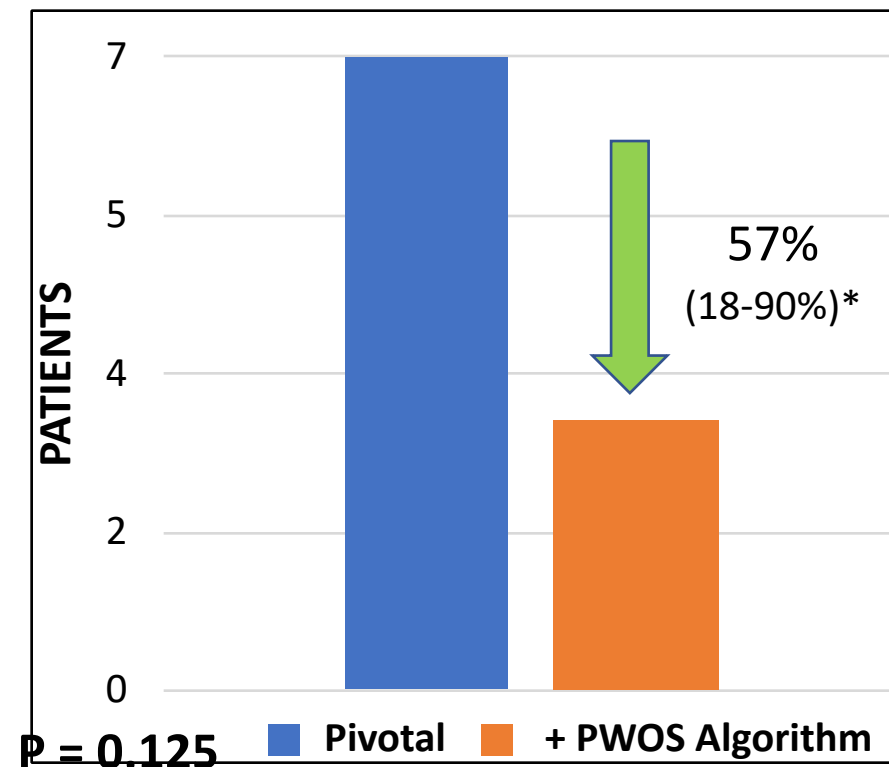
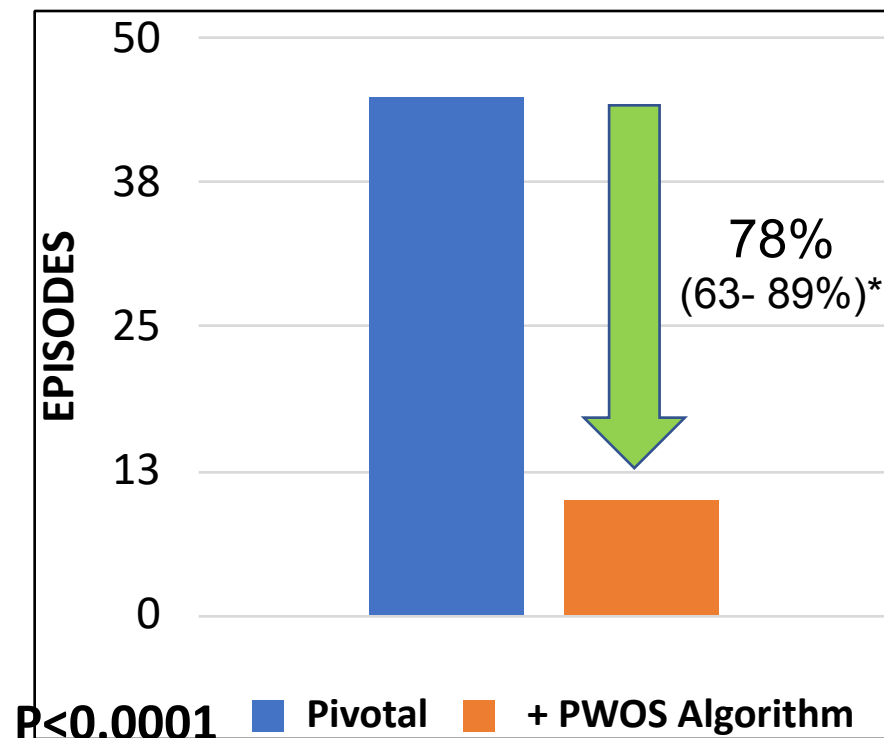
S-ICD

Extravascular ICD

Inappropriate Therapy Delivery: S-ICD cannot improve,
while EV DOES !!!!



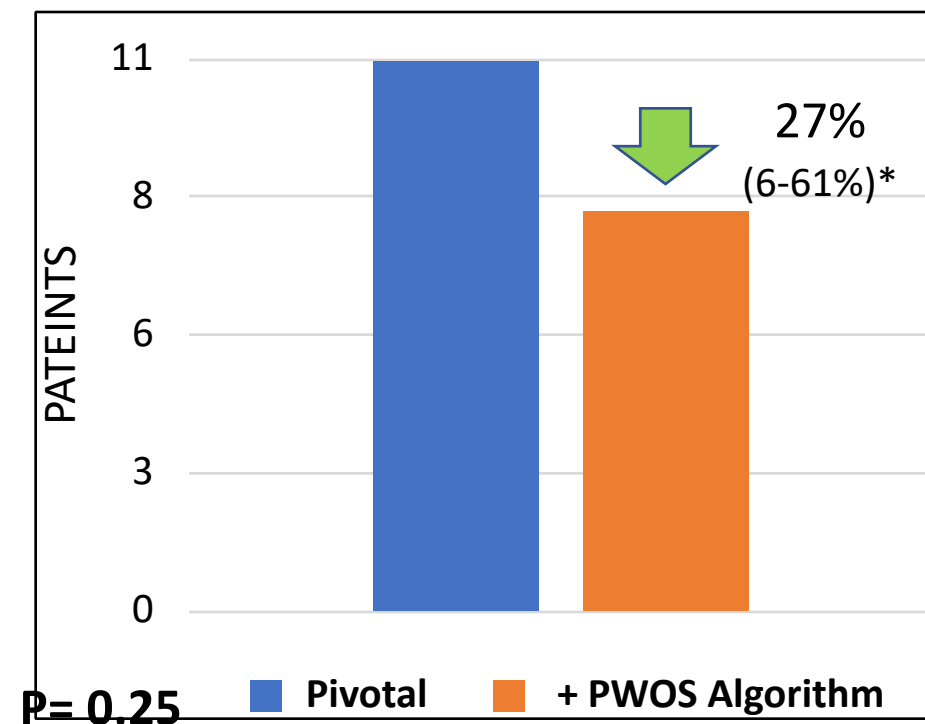
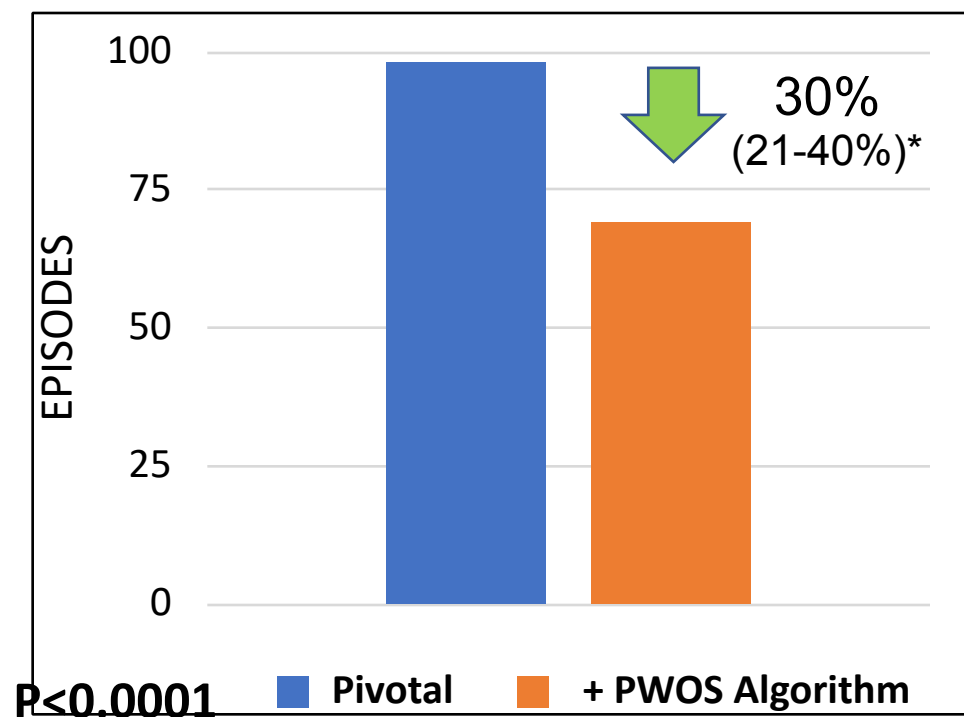
Effect of PWOS Algorithm on Inappropriate Detection of VT/VF due to PWOS



- Risk of inappropriate detection not statistically different between software emulation and device bench testing ($p=0.31$).

* 95% Confidence Interval

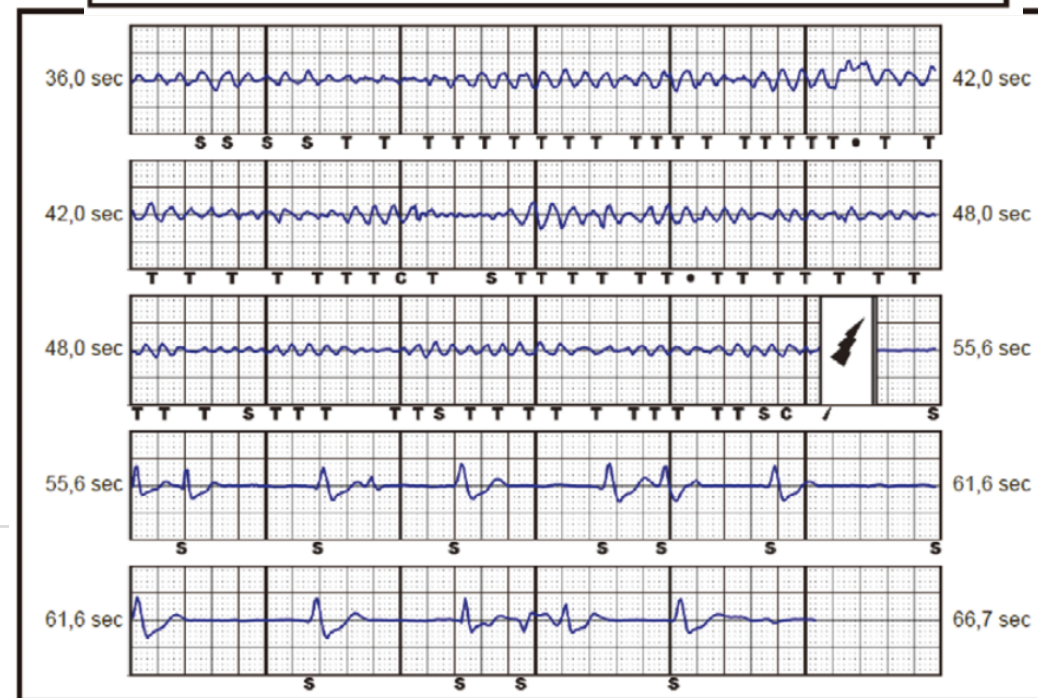
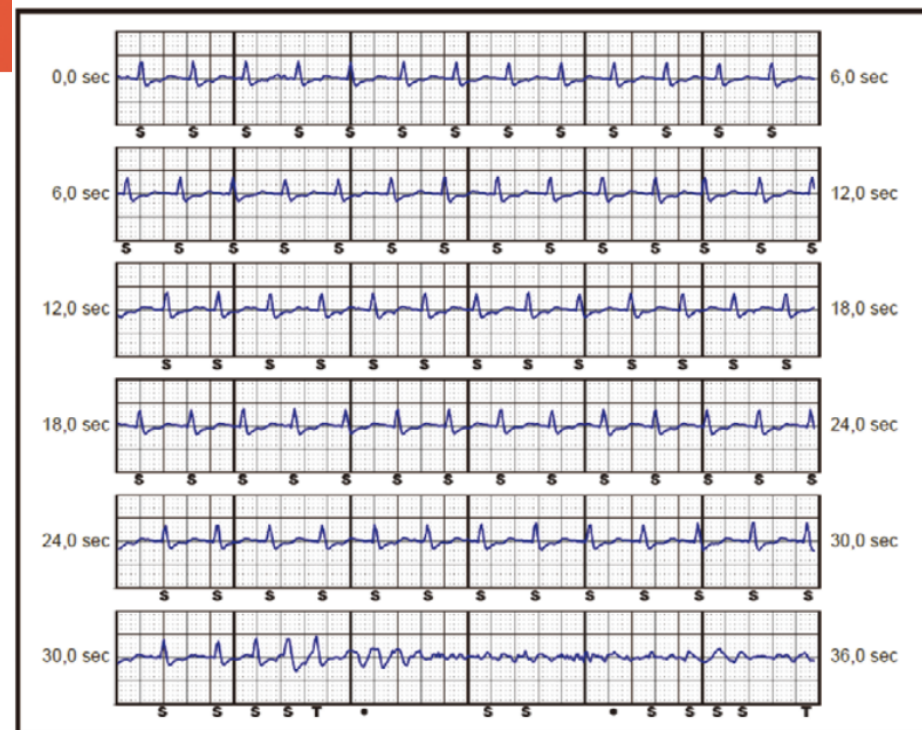
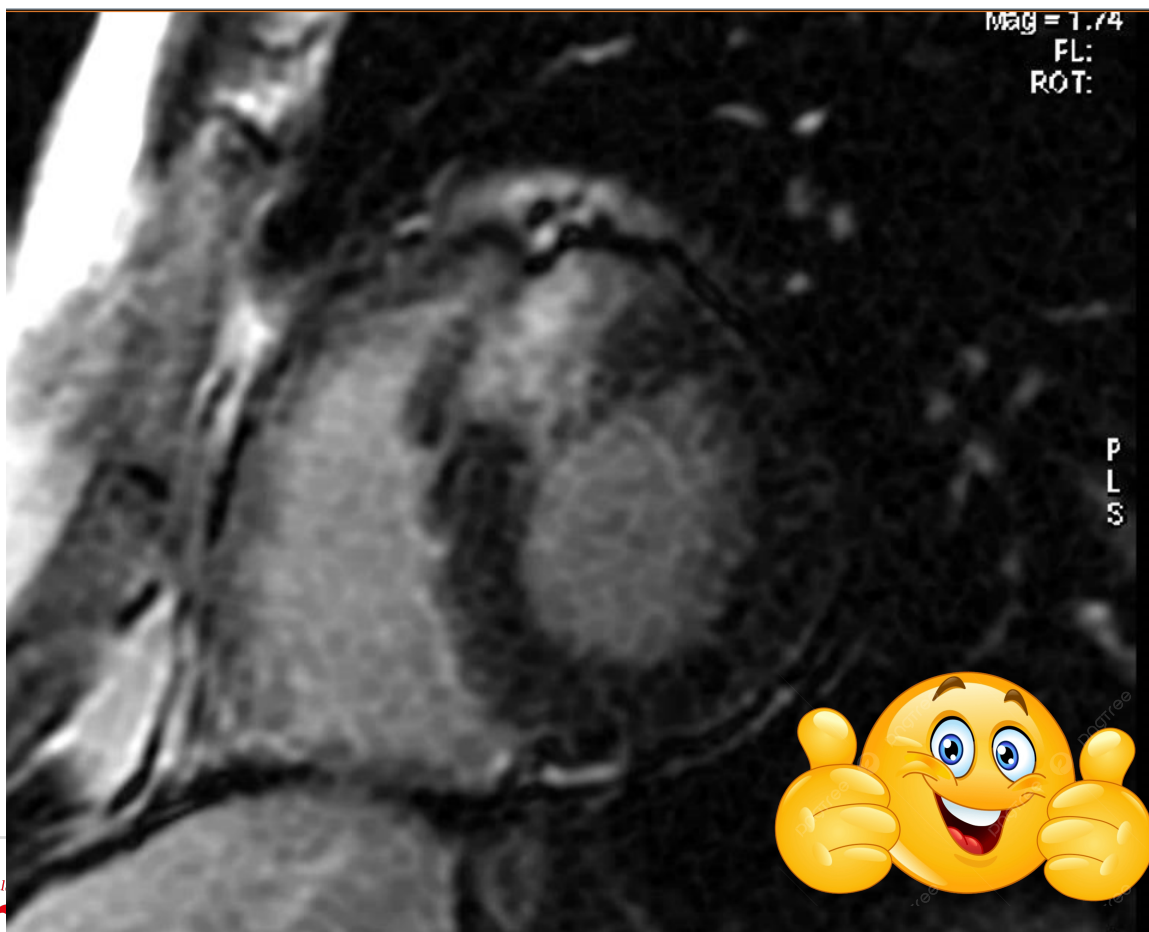
Effect of PWOS Algorithm on Inappropriate Detection of VT/VF due to Noncardiac Oversensing



