

**MINICORSO SULLA CSP: PARTE II - GESTIONE CLINICA E
OTTIMIZZAZIONE DELLA CSP**

Utilizzo degli EGM ventricolari per valutare la stabilità della cattura ventricolare nella LBBAP

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Cardiologia Rovigo



LBBAP dislodgement rates

Macro-dislodgement rate: Occurs typically within hours of days after implantation

- SDL: 1.4% (353 pts)

3.8% (396 pts)

- LLL: 1% (305 pts)

1.5% (364 pts)

2% (196 pts)

1.1% (2137 pts)

De Pooter, JCE 2022
Jastrzebski (MELOS) EHJ 2022

Padala et al, JACC EP 2022

Raymond-Paquin, HR 2022

Vijayaraman, JCE 2022

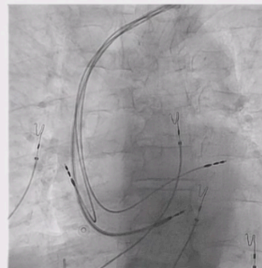
Jastrzebski (MELOS) EHJ 2022

With increasing learning curve
macro dislodgement rates < 1%

Late septal perforation

- Very rare, 0,1-0,3%
- Risk of LV thrombus or ventricular arrhythmias

Stempfel, Rev Int Cardiol, 2025



LBBAP dislodgement rates

Micro dislodgement rate:

- Often underreported, higher with SDL (related to late unwinding/retraction of helix?)

- 9% in LLL versus 25% in SDL (7/28 pts)

- 3% in LLL versus 6% in SDL

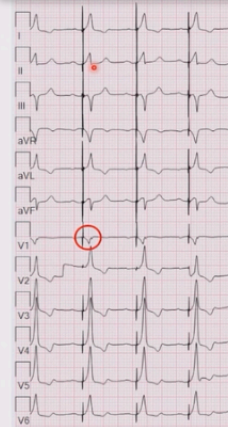
- 0,9% in LLL versus 1,5% in SDL

- Maybe less with purpose-build CSP leads?

Tan et al HR 2022

Sriharan et al, Europace 2023

Cano et al, HRO2 2023

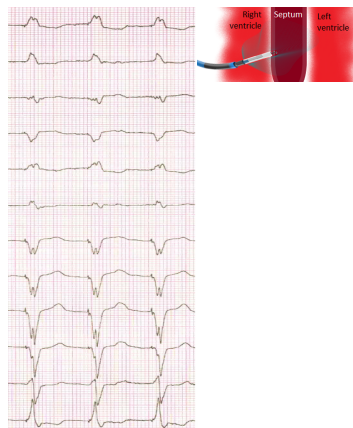
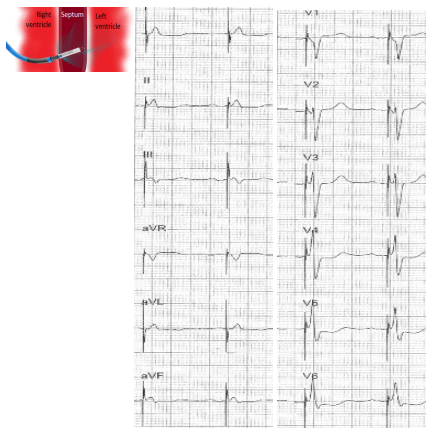


How to avoid micro-dislodgement?

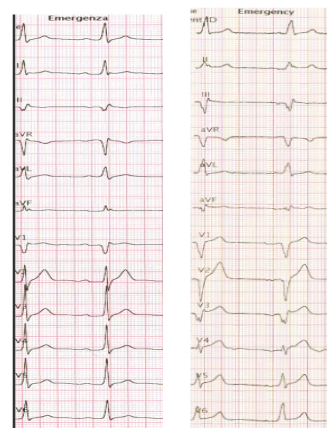
- Check paced QRS after releasing helix locking tool (SDL)
- Check paced QRS after sheath and stylet withdrawal
- Avoid "drill" effect

PM implant

PM FU



PM implant PM FU



CSP lead designs in practice

- Obtaining successful CSP
- Maintaining stable CSP capture on long term
- Avoiding lead damage

Lead designs used for CSP

- Lumenless leads/ Fixed helix
- Stylet-driven leads with extendable/retractable helix
- Stylet-driven leads with fixed helix

