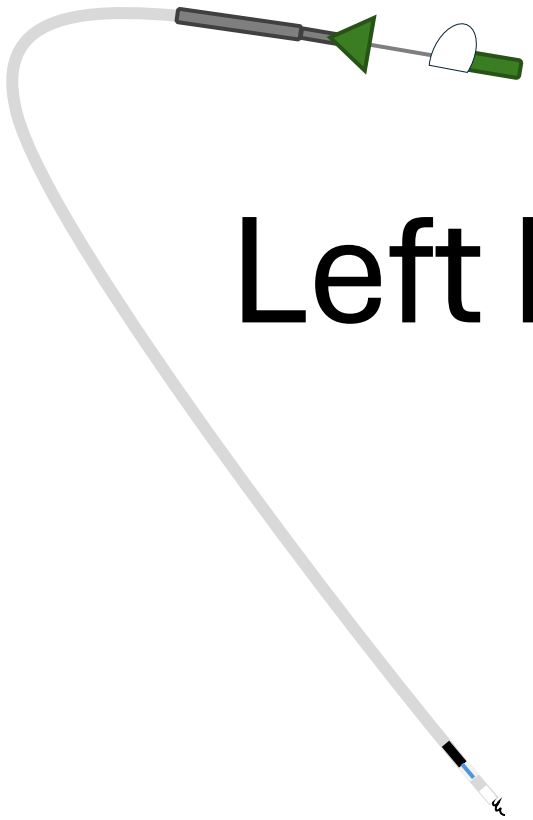
Conduction System Pacing
Summer Summit Berlin 2025