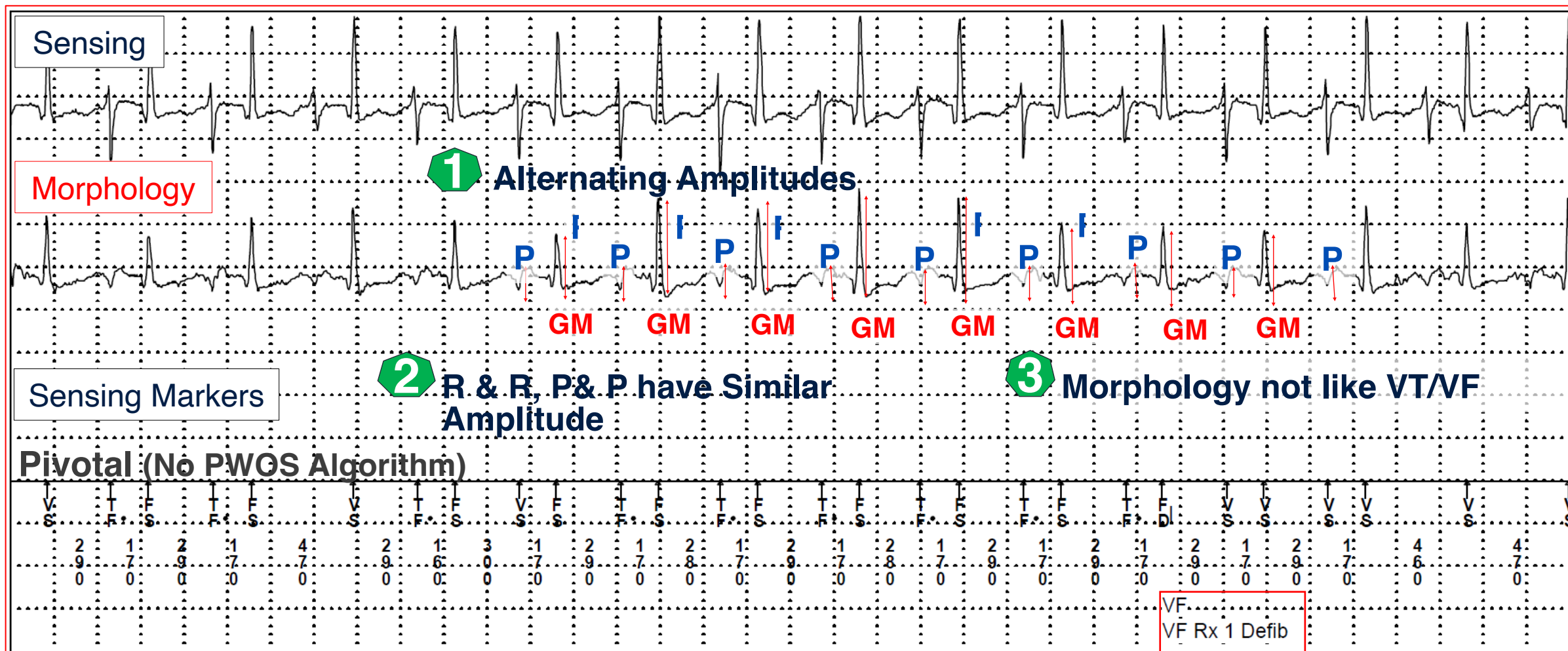
* 95% Confidence Interval

EF = 70 %, MYBPC3

the smaller the substrate, the faster the arrhythmia



PWOS Rejection Algorithm Features



PWOS Algorithm ON:

N N N N N N N

GOALS of Programming



Reliably detect VA



NO IAS



USE RING1-RING2 vector



MINIMIZE Noise detection as NSVT

Brugada Patient with recurrent shocks by an S-ICD due to poor signal in all vectors.
 Implanted with a 0.7-0.9 mV amplitude after 3 tunnelizations

Absence of IAS along 1.5 years FU,
 oversensing managed by the algorithm

Measured R wave
 Programmed Sensitivity

2.1 mV
 0.15 mV

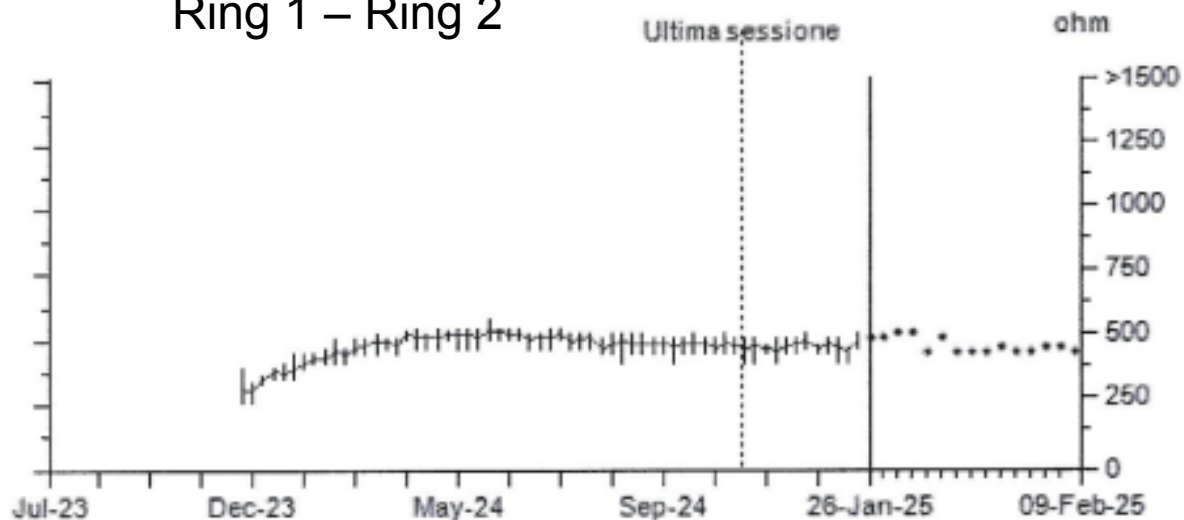
Monitorati

VT (146-182 min ⁻¹)	0	
VT-NS (>4 battiti, >182 min ⁻¹)	1,373	
SVT: Rx VT/VF trattenuta	0	
Oversensing V: Rx VT/VF trattenuta	6	Witheld episodes

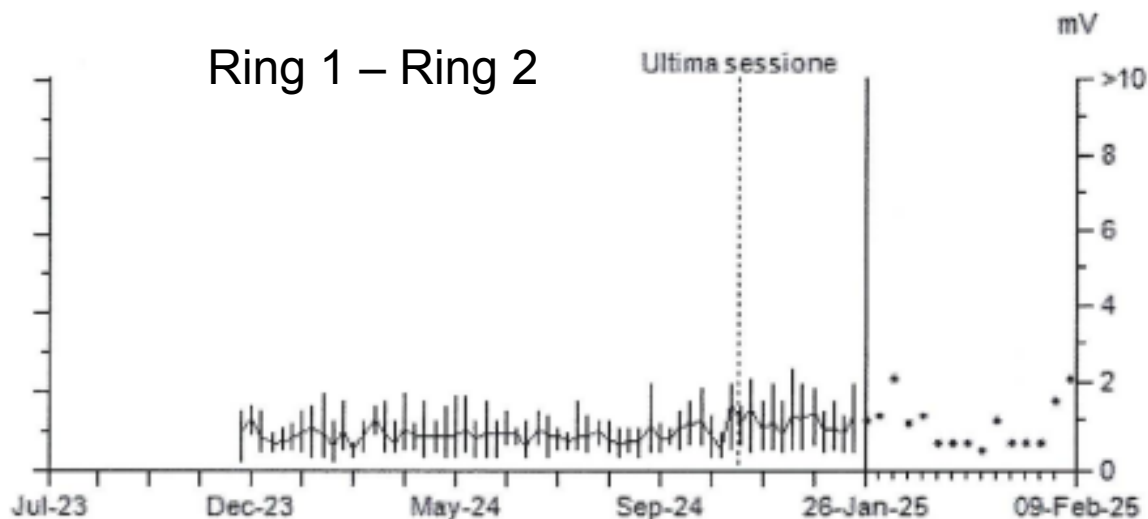
Prevenzione pause

Conteggio episodi	1
-------------------	---

Ring 1 – Ring 2



Ring 1 – Ring 2



Ultime 80 settimane (min/max/media per settimana)

ultimi 15 gg.

SMALL (0.6-1.3 mV) R wave programming

V. Detection

		Initial	Redetect	V. Interval (Rate)
VF	On	45/60	12/16	280 ms (214 bpm)
FVT	via VF			240 ms (250 bpm)
VT	On	100	12	340 ms (176 bpm)
Monitor	Monitor	110		400 ms (150 bpm)

SVTV Limit = 260 ms

Wavelet

Wavelet...	On
Rapid AF	On
Feature Match	On
SVT V. Limit	260 ms
VF Count Reset	On

Other Enhancements

Stability	Off
Onset...	Monitor
High Rate Timeout...	1 On
TWave	On
Noise...	Timeout

Sensing...

0.150 mV

Sensing

Sensitivity	0.150 mV
Sense Polarity	Ring 1 to Ring 2
Blank after Sense	140 ms
Sensing Threshold Decay Delay	360 ms
Sensing Threshold Drop Time	1500 ms
Oversensing Prevention	5

Rephrase your sentence

**Who is Contraindicated to an
Extravascular ICD ?**



Previous sternotomy



CRT or pacing indications



Previous pericarditis ??