SelectSecure 3830, Medtronic

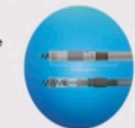
SoliaS,
Biotronik

stylet
position

Ingevity (Plus),
Boston Scientific

stylet
position

Tendrill / Ultipace
Abbott



stylet
position

Solia CSP S, Biotronik

Nessuno di questi cateteri sono stati disegnati per CSP

Lead dedicati per CSP

ed leads

2023 HRS/APHRS/LAHR guideline on cardiac physiologic pacing for the avoidance and mitigation of heart failure ^e

Top 10 take-home messages

At FU:

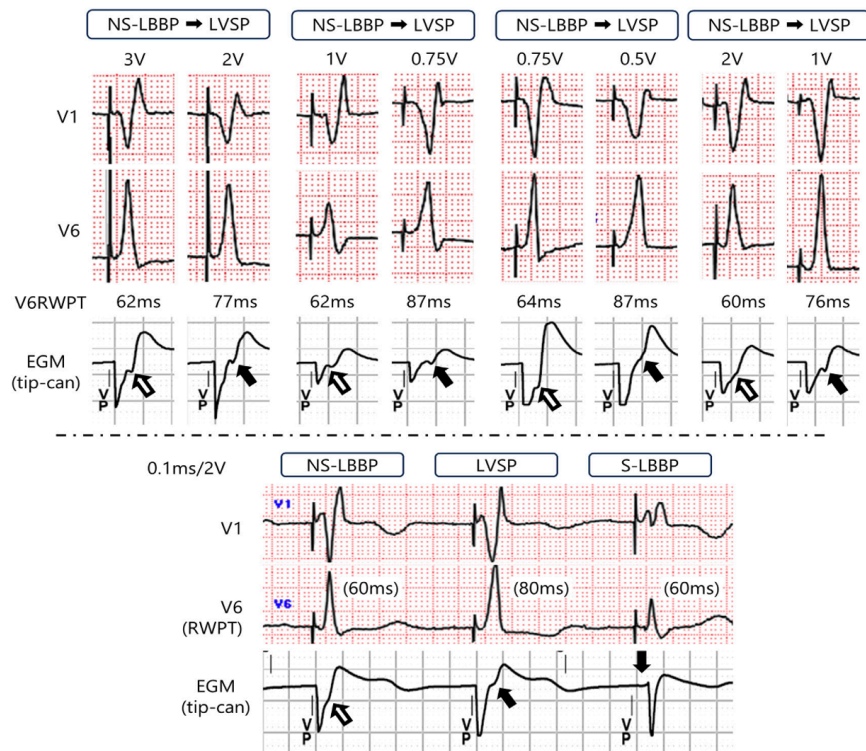
12-lead ECG demonstration of CS capture is essential

10. During implantation and follow-up of patients with CPP devices, electrocardiographic demonstration of BiV (for CRT) or conduction system (for CSP) capture is essential.



- Limitazioni nella gestione dei paziente mediante monitoraggio remoto
- Conferma di CSP nei casi di resincronizzazione mediante LBBAP
- Prevenzione della PIC

A Representative cases of ECG and EGM



RESEARCH LETTER

Device Electrogram-Guided Determination of Output-Dependent QRS Transition in Left Bundle Branch Pacing

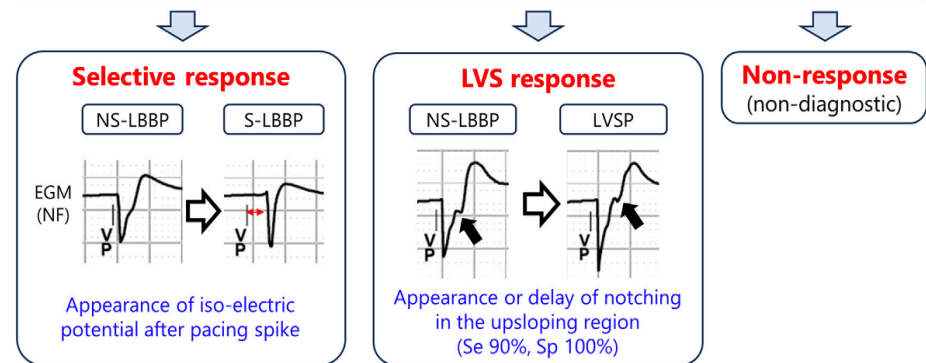
JACC: CLINICAL ELECTROPHYSIOLOGY VOL. 10, NO. 4, 2024

APRIL 2024:768-770

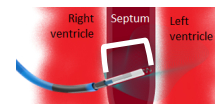
Shimeno K et al.