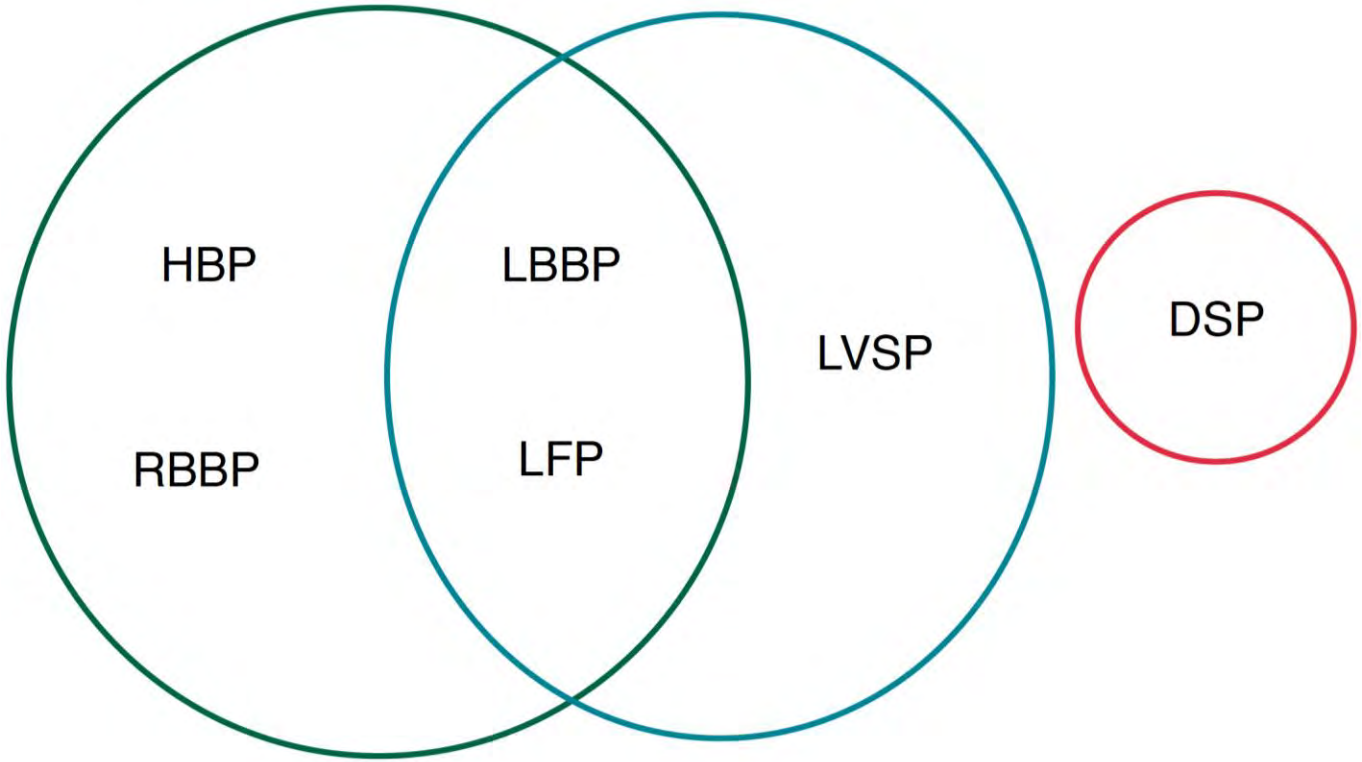
Friday / Saturday, June 13rd/14th, 2025



Left bundle branch area pacing

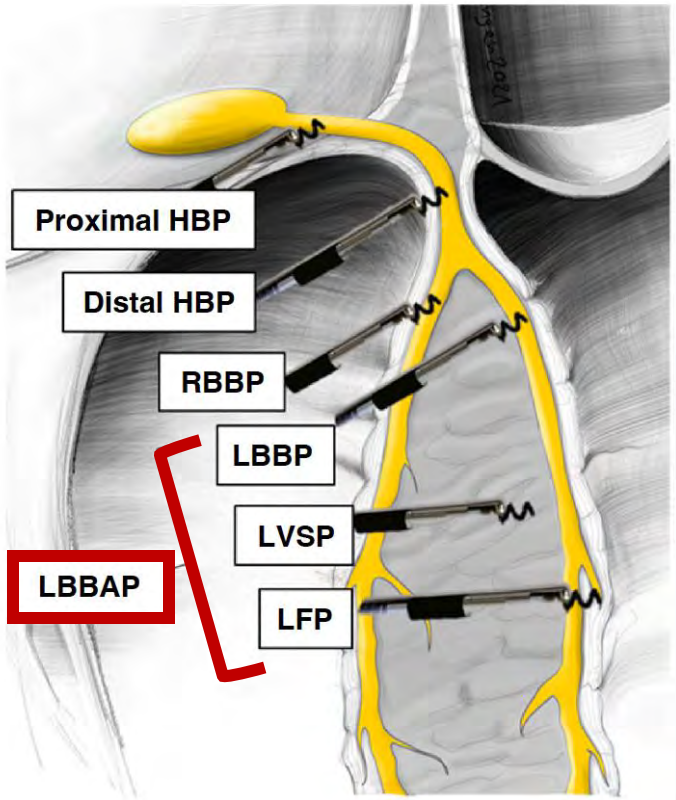
assist. prof. **DAVID ŽIŽEK**, MD, PhD
Head of electro-stimulation program
Department of Cardiology
University Medical Centre Ljubljana
SLOVENIA

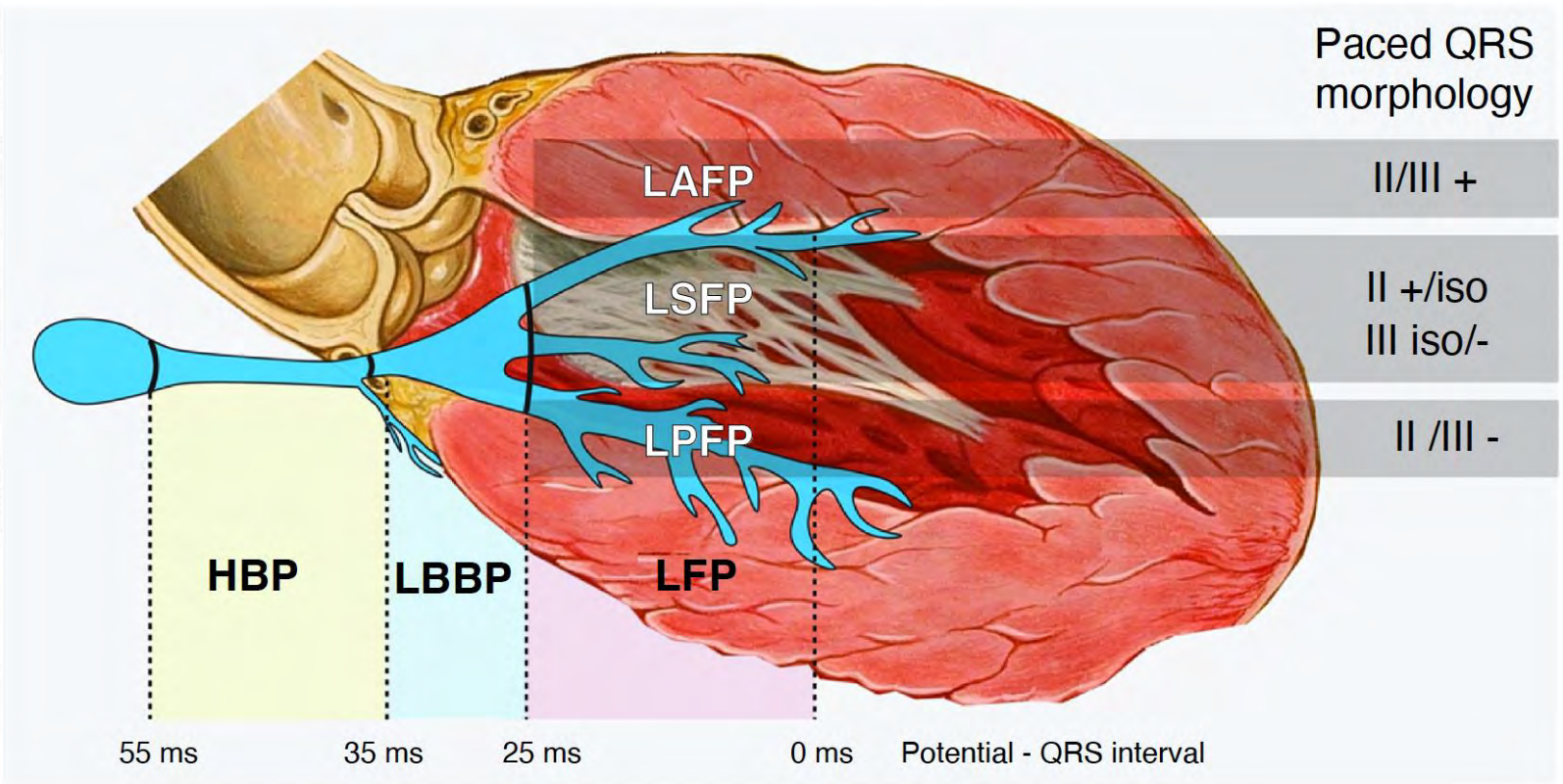
Conduction system pacing (**CSP**)



- Burri H, Jastrzebski M, et al. EHRA clinical consensus statement on conduction system pacing implantation. Europace. 2023; 25: 1208-1236