Mediastinal view at left sternum border: see bone thickening *



Parenchymal view at left sternum border: see bone thickening *

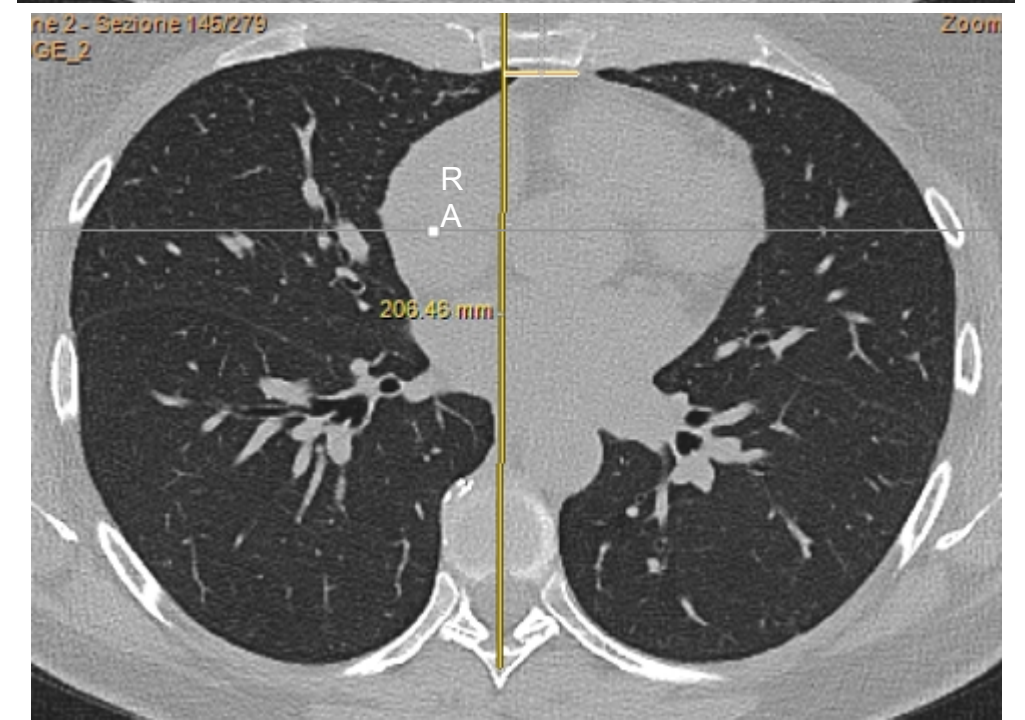
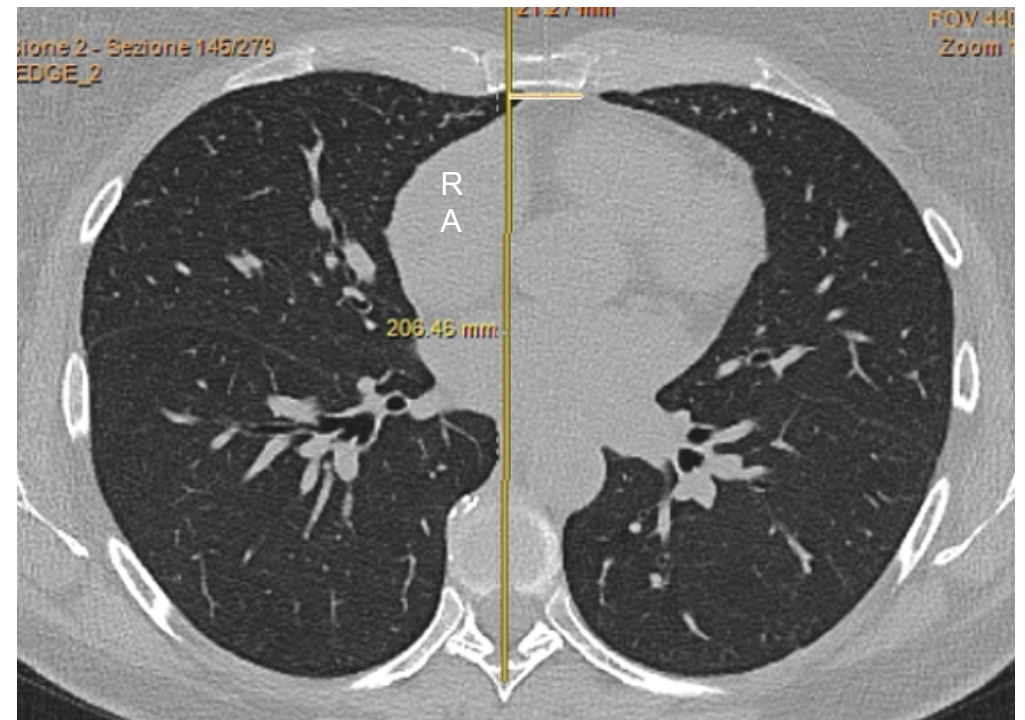
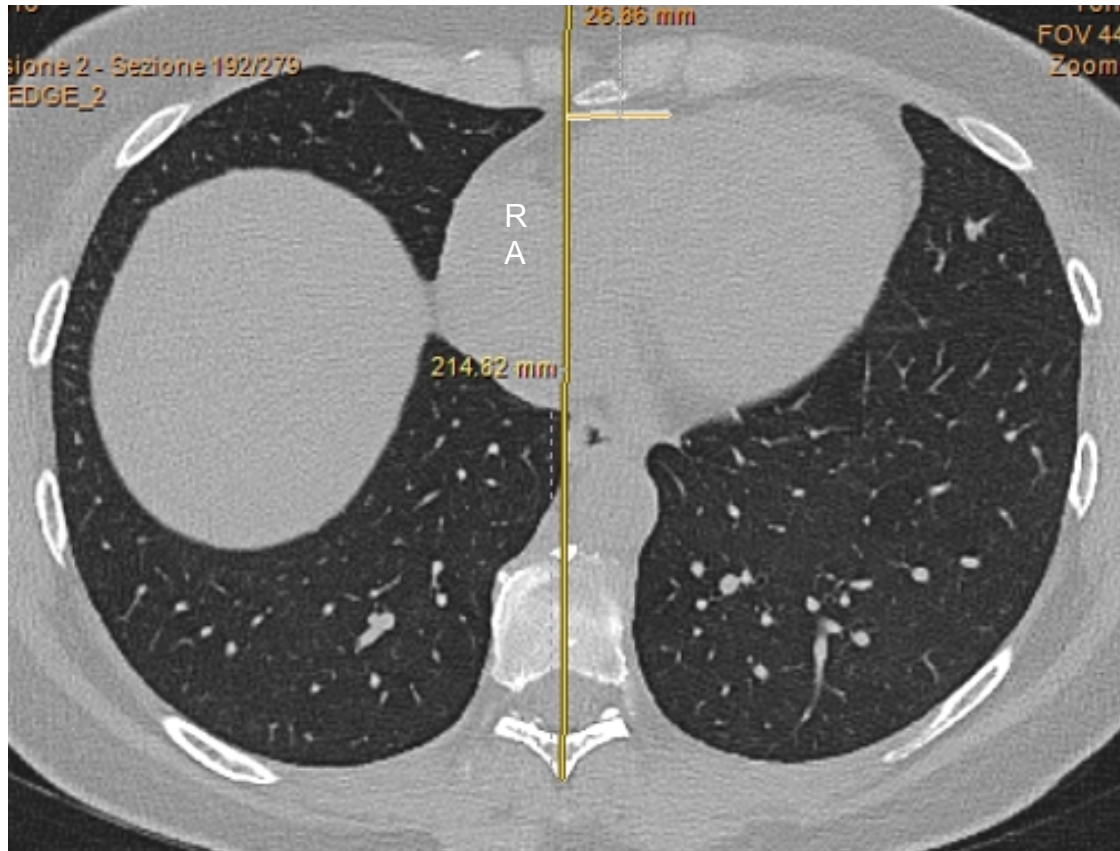


Left Border of the sternum: see bone thickening



Sternum-rib junction: bony spur and thickening

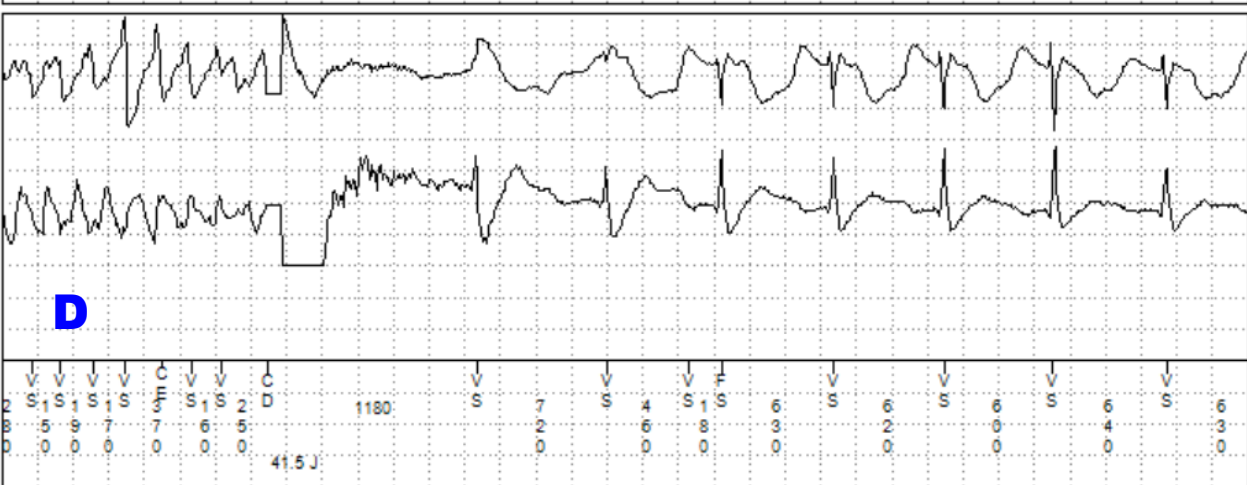
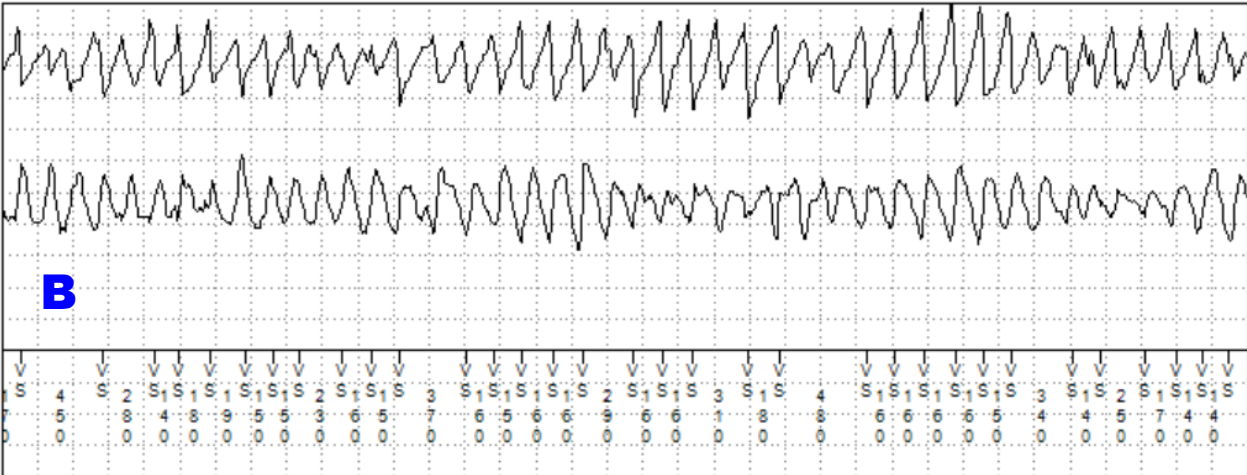
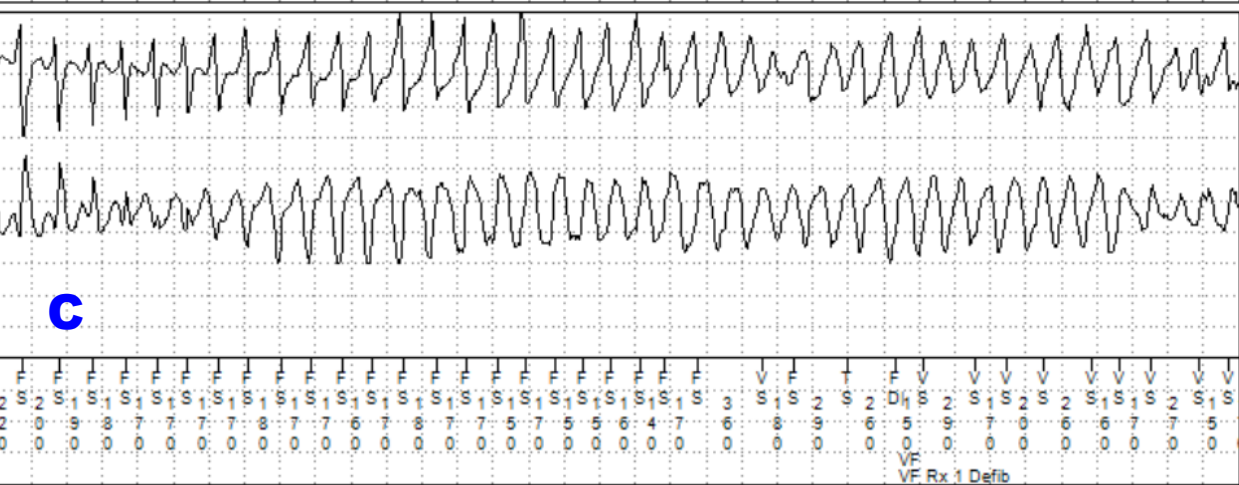
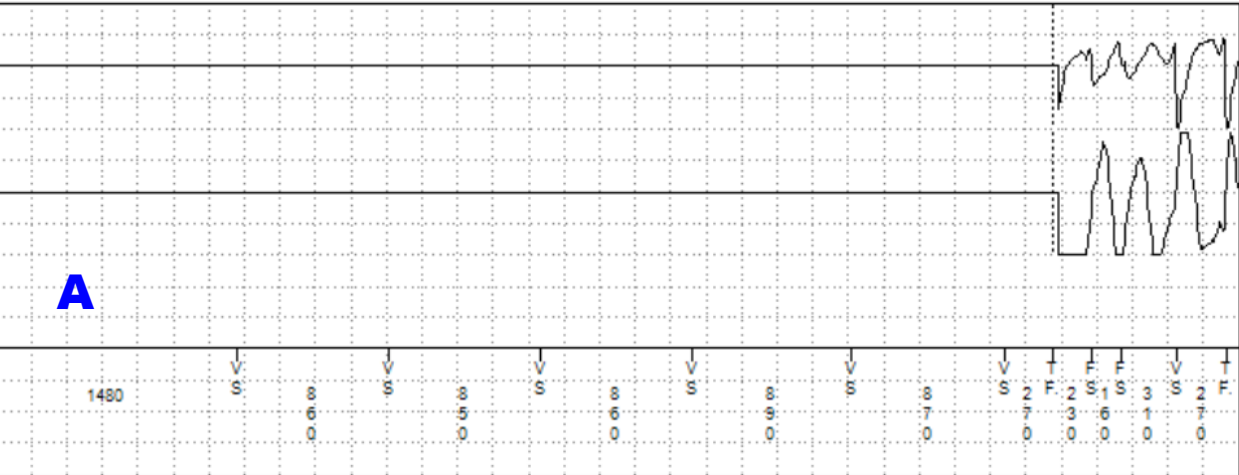
Avoid P-wave oversensing: Right atrium size and location



27 yrs old man, resuscitated CA, no heart disease, possible Brugada. Genetic evaluation ongoing

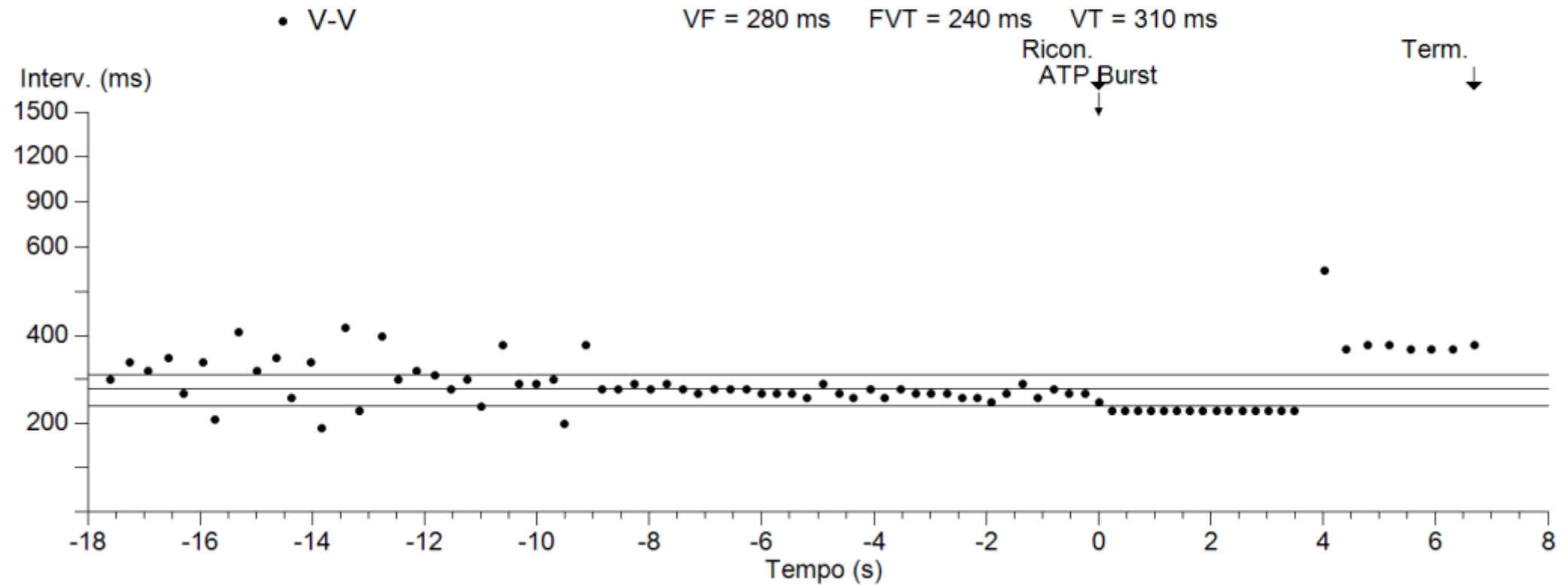
3 MONTHS after Implantation

Tipo	ATP Seq	shock	Succ.	ID#	Data	Ora hh:mm	Durata Media min-1 hh:mm:ss	Max min-1 V	Max min-1 V
VF	0	40J	SI	6	02-Jan-2025	04:08	:20	222	353