B EGM guided determination of output-dependent QRS transition

Threshold test by output decremental method using EGM

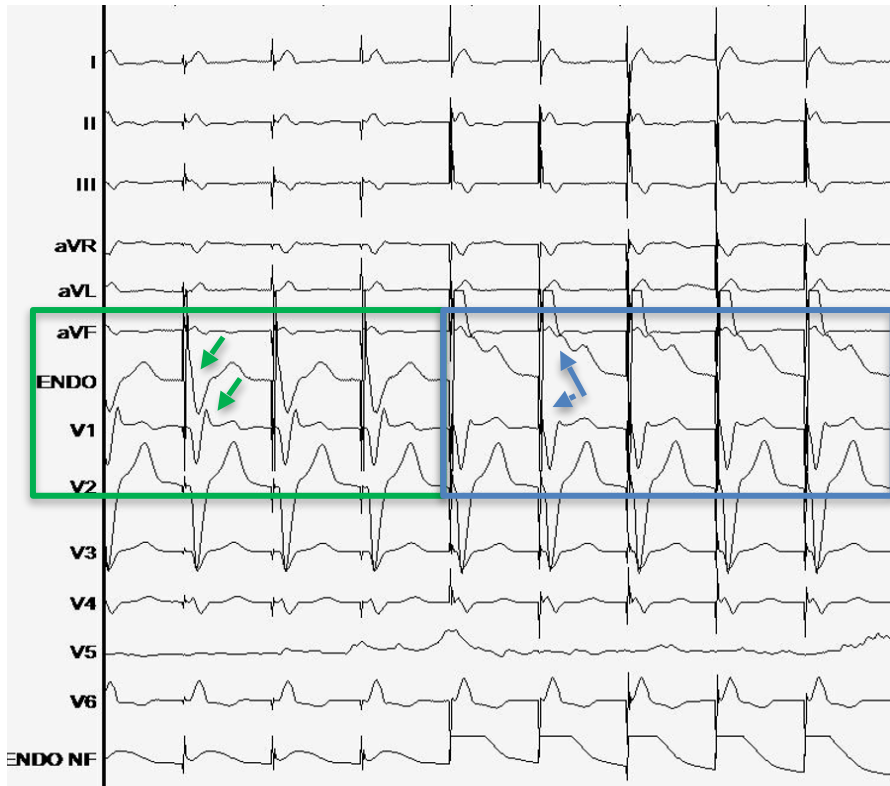


Near-field

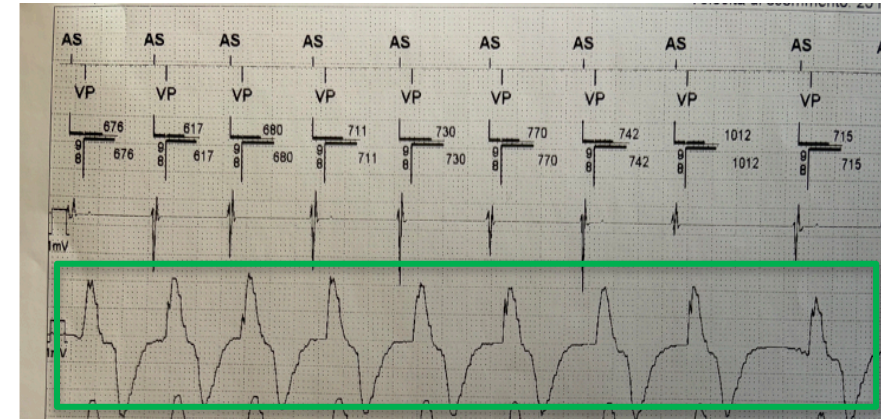
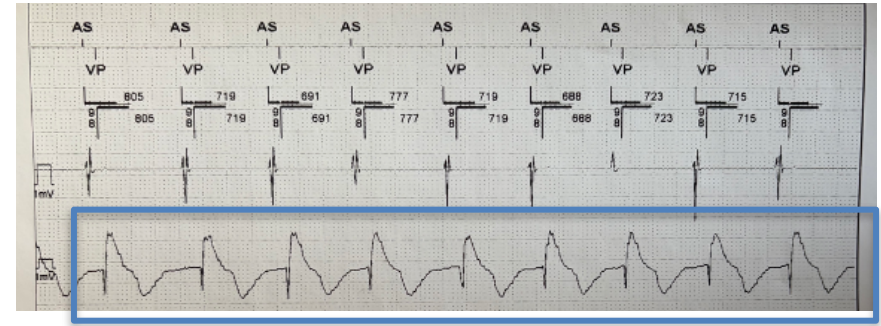