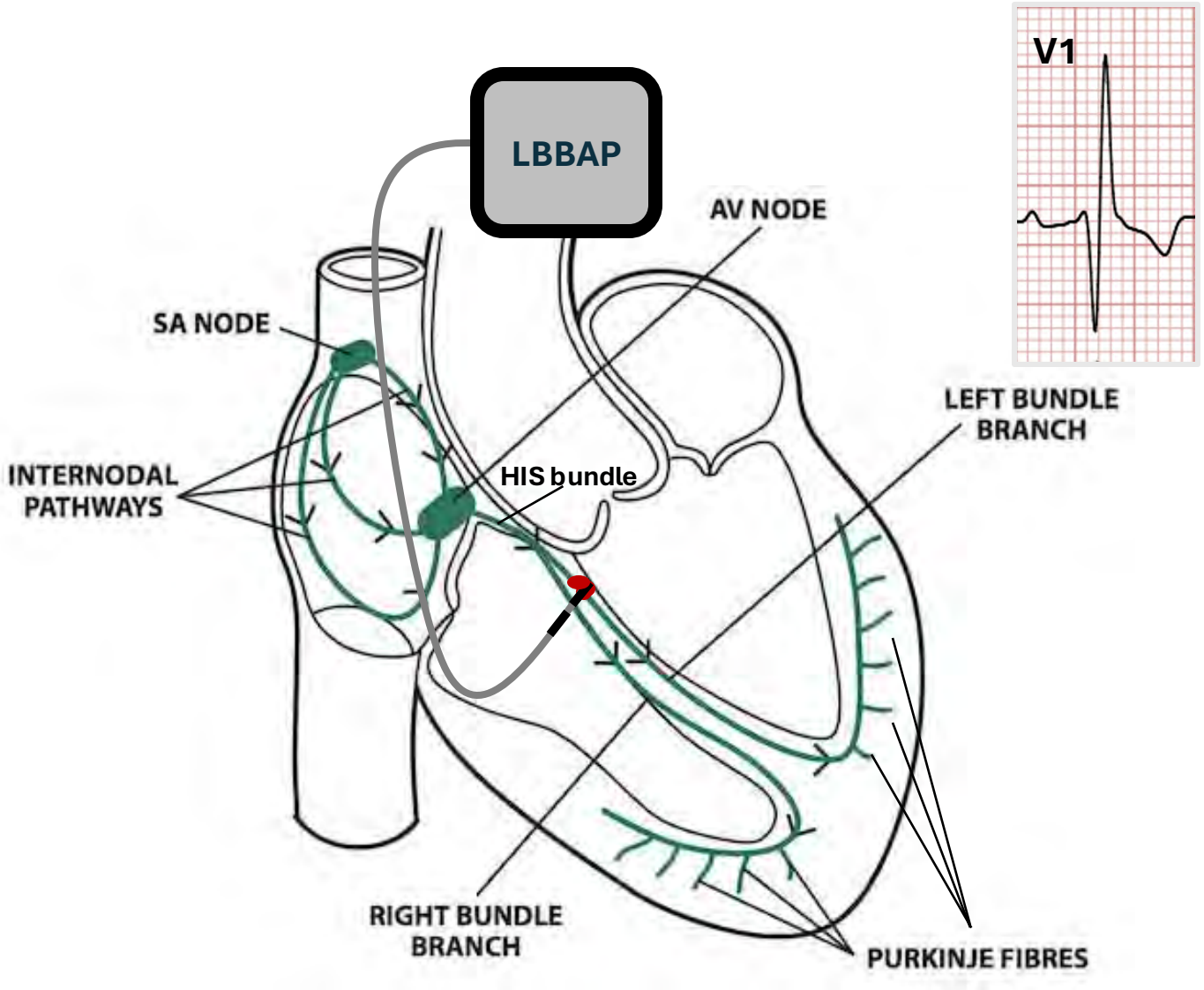
Left bundle branch area pacing (**LBBAP**)





- Jastrzębski M, et al. Left bundle branch area pacing outcomes: the multicentre European MELOS study. Eur Heart J 2022; 43:4161-4173

LBBAP *vs.* HBP in clinical practice



PROS:

- **easier to perform**
- stable long-term pacing parameters
- simple programmming

CONS:

- „less physiological“ pacing
- **more difficult to confirm**

Complications attributed to the transseptal route of the pacing lead

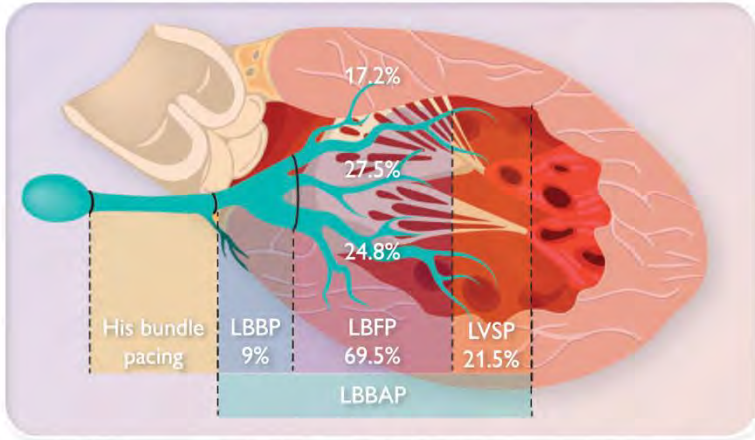
Intraprocedural perforation into the LV cavity	93 (3.67%)
Delayed perforation into the LV cavity	2 (0.08%)
Acute chest pain	25 (0.98%)
Acute ST-segment elevation in multiple leads	6 (0.24%)
Acute coronary syndrome [c]	11 (0.43%)
Coronary vein fistula	7 (0.28%)
Coronary artery fistula	2 (0.08%)
Painful pacing/chest pain	4 (0.16%)
LBBAP lead unscrewable/trapped/damaged helix	11 (0.43%)
LBBAP lead dislodgement	38 (1.5%)
Threshold rise to an absolute value > 2 V	17 (0.67%)
Threshold rise > 1 V from baseline	18 (0.71%)
Threshold rise leading to re-intervention	4 (0.16%)
Stroke/TIA	0 (0)
Summary	209 (8.25%)

MELOS — MULTICENTER EUROPEAN LEFT BUNDLE BRANCH AREA PACING OUTCOMES STUDY

Prospective, multicenter, registry-based observational study

2533 Participants

14 European centres



Independent predictors of LBBAP lead implantation failure

Heart failure indication	**OR 1.49**, 95% CI 1.01–2.21
Baseline QRS duration, per 10 ms	**OR 1.08**, 95% CI 1.03–1.14
LVEDD, per 10 mm increase	**OR 1.53**, 95% CI 1.26–1.86