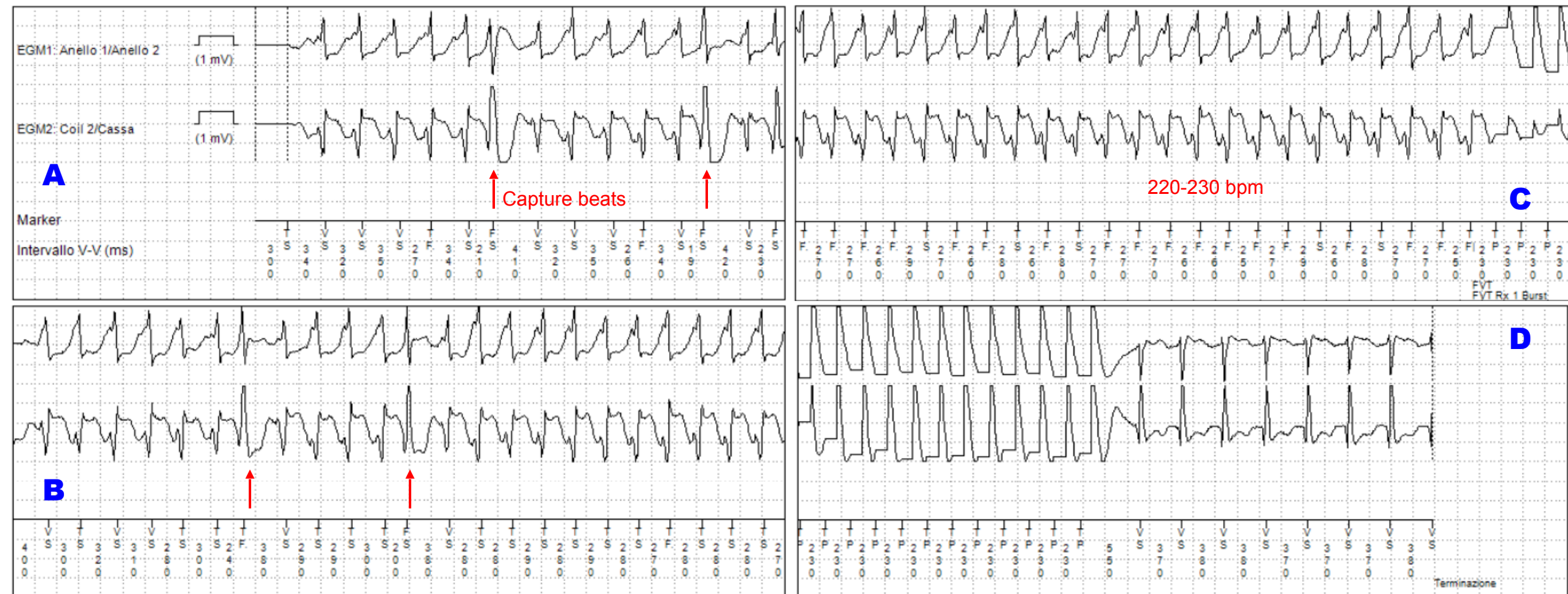


12 DAYS LATER, during exercise, no symptoms

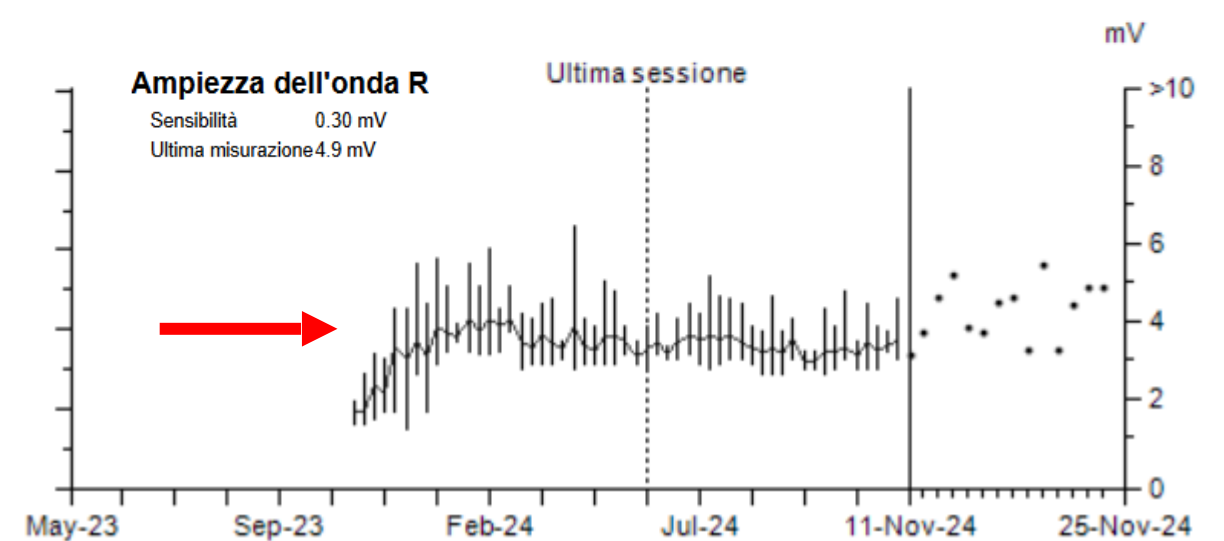
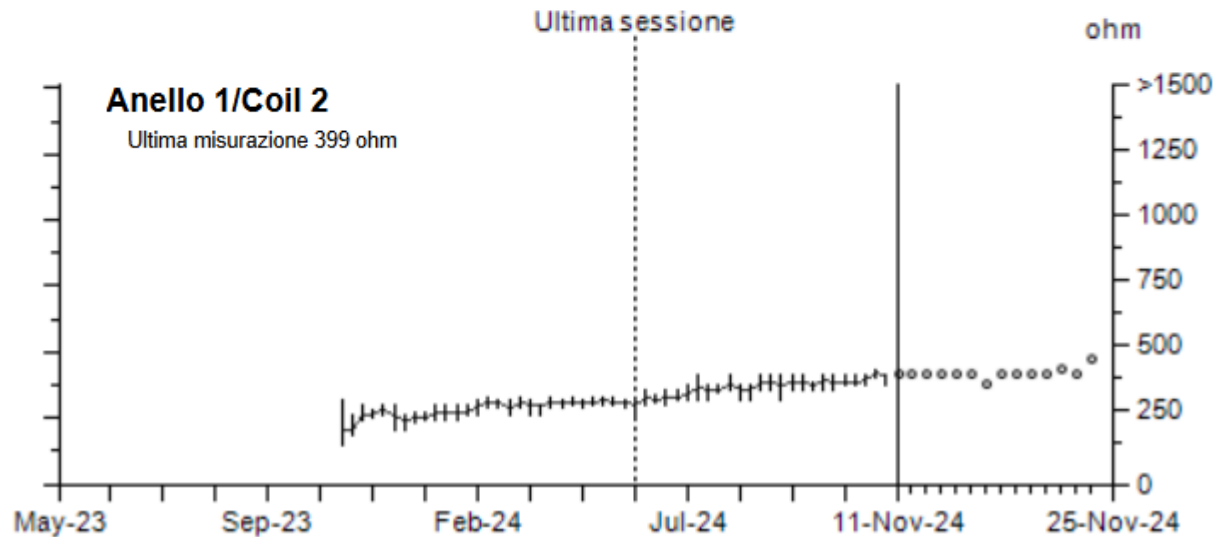
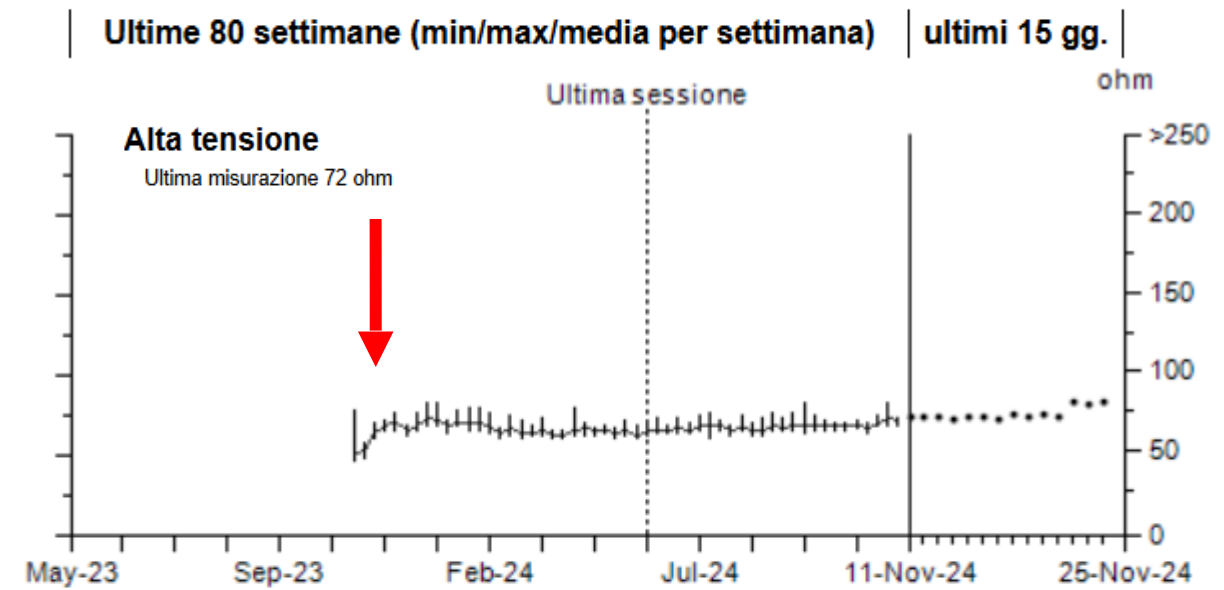
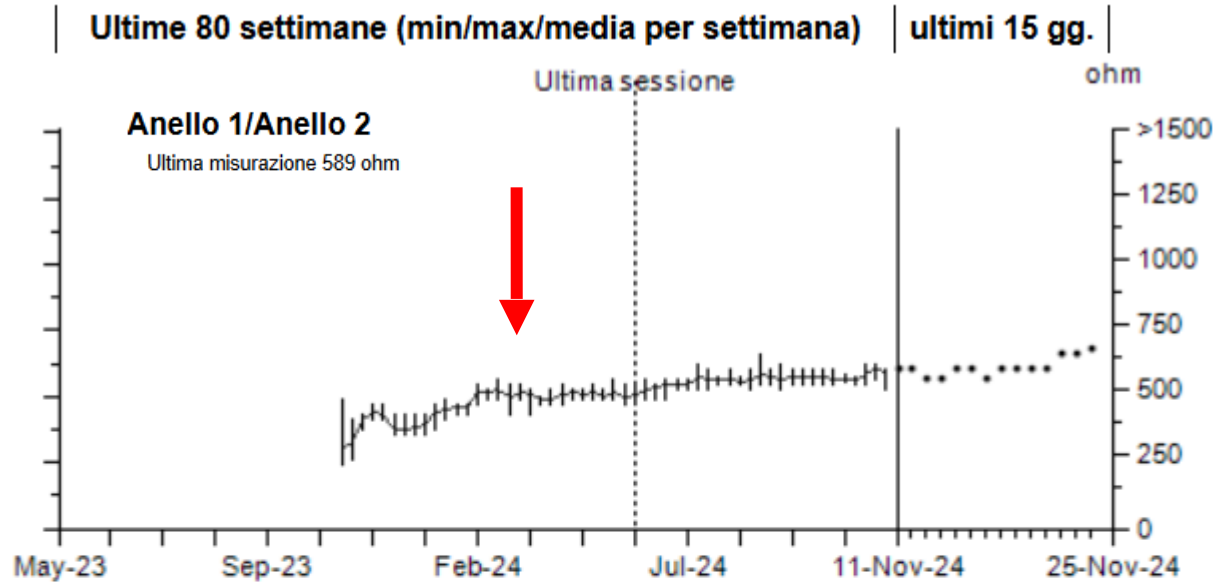
Tipo	ATP Seq	shock	Succ.	ID#	Data	Ora hh:mm	Durata hh:mm:ss	Media min ⁻¹ V	Max min ⁻¹ V
FVT	1		Si	7	14-Jan-2025	11:01	:25	231	---



The (UN...)expected advantage of ATP: rather have it on board !