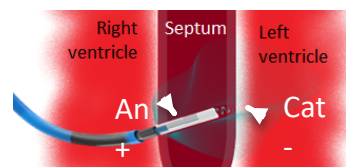
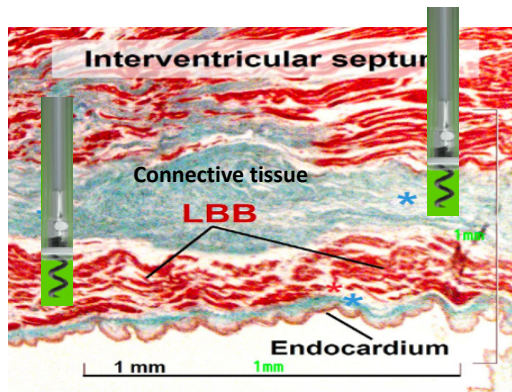
Cambio morfologia EGM a diversi output

Durante impianto: poligrafo

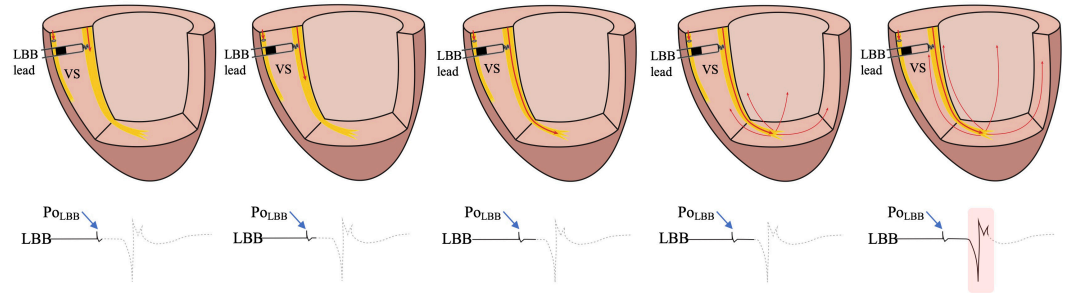


Post impianto: con programmatore

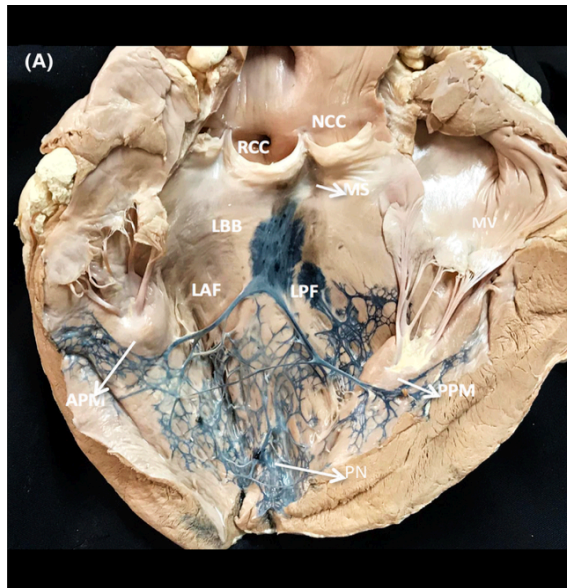
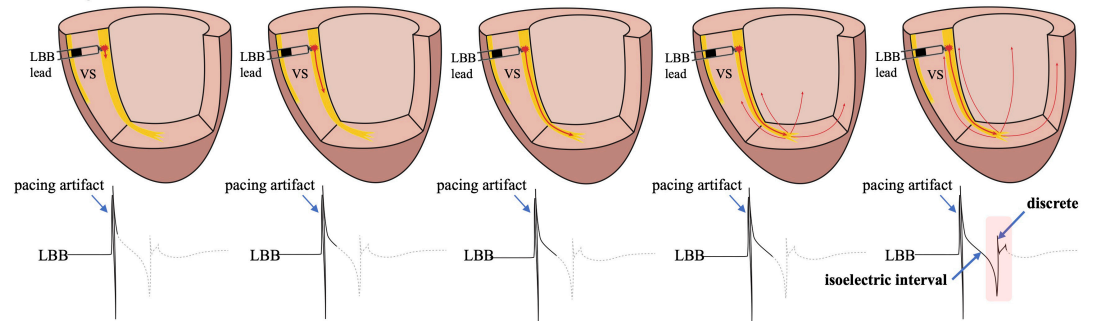




Intrinsic impulse conduction



Pacing stimulus conduction



Pazienti classificati in base allargamento pQRS
cutoff ≥ 20 ms (Baseline-implant vs 1Y FU)