LBBAP implantation success

Bradycardia indication success	**92.4%**
Heart failure indication success	**82.2%**

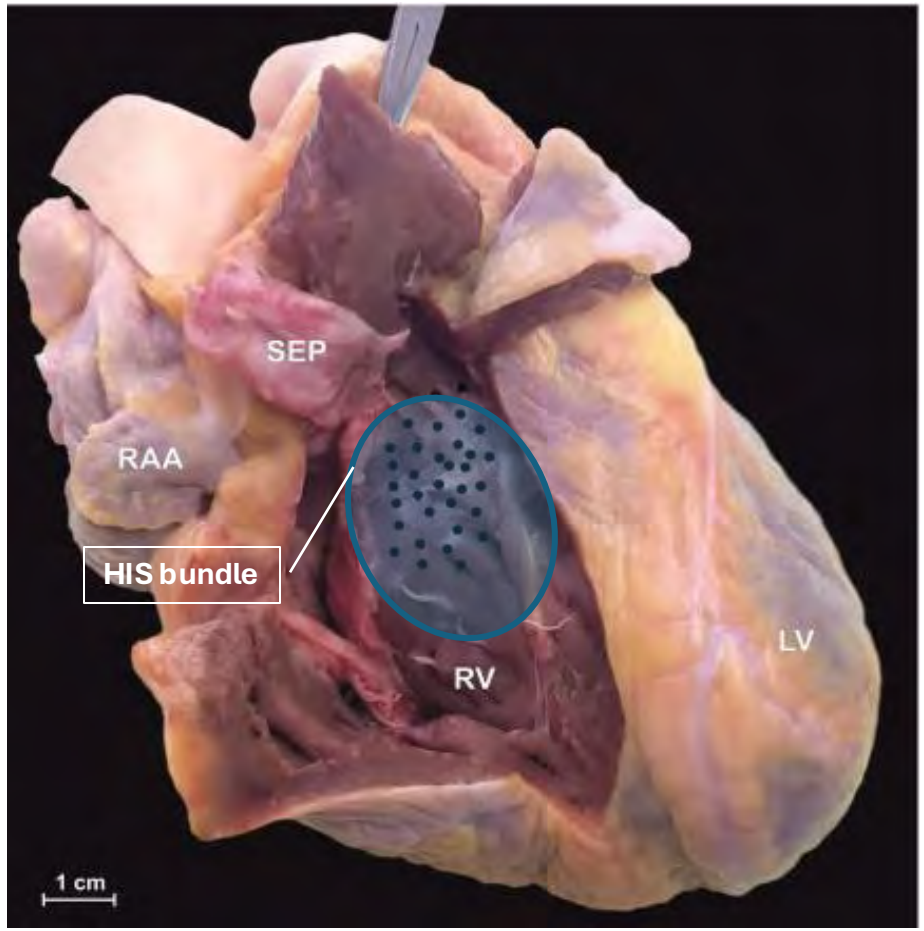
LBBAP lead complications	**8.3%**
• Acute perforation to LV	3.7%
• Lead dislodgement	1.5%
• Acute chest pain	1.0%
• Capture threshold rise	0.7%
• Acute coronary syndrome	0.4%
• Trapped/damaged helix	0.4%
• Delayed perforation to LV	0.1%
• Other	0.7%

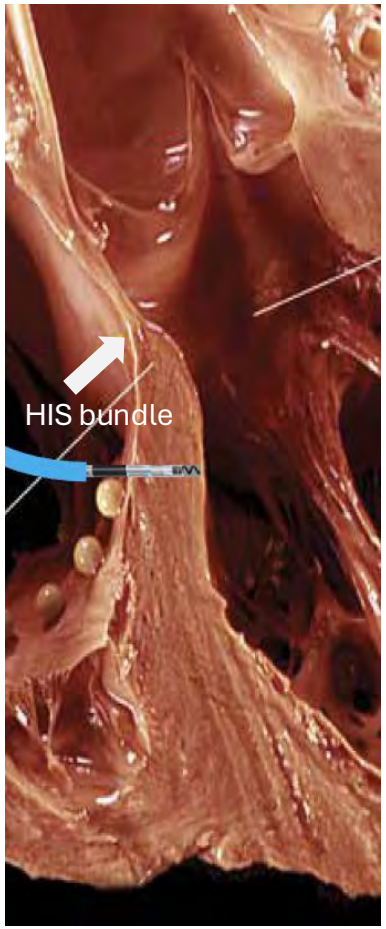
Steps for successful LBBAP procedure...