R wave at follow up, air reabsorption

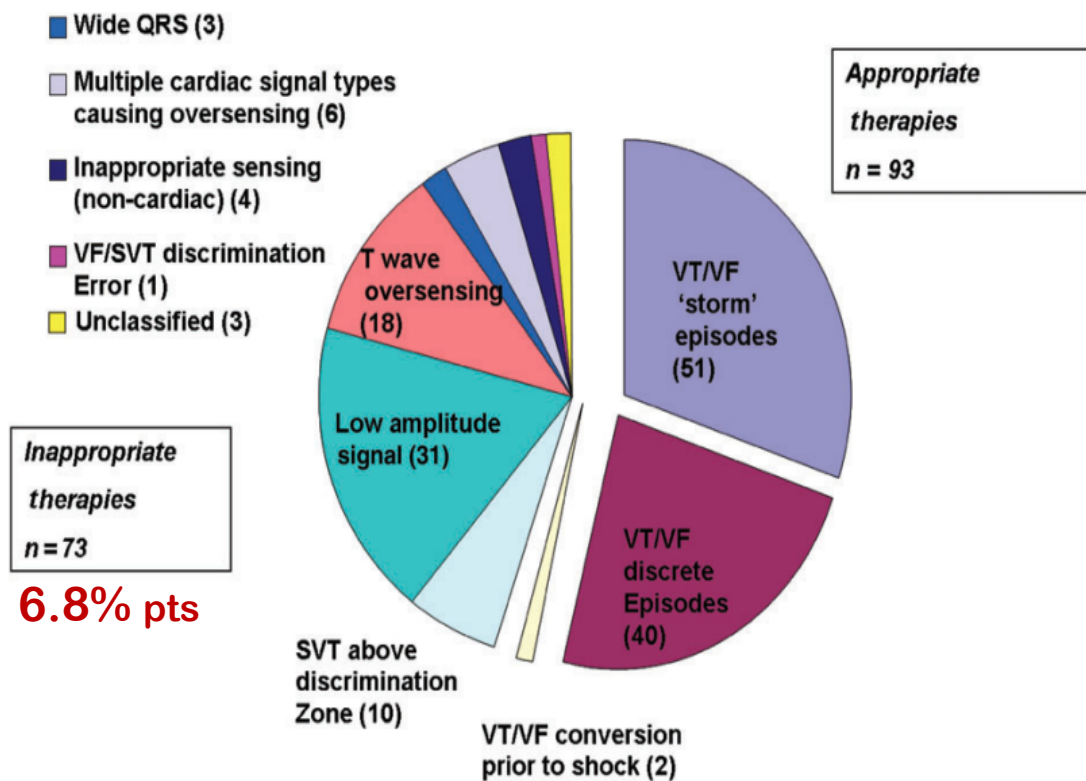


S-ICD

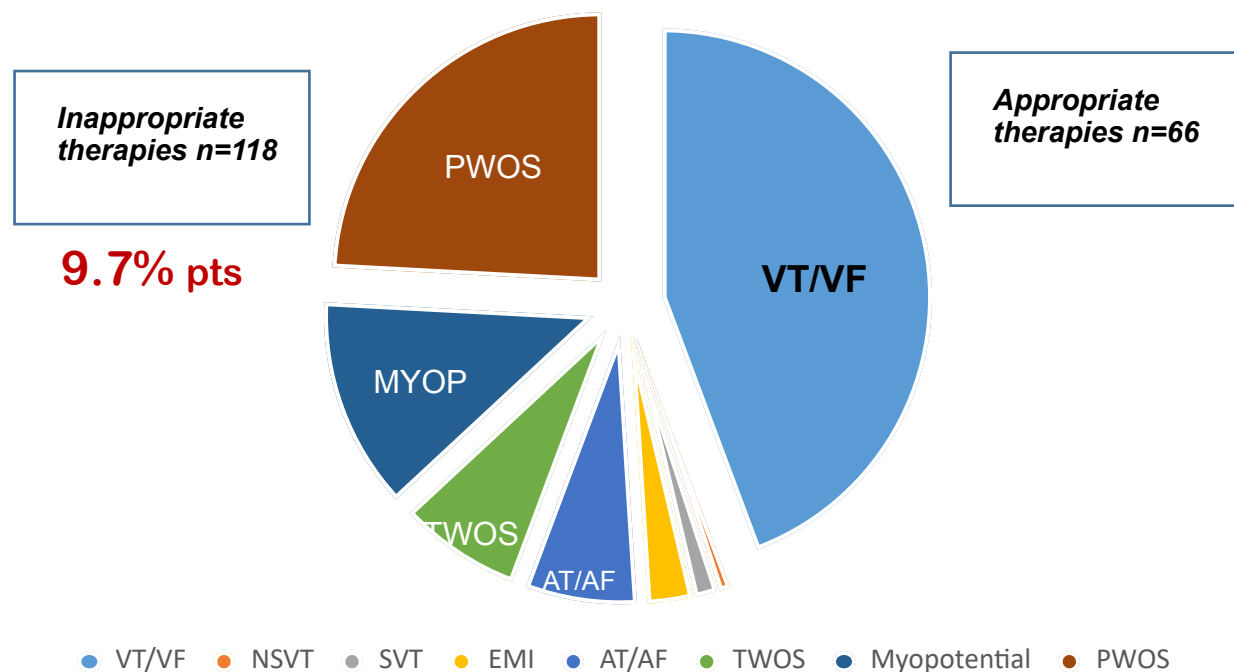
Extravascular ICD

Delivered therapy

EFFORTLESS, 472 patients



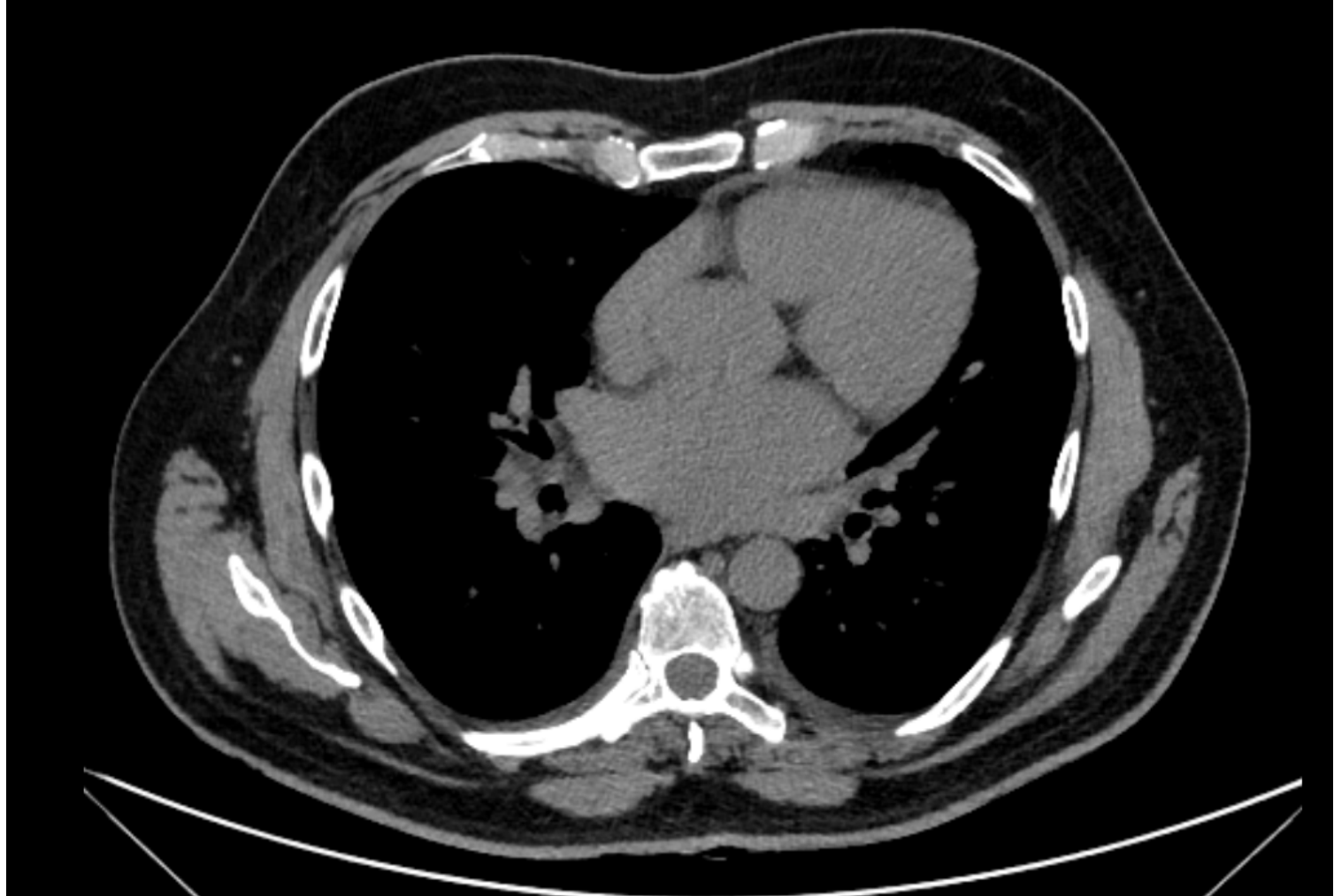
PIVOTAL, 299 pts

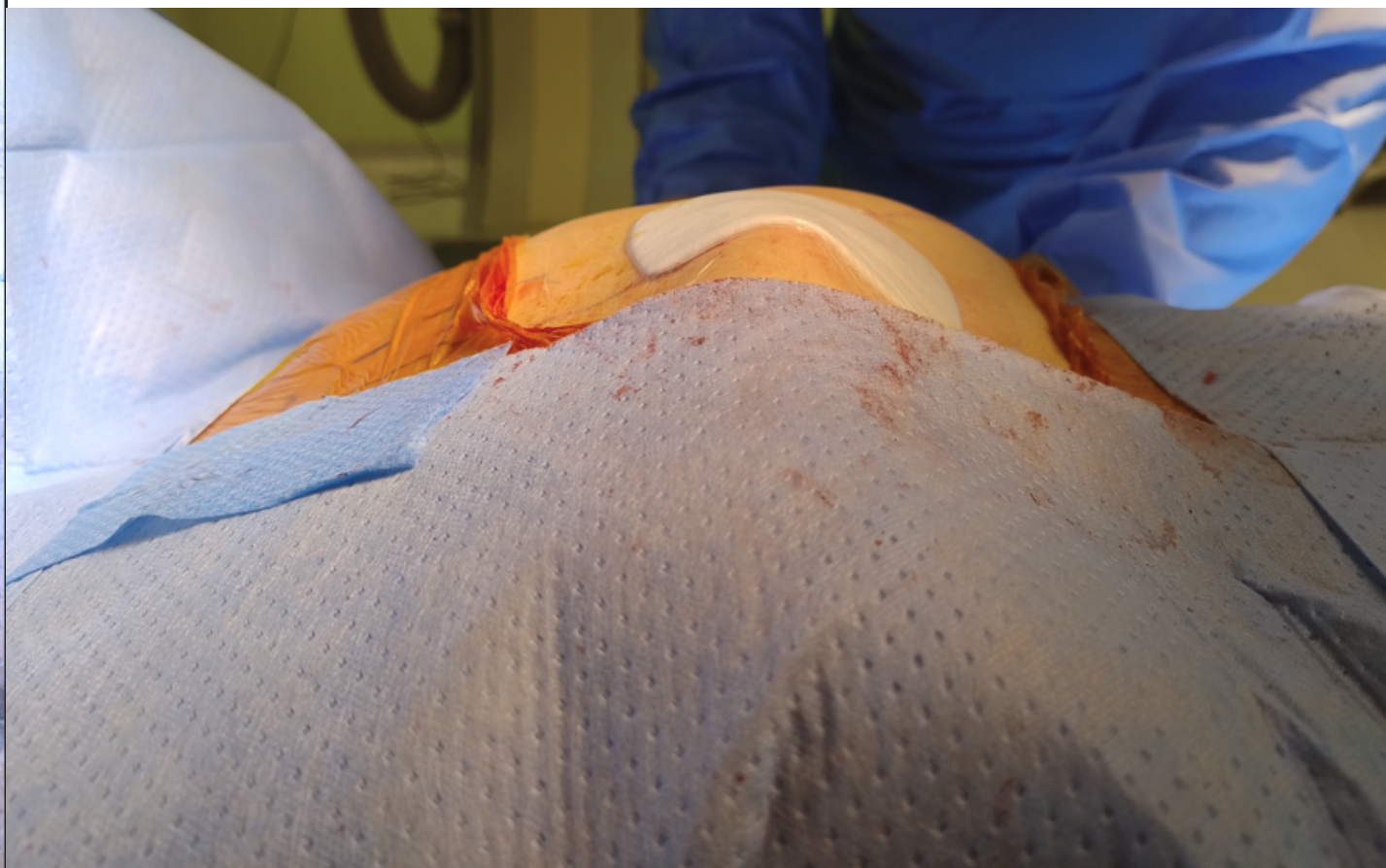
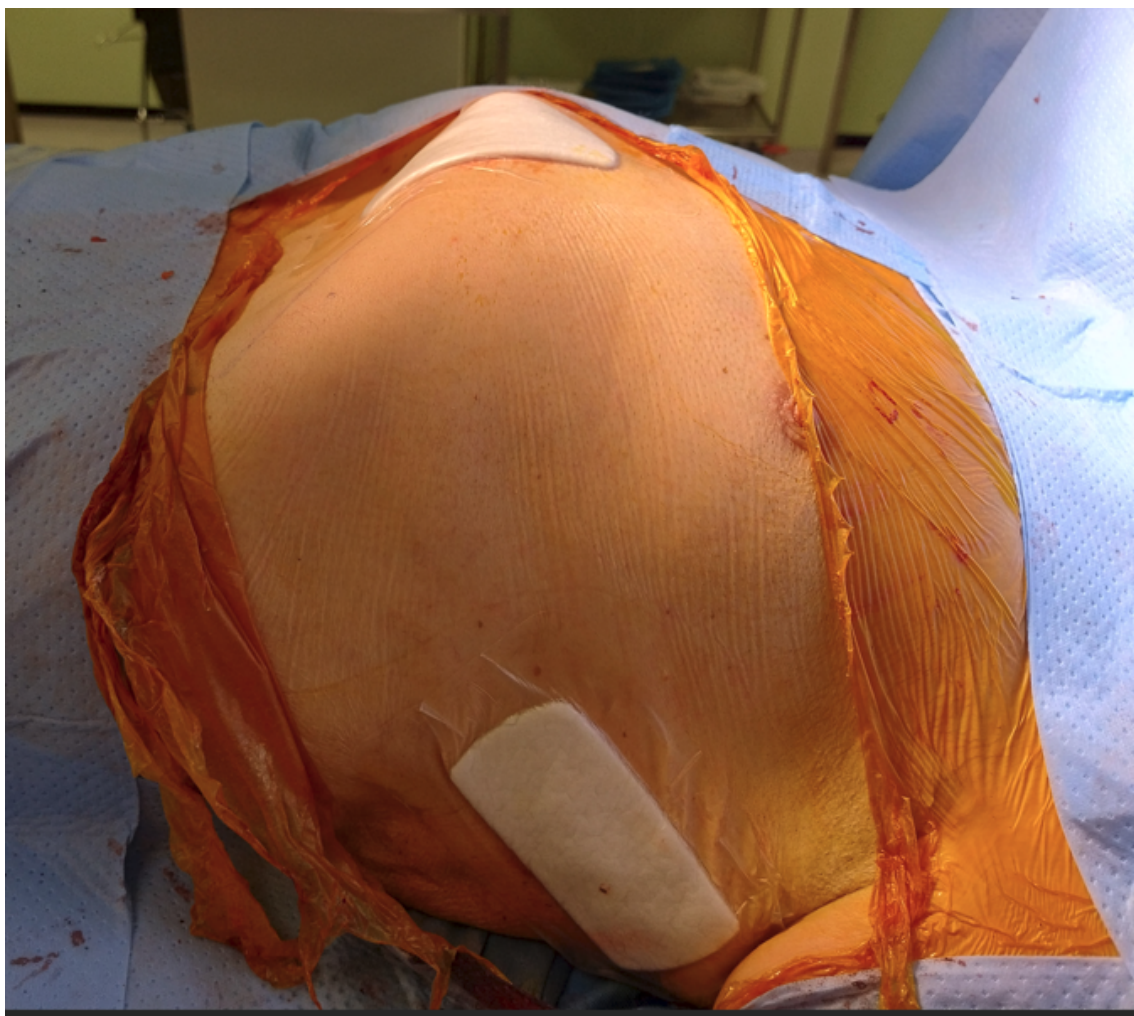