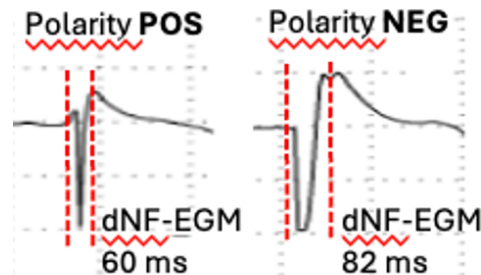
Δ pQRS-INCR ≥ 20 ms $\longleftrightarrow$ Δ pQRS-STABLE < 20 ms

MODIFICHE DI NF (near field) EGM

-dEGM: durata della deflessione rapida

Interv. Tra inizio EGM a transizione verso attivazione più lenta (comparsa o ritardo del notching)

-Polarity inversion della deflessione rapida iniziale

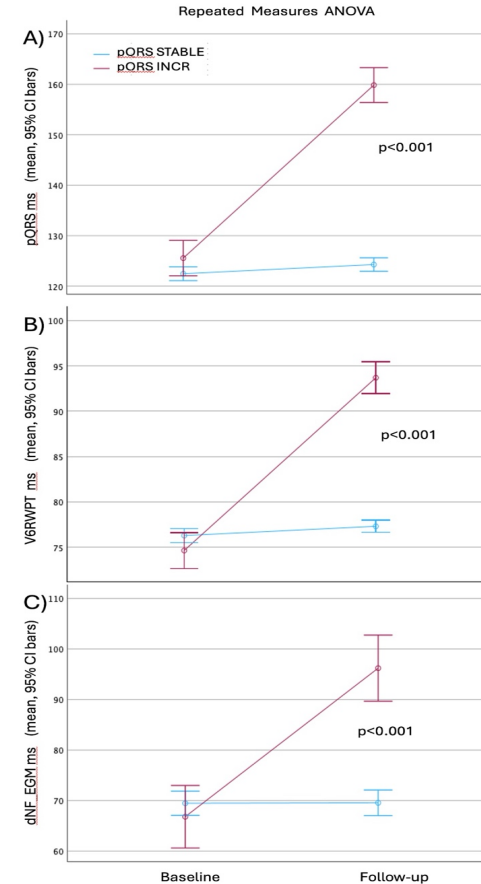


	pQRS-INCR (n = 20 pts)	pQRS-STABLE (n = 133 pts)	p value
Clinical Characteristics			
Age (years)	77.7 ± 8.3	75.8 ± 8.6	0.36
LVEF (%)	51.9 ± 15.8	54.9 ± 10.9	0.28
Males	12 (63.2%)	88 (66.2%)	0.80
Coronary Disease	2 (10.0%)	25 (18.8%)	0.53
Hypertension	18 (90.0%)	104 (78.2%)	0.37
Diabetes	10 (50.0%)	31 (23.3%)	0.03
Severe Renal Failure	3 (15.0%)	12 (9.1%)	0.42
AF	1 (5.0%)	25 (18.8%)	0.04
Sinus rhythm	19 (95.0%)	108 (81.2%)	
Implant Indications			
AV Block	10 (52.6%)	78 (59.5%)	0.82
Sinus Node Disease	4 (21.1%)	21 (16.0%)	
Slow rate AF	1 (5.3%)	12 (9.2%)	
Ablate & Pace	0 (0%)	1 (0.8%)	
CRT	4 (21.1%)	16 (12.2%)	
Conduction Disturbances (baseline pre-implant ECG)			
Narrow QRS	8 (42.1%)	60 (45.5%)	0.99
LBBB	4 (21.1%)	28 (21.2%)	
RBBB	3 (15.8%)	19 (14.4%)	
LBBB+RBBB	4 (21.1%)	25 (18.9%)	
Lead type			
LLL	6 (31.6%)	80 (60.2%)	0.02
SDL	13 (68.4%)	53 (39.8%)	

Variazione intrapaziente (1YFU vs post implant) di:
pQRS, V6RWPT e dNF-EGM
nei 2 gruppi (pQRS-INCR, pQRS-STABLE)