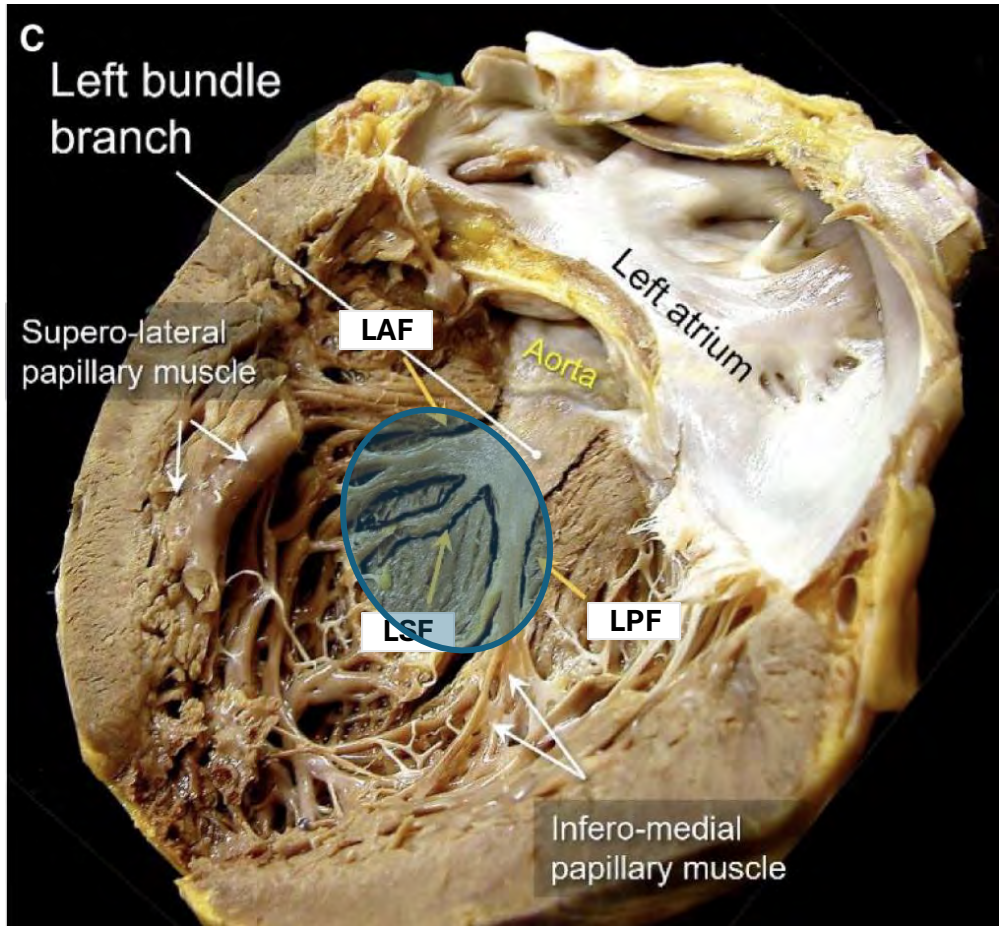
SWITCHING ON the electrophysiological mindset

1. BASIC ANATOMY of the conduction system
2. Understanding LEAD PREPARATION / BEHAVIOUR / POSITIONING
3. TRANS-SEPTAL SCREWING technique
4. BASIC EP to confirm conduction system engagement