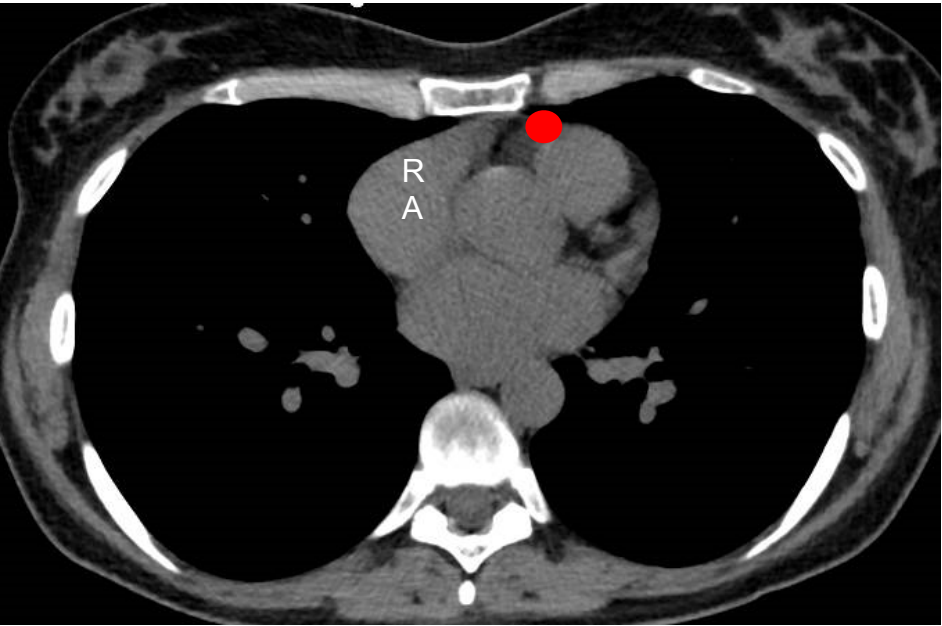
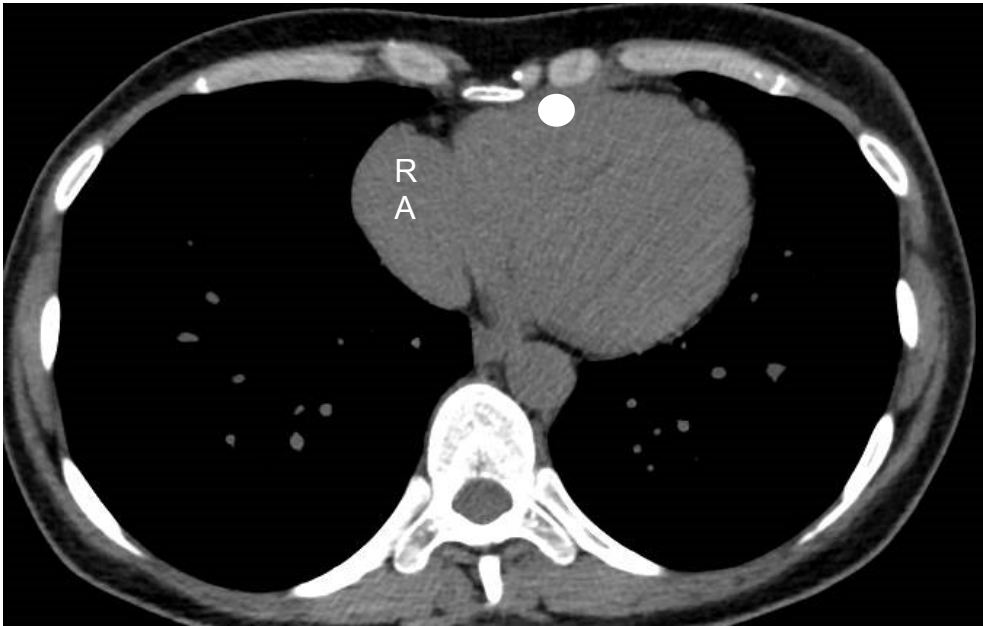
GET FAMILIAR WITH CT SCAN : **CT-GUIDED IMPLANTATION**

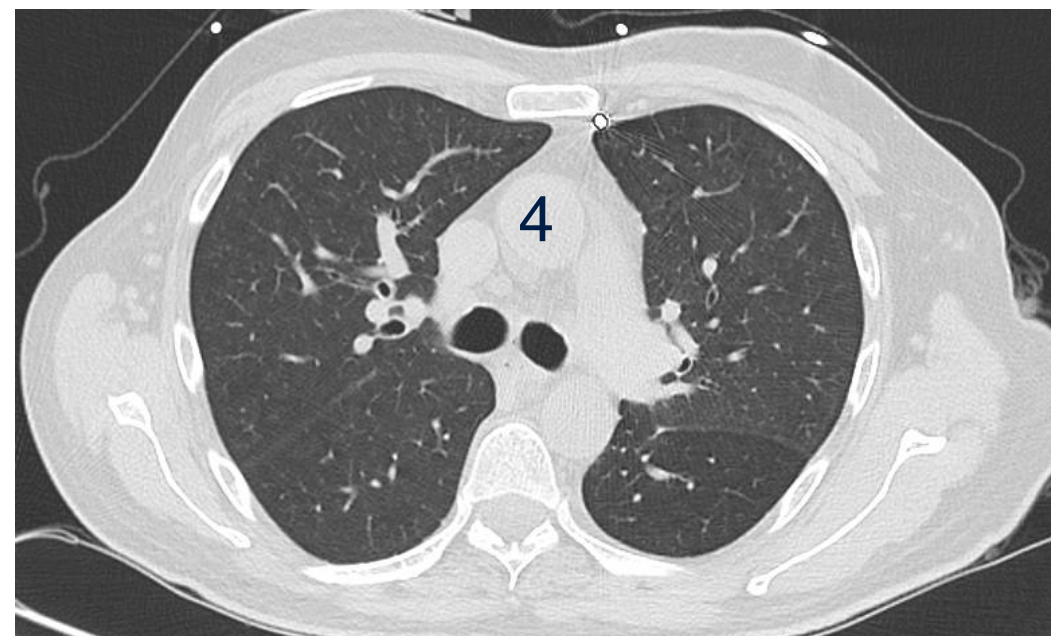
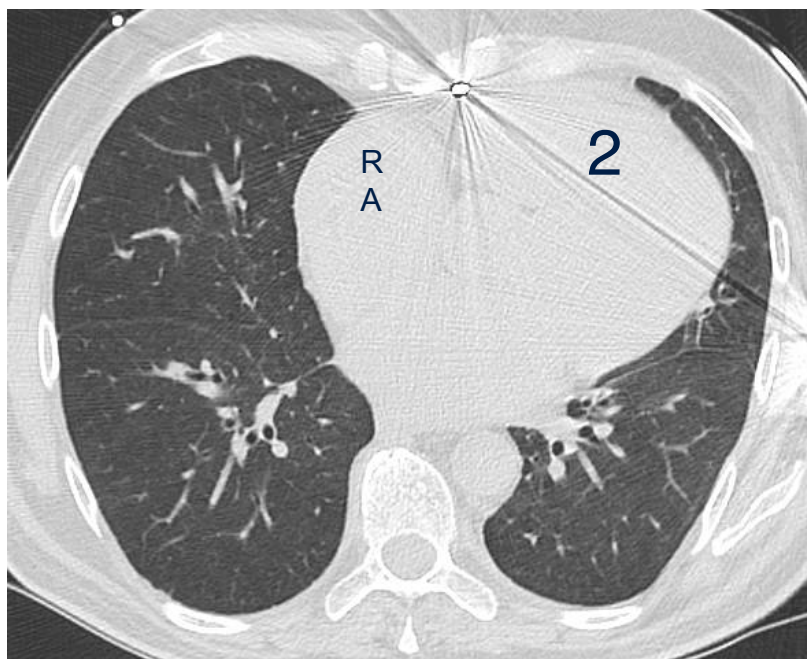
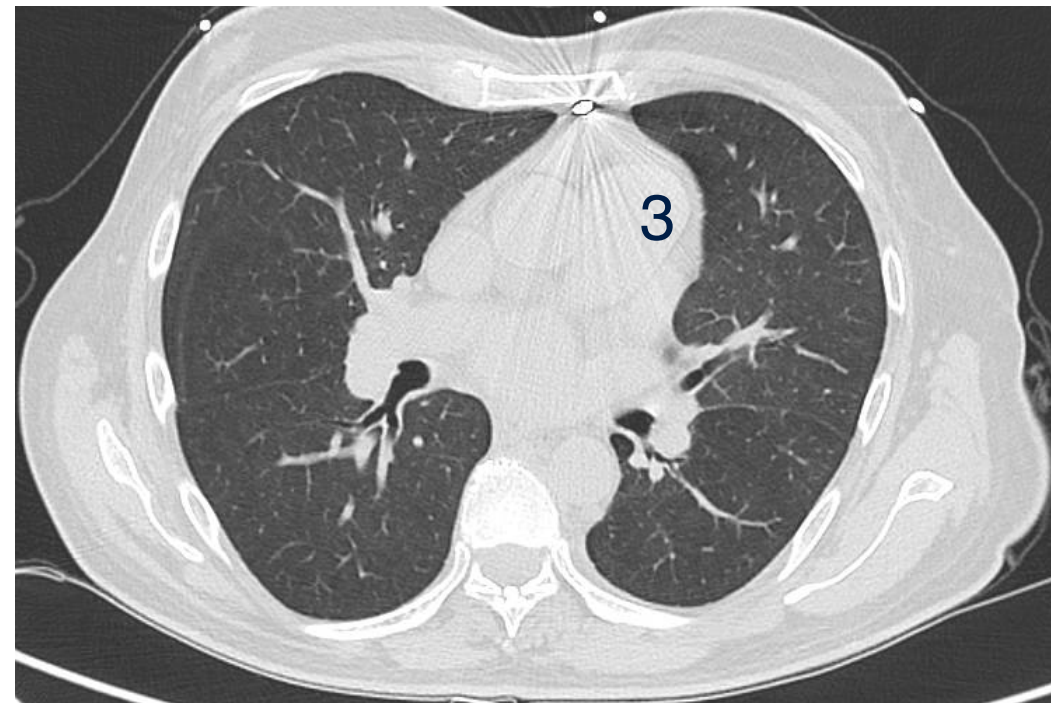
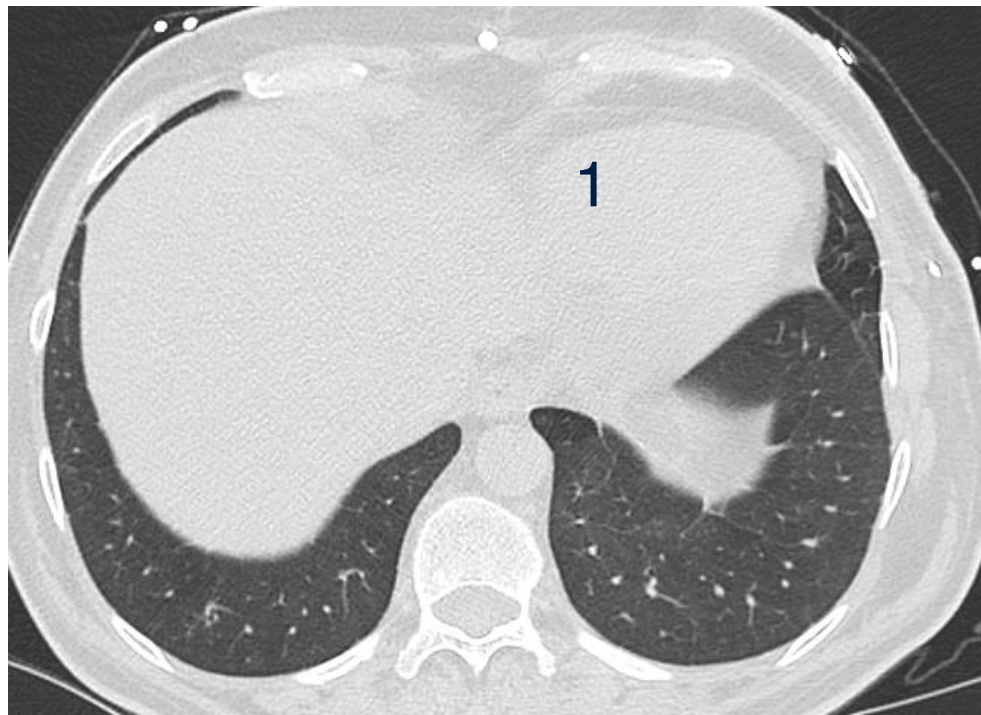
- Right atrium size and proximity to sternum
- Pleura kissing point
- Right ventricular size
- Rib-sternum junction

**SAFETY and OPTIMAL EV ICD
PERFORMANCE**

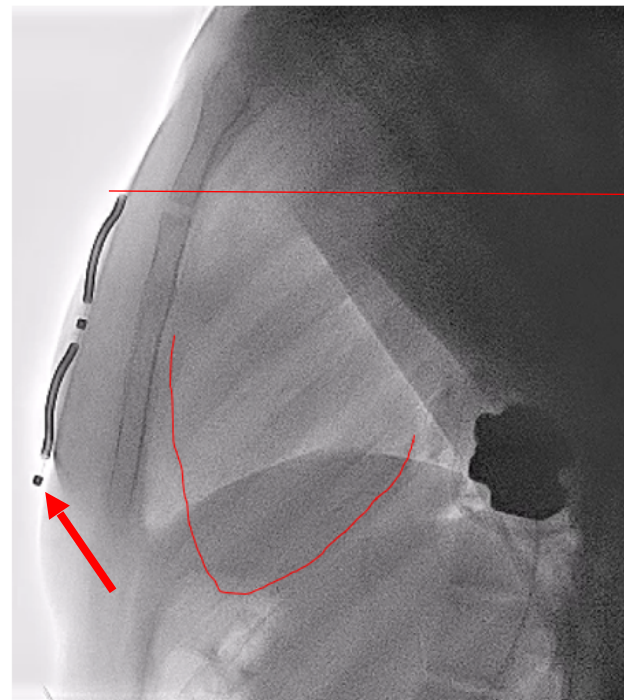




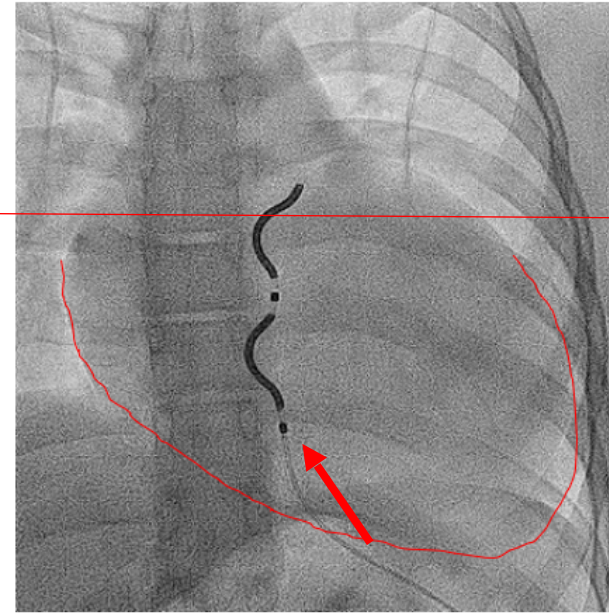
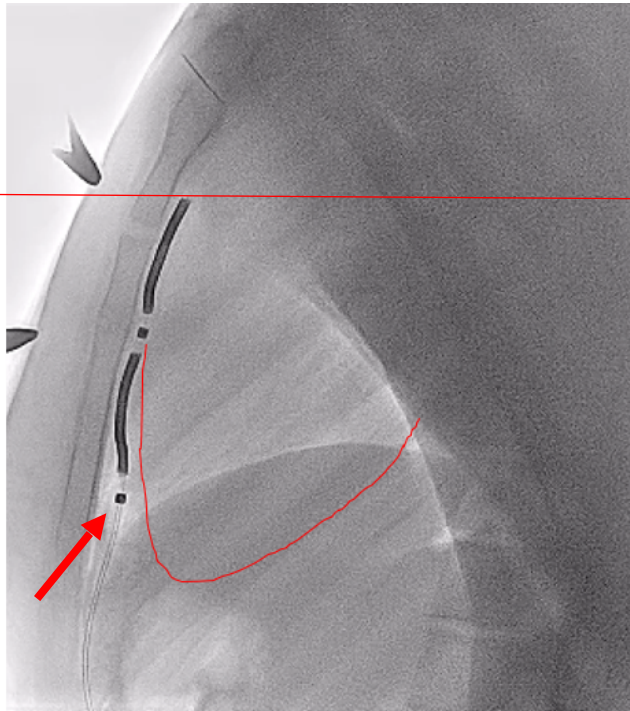