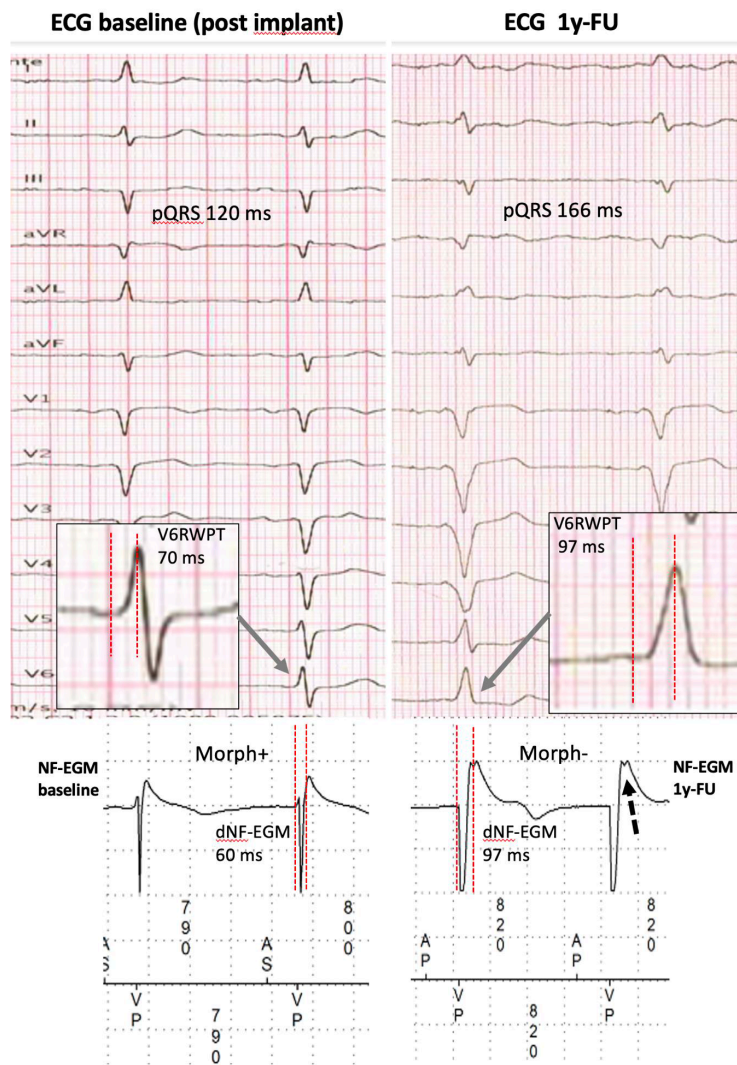
Misure di ECG e EGM basali (post impianto) e 1Y-FU

		pQRS-INCR (n=20 patients)	pQRS-STABLE (n=133 patients)	<i>p value</i>
12-lead ECG				
V6RWPT (ms)	Post-implant	74.7 ± 2.9	76.3 ± 4.6	0.05
	FU	93.7 ± 4.7	77.3 ± 3.9	<0.001
pQRS (ms)	Post-implant	125.5 ± 6.2	122.4 ± 8.2	0.11
	FU	159.8 ± 9.7	124.3 ± 7.5	<0.001
NF-EGM				
dNF-EGM (ms)	Post-implant	66.8 ± 11.7	69.5 ± 14.3	0.43
	FU	96.2 ± 19.1	69.5 ± 14.8	<0.001
Polarity inversion	FU	15 (75%)	0 (0%)	<0.001