1. **Basic anatomy** of the conduction system

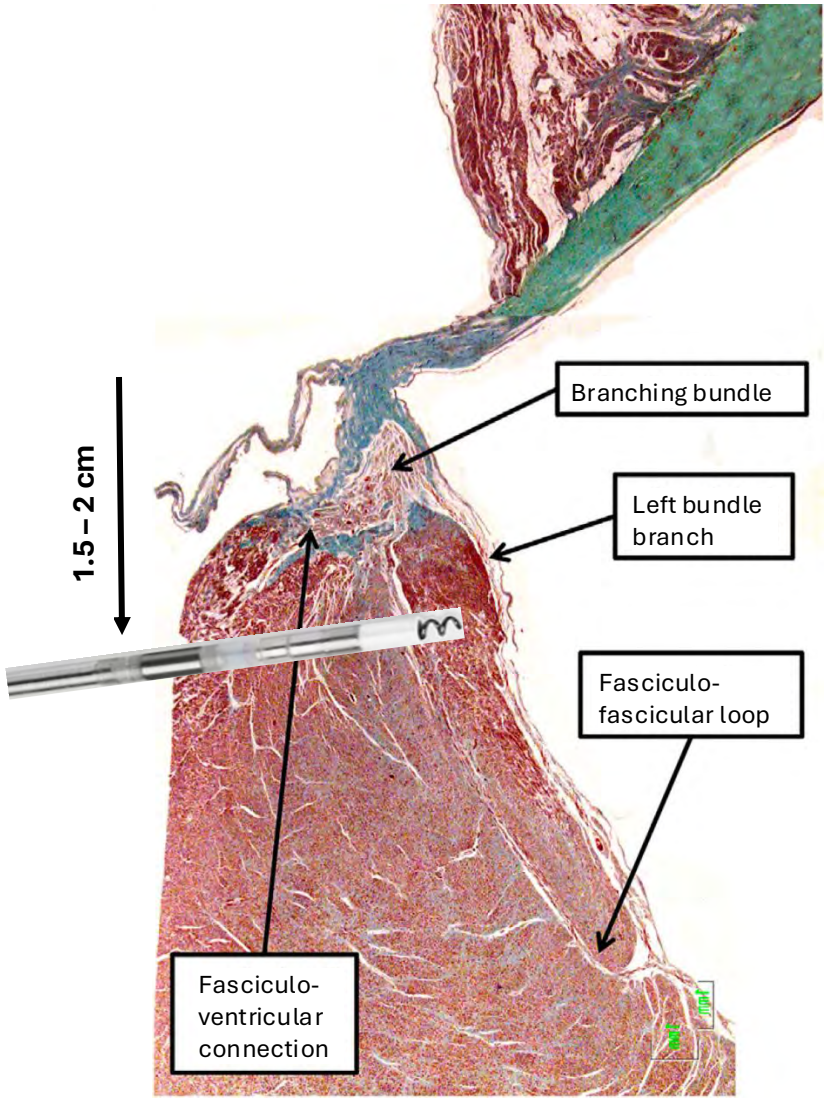


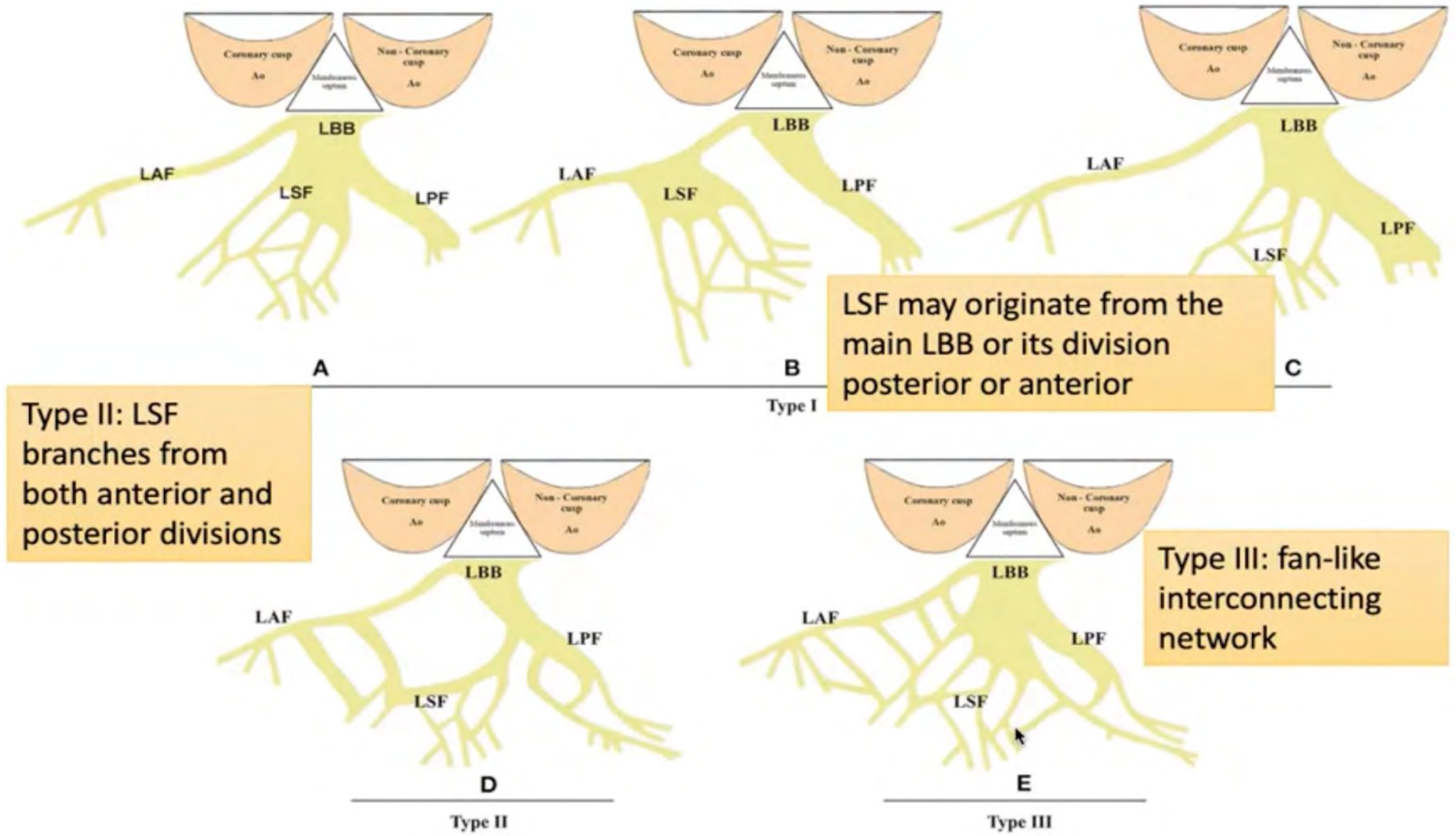




- Jastrzesbsky M et al. Europace 2020; 22, 156–161

1. **Basic anatomy** of the conduction system

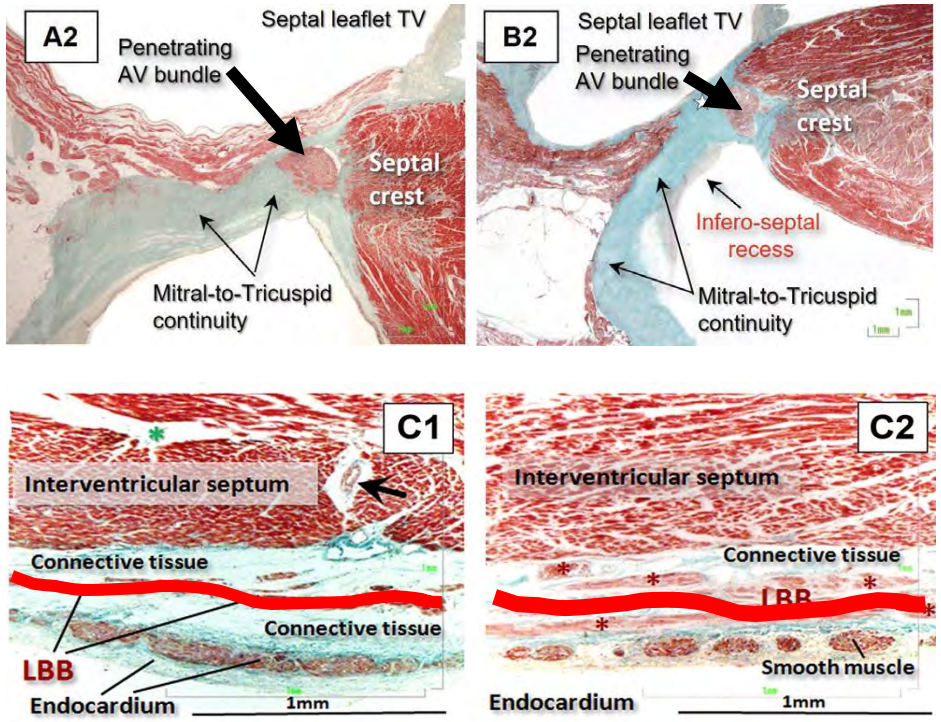


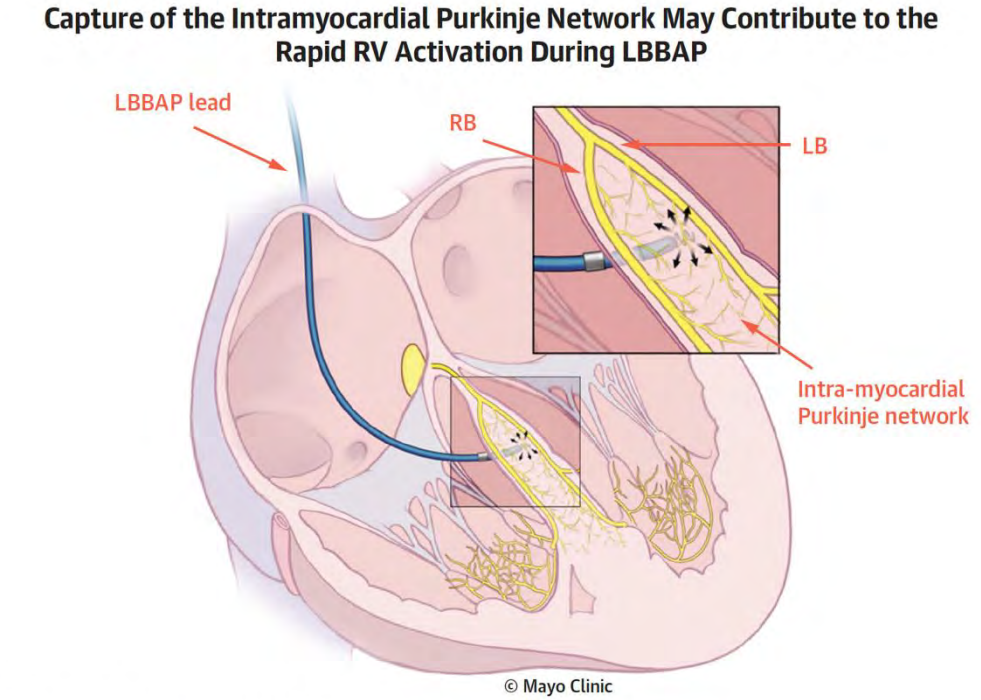


- Arrhythmia & Electrophysiology Review 2021;10:181–9

1. **Basic anatomy** of the conduction system

- **His bundle** encapsulated in fibrous tissue (atrial side) – ***higher thresholds***