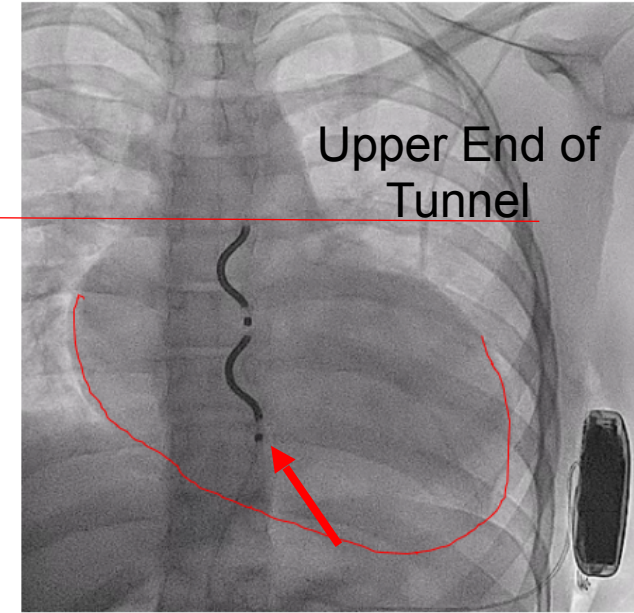
Build a demo on patient's chest

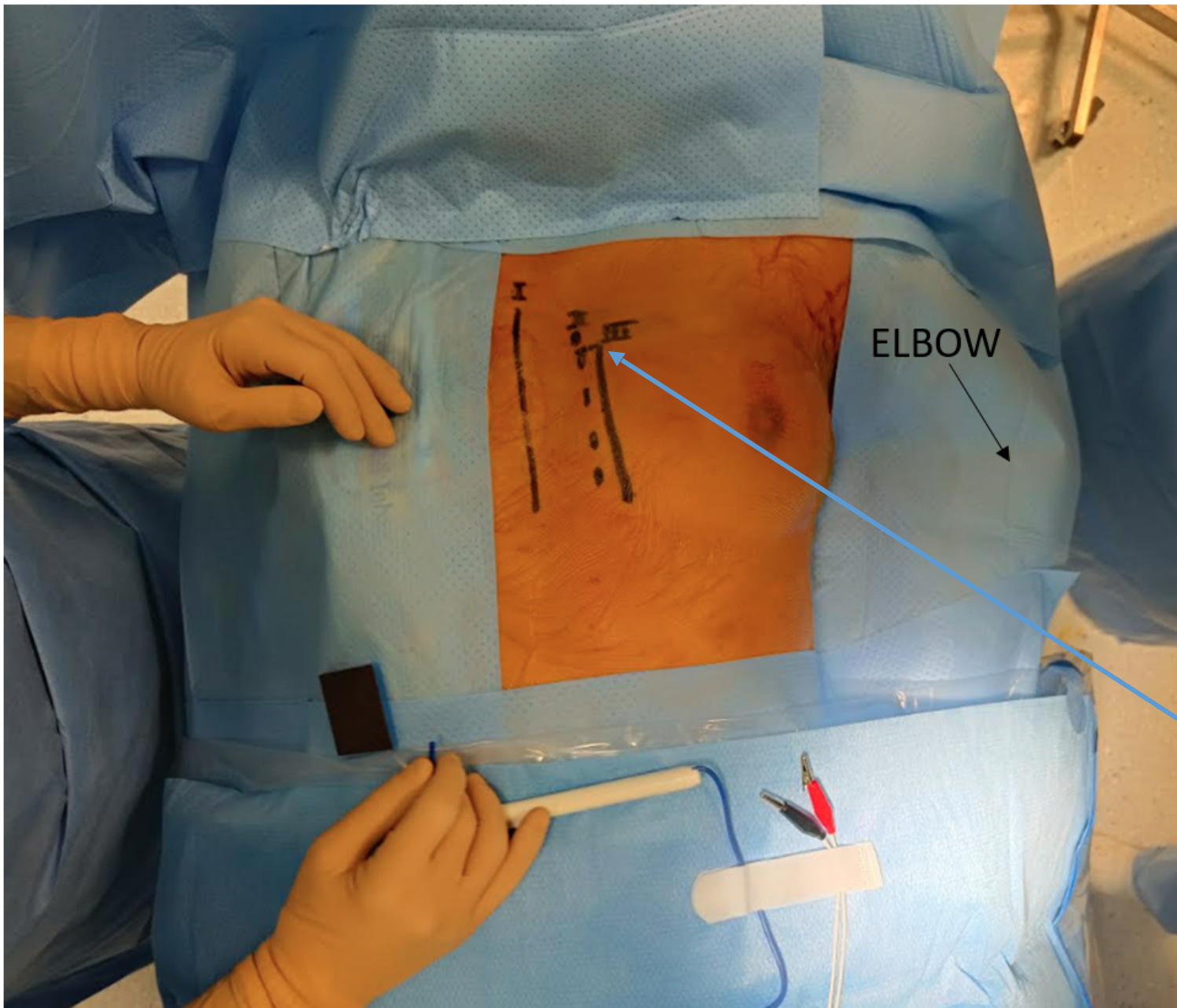


RING 2 must be cranial to the APEX in **LL** View



RING 2 must be cranial to the lower ventricular border **PA** View





I. MID-spine line

II. left sternal border

III. line of Tunnel

Upper End of Tunnel

HOW to do IT: experience on 81 patients



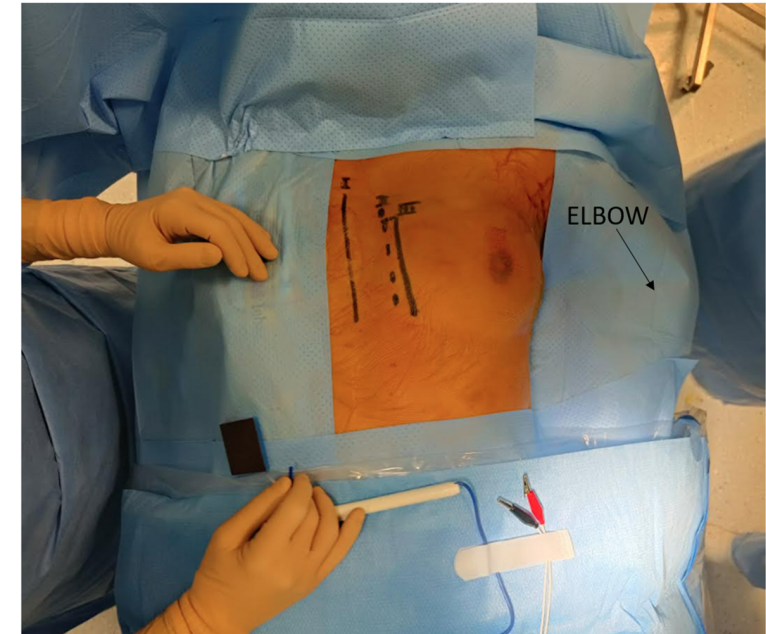
Vertical Skin Incision at the sternum-rib junction



Finger tunneling up in the mediastinum



TUNNELLING TOOL for the remaining few centimeters



46 yrs old, male

2011: diagnosis of ALVC (FVT > 230 bpm), TV-ICD implantation



VT/VF Counters

Prior Session	Last Session	Device Lifetime
17-Apr-2019 to	09-Sep-2019 to	Total
09-Sep-2019	04-Nov-2019	(Since 16-May-2013)
5 months	56 days	78 months

SVT: VT/VF Rx Withheld

Wavelet	0	0	0
V. Stability	0	0	0
Onset	0	0	0

V. Oversensing: VT/VF Rx Withheld

V. Oversensing-TWave	0	0	0
V. Oversensing-Noise	0	0	0

VT/VF Therapy Summary

Pace-terminated	7 of 7	0	419 of 420
Shock-terminated	0	0	1 of 1
Total VT/VF Shocks	0	0	1
Aborted Charges	0	0	9

Event List

Page 2

Time	Duration	Avg bpm
mm	hh:mm:ss	V
25	:02	242
14	:10	240
47	:10	240
19	:10	240
37	:01	273
47	:01	248
49	:02	249
43	<:01	240
Session 30-Jan-2019		
29	<:01	283
47	:11	222
25	:38	240
53	:01	279
14	:10	240
12	:10	250
59	:09	273
20	:09	250
18	:10	250
37	:01:51	165
17	:10	240

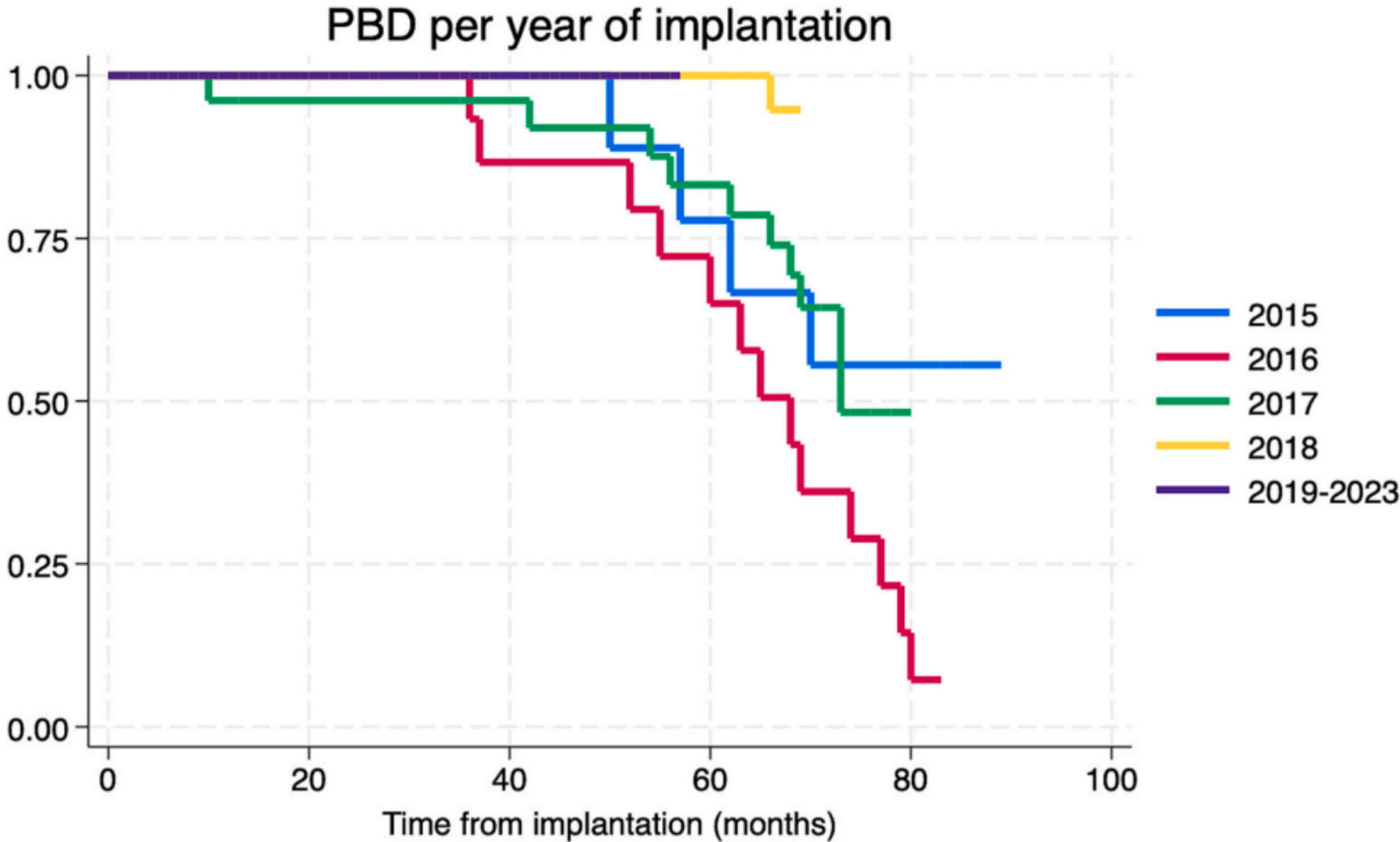


Unanticipated subcutaneous ICD end-of-service due to premature battery depletion and occurrence of lead fracture: A single centre experience

Mirco Lazzeri ^{a,*}, Matteo Ziacchi ^a, Andrea Angeletti ^a, Alessandro Carecci ^a, Michele Bertelli ^a,
Federica Locchi ^b, Jennifer Oppimitti ^b, Mauro Biffi ^a

Table 1
Baseline characteristics of S-ICD patients at implantation.