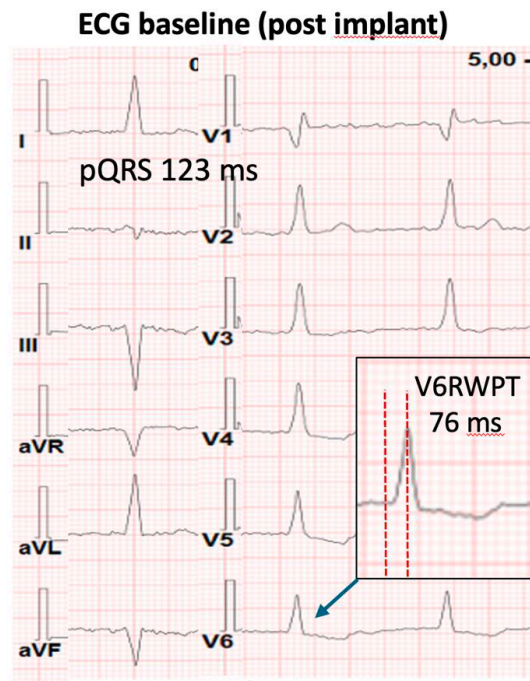


Paziente con pQRS-INC

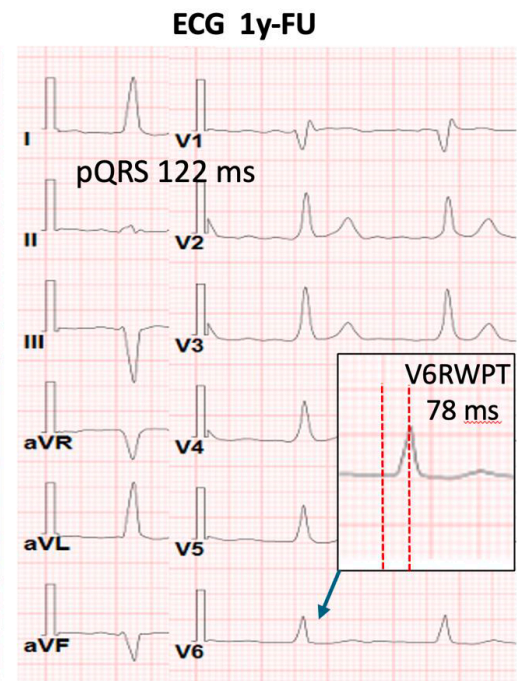
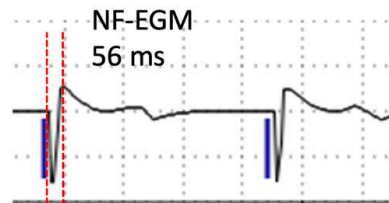
(switch from NS LBBAP to LVSP/deep septal)



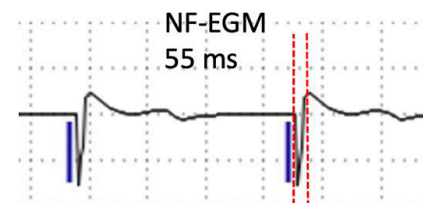
Paziente con pQRS-STABLE



**EGM
baseline**



**EGM
1y-FU**



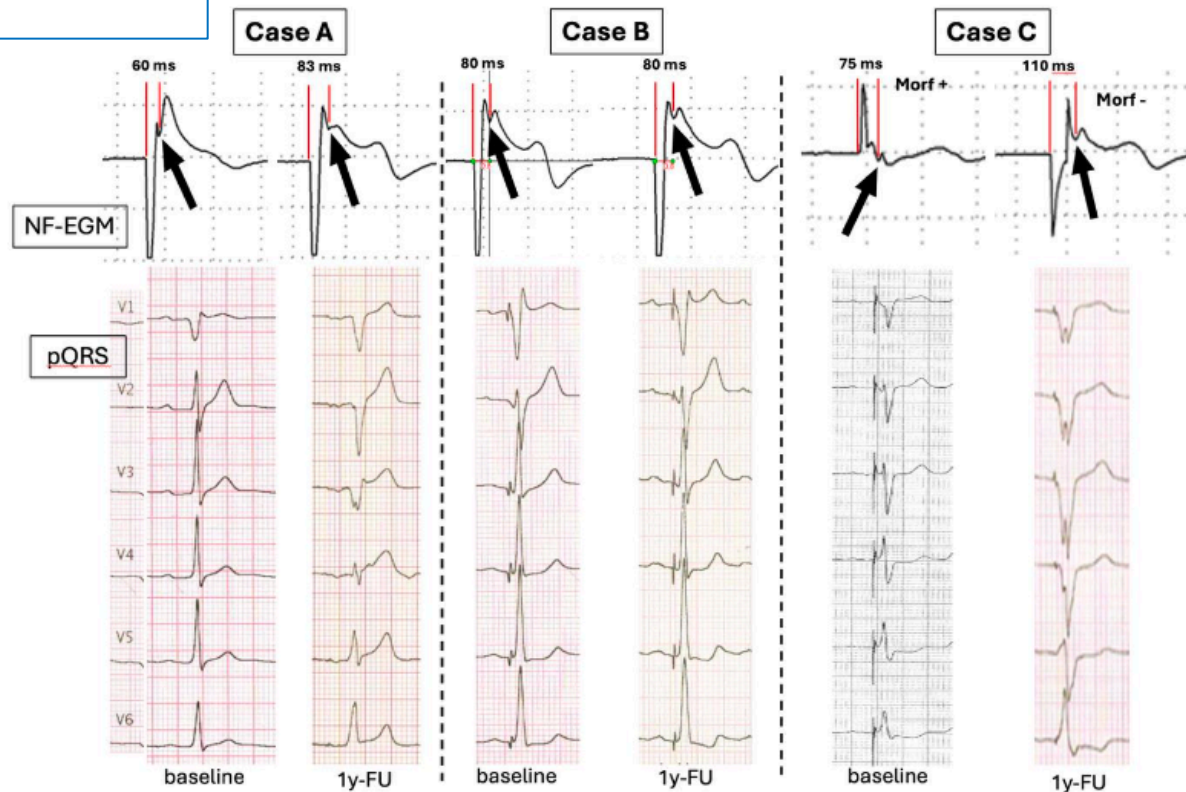
Vertical blue line: VP

Can we rely on remote electrogram analysis to monitor long-term conduction system capture in left bundle branch area pacing?