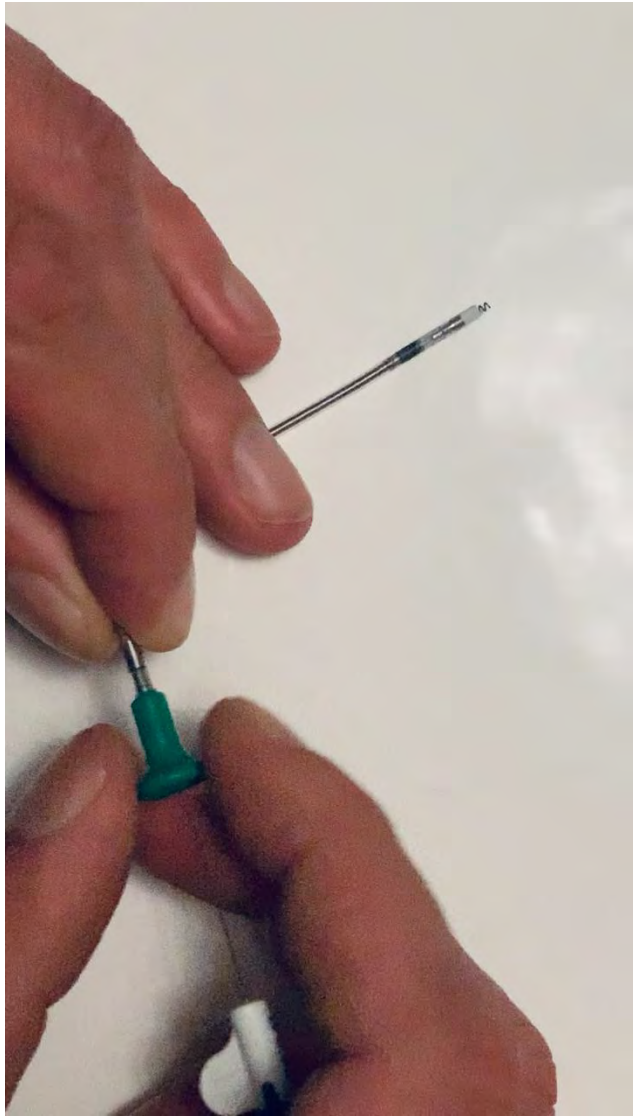


Liu X, et al. JACC Clin Electrophysiol. 2025

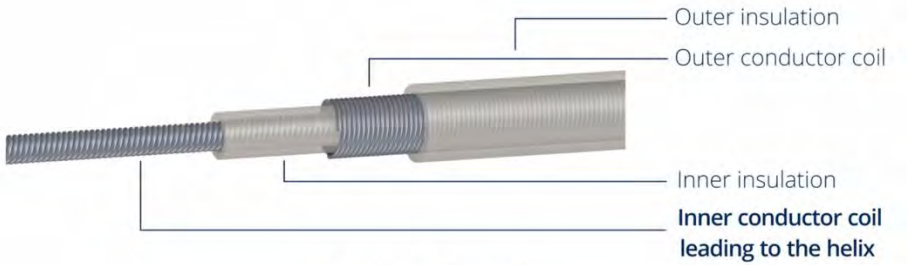
- **LBB** generally covered with myocytes – ***lower thresholds***
- connective tissue mainly on endocardial level – **prevents perforation**
- Fast conducting fibres are widely distributed and progressively broaden to create a subendocardial network – **anatomical variability**

- Tracking Down the Anatomy of the Left Bundle Branch to Optimize Left Bundle Branch Pacing, JACC Case Reports 2020;5:750-755