Baseline characteristics	
Patients	192
Age (y)	45 ± 18
Male	138 (72%)
NYHA class	1,5 ± 0,7
LVEF	51,4% ± 15,8
Primary prevention	108 (56%)
Underlying HD	156 (81%)
Ischemic HD	23 (12%)
Dilated CMP	27 (14,1%)
Hypertrophic CMP	53 (27,6%)
Arrhythmogenic CMP	38 (19,8%)
Congenital HD	6 (3,1%)
Other HD*	8 (4,2%)
Primary electric HD**	37 (19%)



Subcutaneous Implantable Cardioverter-defibrillator Explantation—A Single Tertiary Center Experience

NAGA VENKATA K. POTHINENI, MD,¹ THARIAN CHERIAN, MD,¹ NEEL PATEL, DO,¹
JEFFREY SMIETANA, MD,¹ DAVID S. FRANKEL, MD,¹ RAJAT DEO, MD,¹ ANDREW E. EPSTEIN, MD,¹
FRANCIS E. MARCHLINSKI, MD,¹ and ROBERT D. SCHALLER, DO¹

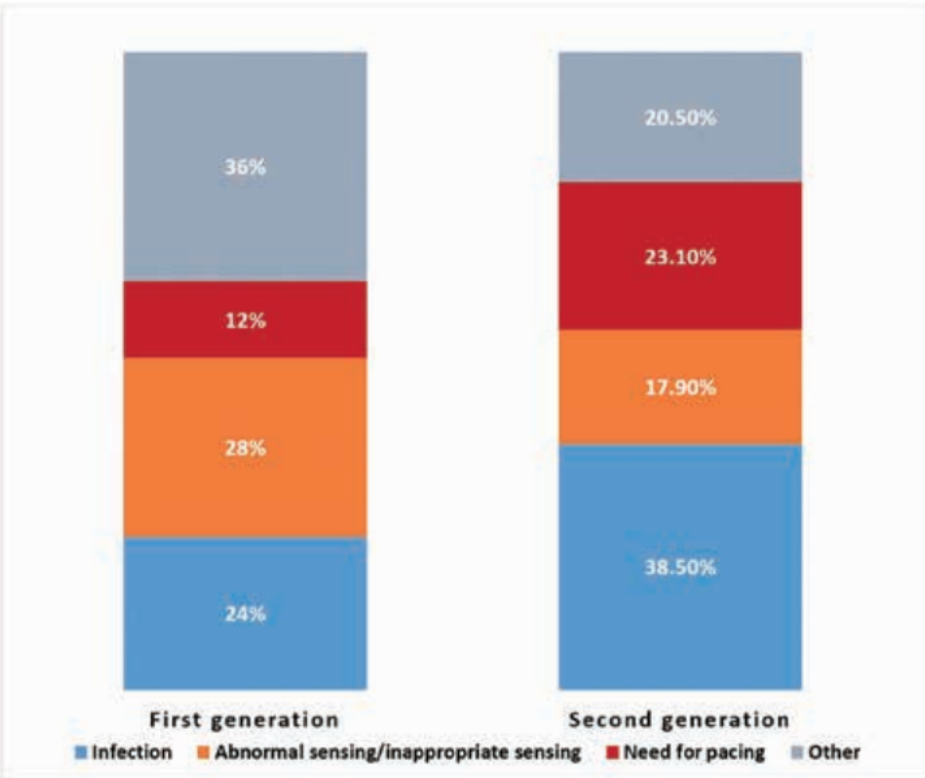
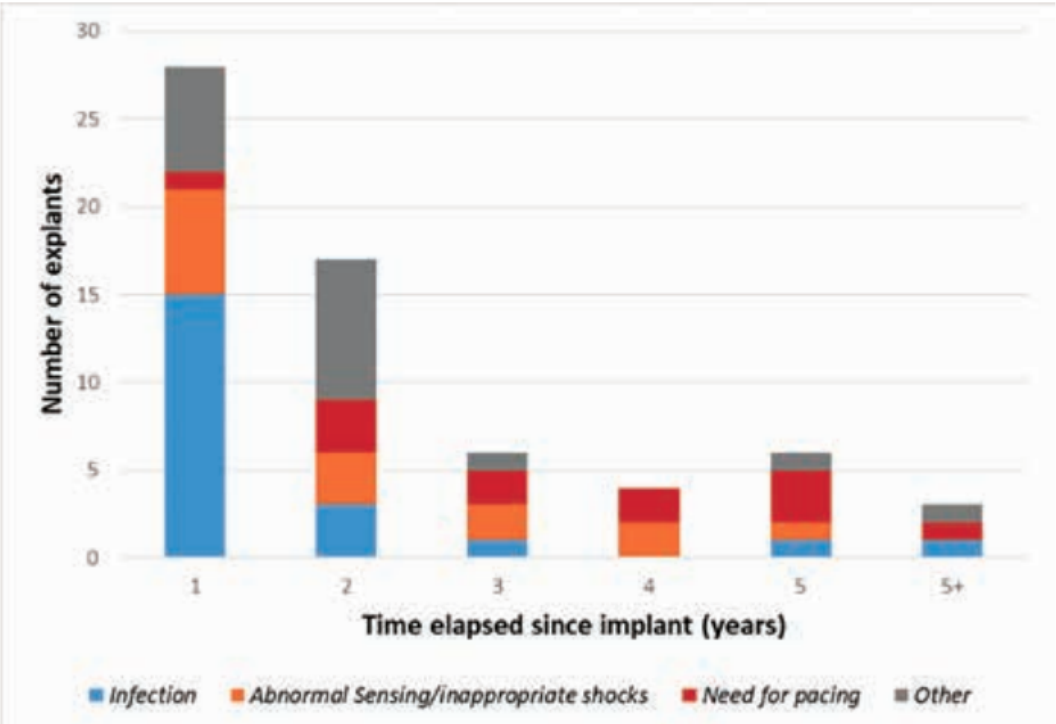
¹Section of Cardiac Electrophysiology, Division of Cardiovascular Medicine, University of Pennsylvania, Philadelphia, PA, USA

J Innov Cardiac Rhythm Manage. 2022;13(4):4947–4953

Timeline 2014-2020

53 explantations over 410 implants (12.9%)

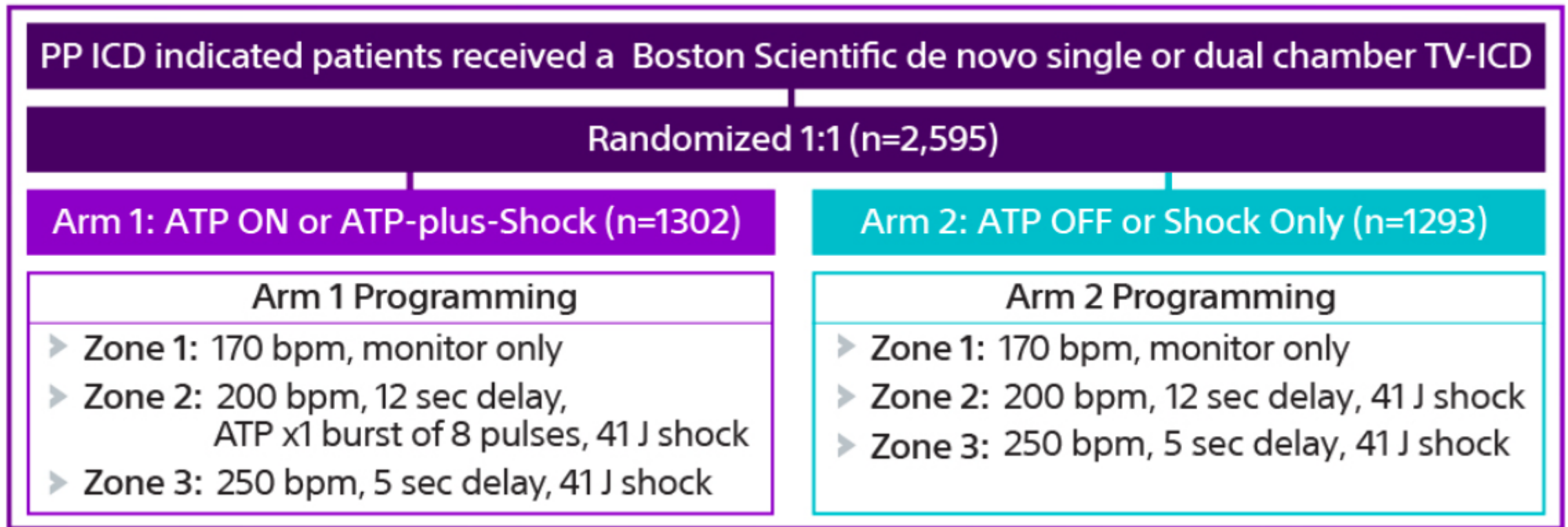
- ¼ extractions due to abnormal sensing at FU



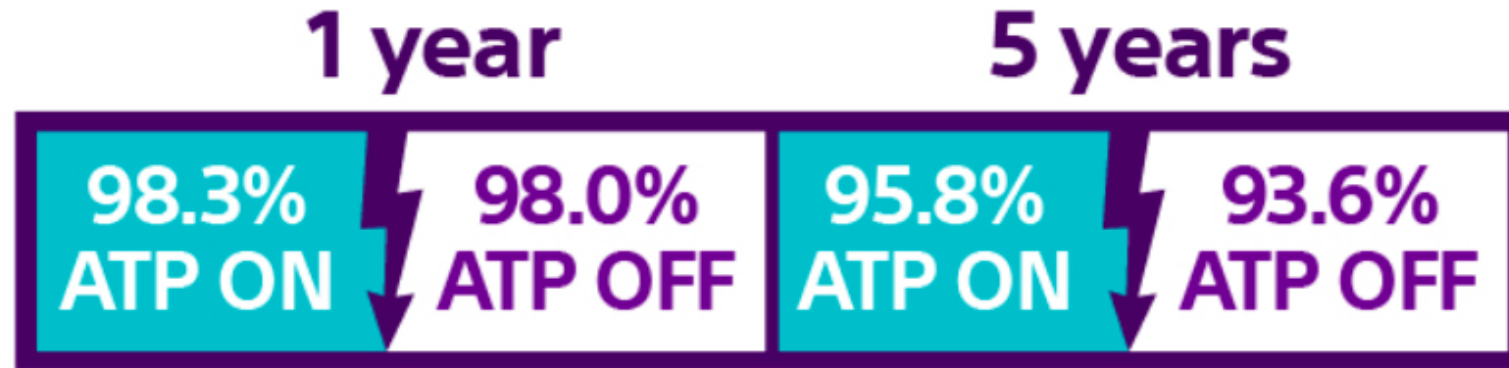


ATP

The APPRAISE Trial



- ▶ % of TV-ICD patients free from inappropriate shocks at 1 year and 5 years in each arm



Full follow-up results

Shock burden

ATP ON

ATP OFF

Shock burden[§] was not significantly different between the two arms ($p=0.38$)¹¹

Risk

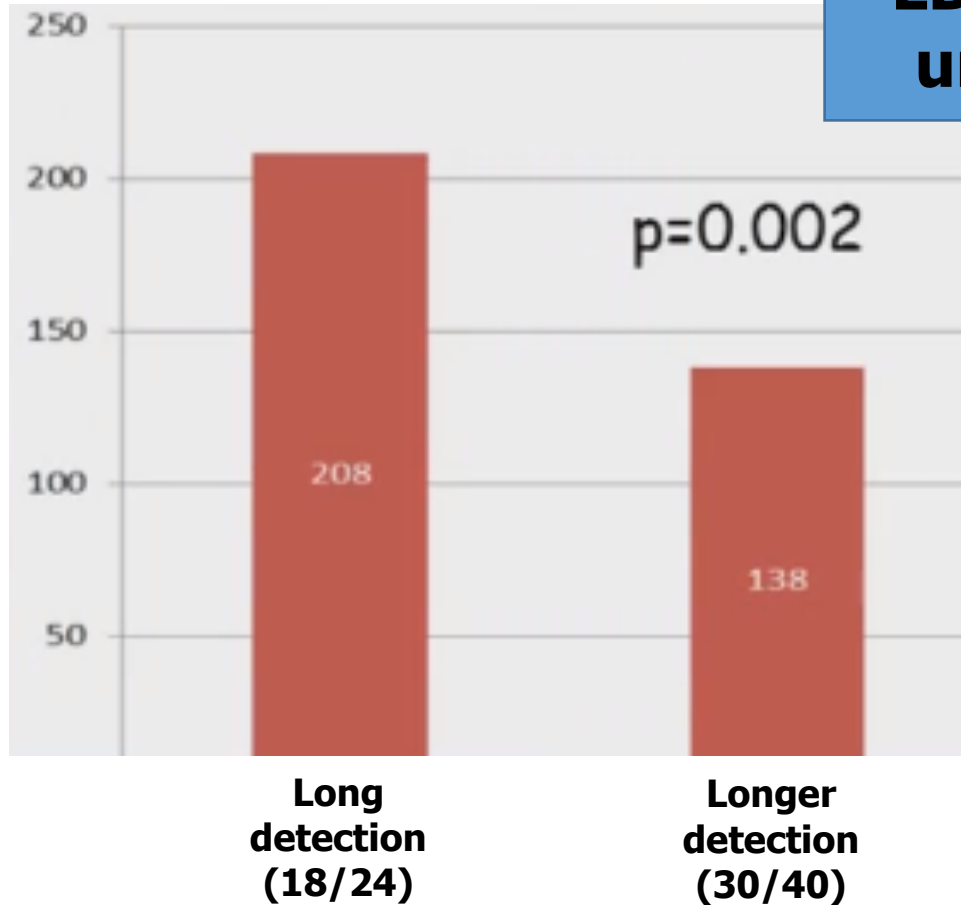
Higher risk of VT/VF storms in the **ATP ON Arm** (HR: 2.39, 95% CI 1.29-4.44, $p=0.006$)¹¹

Deaths

Numerically higher in **ATP ON Arm** (196 vs. 174), but no significant difference in deaths between the two arms (HR: 1.15, $p=0.184$).¹¹ This demonstrates there was no signal that **ATP OFF** increased mortality.

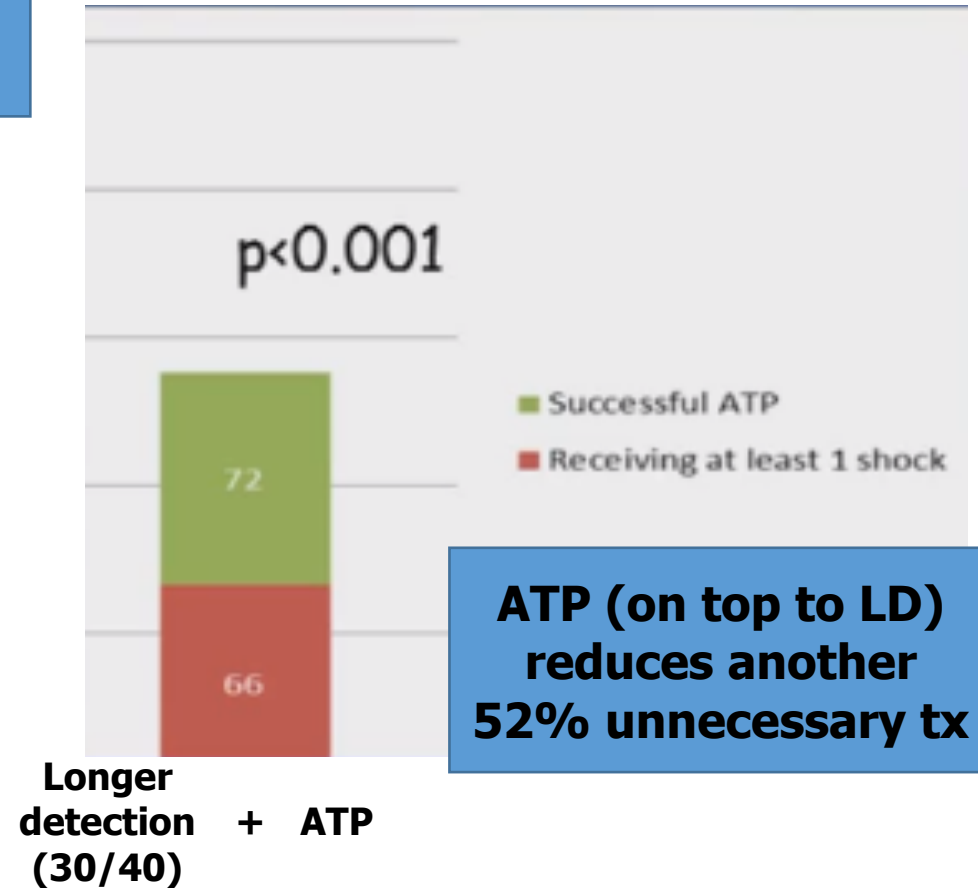
Different impact of long-detection interval and anti-tachycardia pacing in reducing unnecessary shocks: data from the ADVANCE III trial

Considering Shock only....



LD reduces 37% unnecessary tx

But



ATP (on top to LD) reduces another 52% unnecessary tx

Added value
Long detection vs longer detection
Primary and secondary prevention
Any ICD type
All ICD therapies