Pastore G. et al, 2026

Tutti i pazienti con paced QRS «stable» al 1y-FU presentava NF EGM invariato (durata e morfologia)

Variazioni di NF EGM predicono variazioni pQRS
Sensibilità 0.75 e Specificità 0.96



Micro-dislodgment

pQRS stable

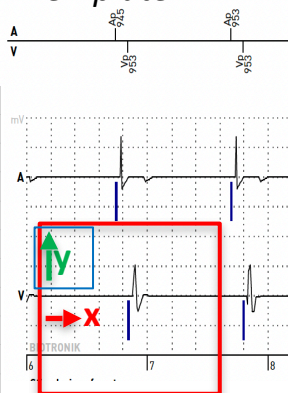
Macro-dislodgment

Dati «grezzi»

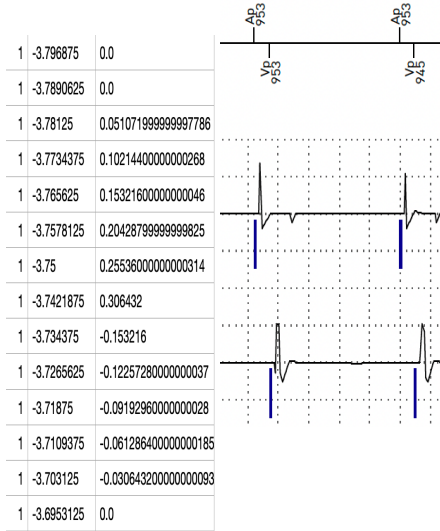
RV xPos yPos

1	-7.4609375	0.0
1	-7.453125	0.0
1	-7.4453125	0.0
1	-7.4375	0.0
1	-7.4296875	0.0
1	-7.421875	0.0
1	-7.4140625	0.0
1	-7.40625	0.0
1	-7.3984375	0.02553599999999998893
1	-7.390625	0.0510719999999999956
1	-7.3828125	0.0766080000000000023
1	-7.375	0.102143999999999912
1	-7.3671875	0.12767999999999998
1	-7.359375	0.153216
1	-7.3515625	0.109439999999999932
1	-7.34375	0.065663999999999817
1	-7.3359375	0.021887999999999702
1	-7.328125	-0.02188800000000000574
1	-7.3203125	-0.065664000000000172
1	-7.3125	-0.109440000000000287
1	-7.3046875	-0.153216
1	-7.296875	-0.1225728000000000037
1	-7.2890625	-0.0919296000000000028
1	-7.28125	-0.06128640000000000185
1	-7.2734375	-0.03064320000000000093
1	-7.265625	0.0
1	-7.2578125	0.0
1	-7.25	0.0

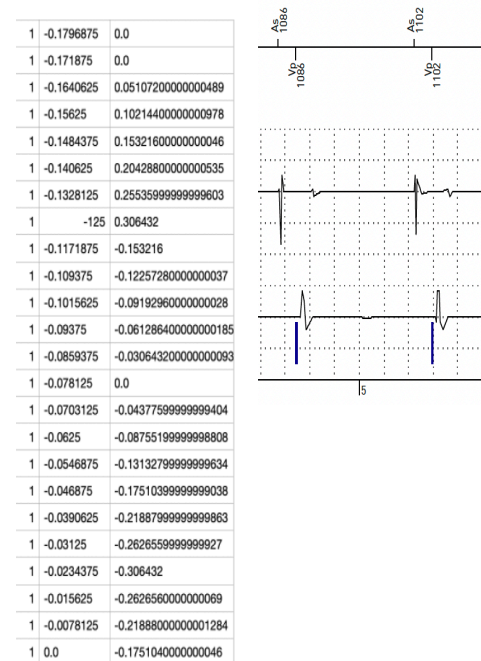
EGM Base (implant)
Template



EGM FU... X



EGM FU X+1



MODELLO AI

Variabili:

- Area sottesa
- Picco (max escursione rel/ass)
- Calcolo vettore picchi

Def. Del peso
% delle variabili

Def.criteri di sens./
specificità

Test del modello:
analisi interpretazione AI vs
controllo ECG 12 lead ai FU

The Future of Remote Monitoring

A closed AI-assisted loop — from the patient's CIED back to the patient



AI IEGM ANALYSIS

On the remote server, every transmitted intracardiac electrogram is screened automatically.



Morphology-Change Alert

Automatically triggered when the QRS / IEGM signal morphology shifts from the patient's baseline template.



Adjustable Thresholds

Configurable levels of **sensitivity** and **specificity** — tune alert aggressiveness per patient.