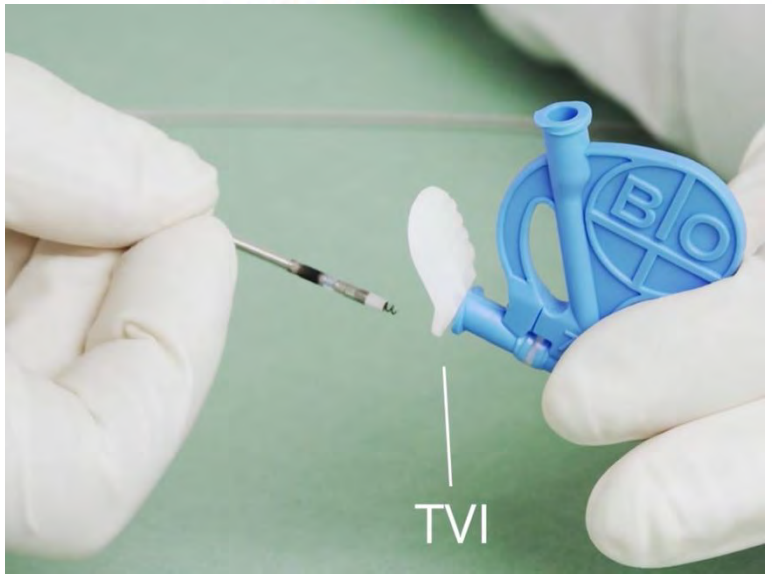
2. **Lead preparation** to reach the LBBAP



- building the tension on the inner coil
- **6 – 9** additional clockwise rotations



Solia S Lead



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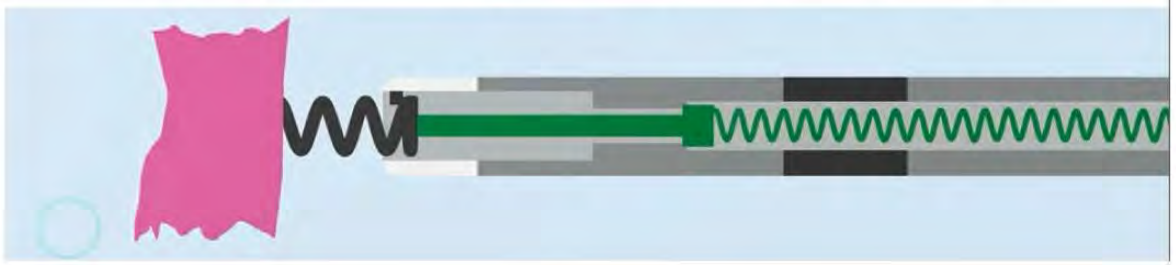


Retraction of extendible helix with screwing of lead

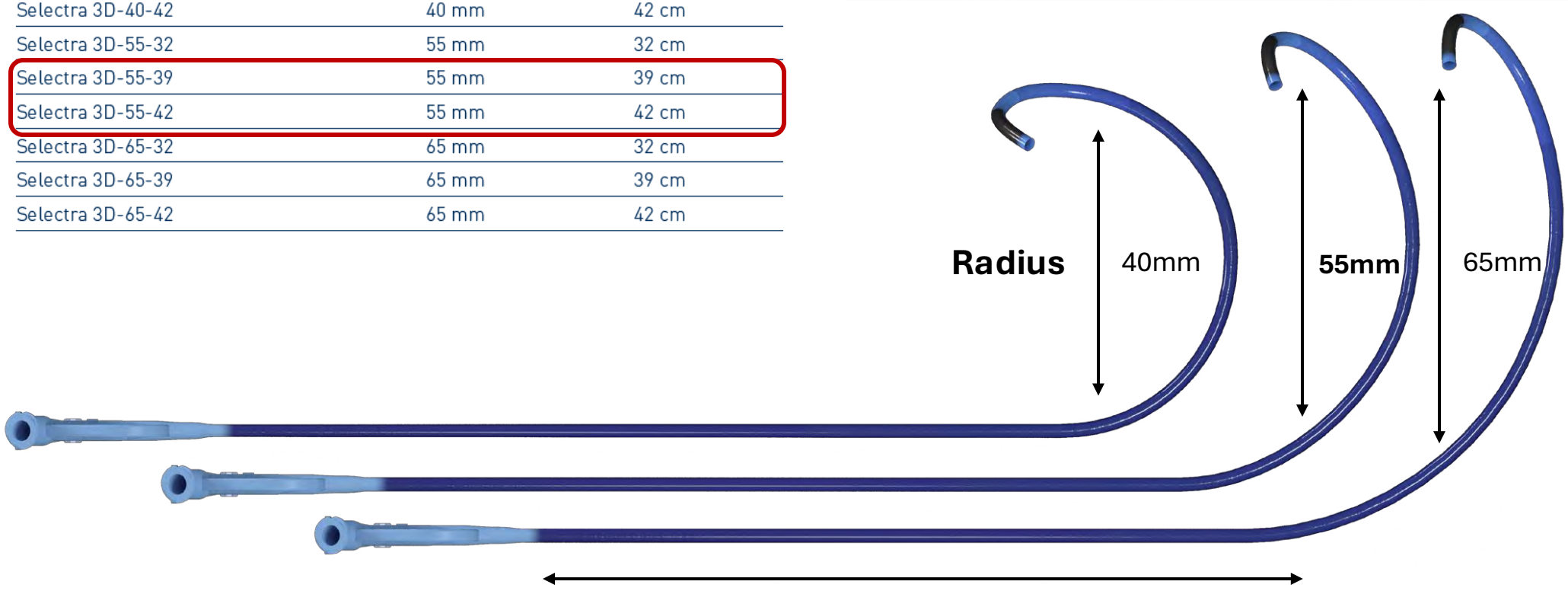
2. **Lead preparation** to reach the LBBAP

Model	Radius*	Length
Selectra 3D-40-32	40 mm	32 cm
Selectra 3D-40-39	40 mm	39 cm
Selectra 3D-40-42	40 mm	42 cm
Selectra 3D-55-32	55 mm	32 cm
Selectra 3D-55-39	55 mm	39 cm
Selectra 3D-55-42	55 mm	42 cm
Selectra 3D-65-32	65 mm	32 cm
Selectra 3D-65-39	65 mm	39 cm
Selectra 3D-65-42	65 mm	42 cm

- Selection based on:

RA size – *Radius size* and **patient size** – *Length*

- **55-39** / **55-42** most commonly used**!**

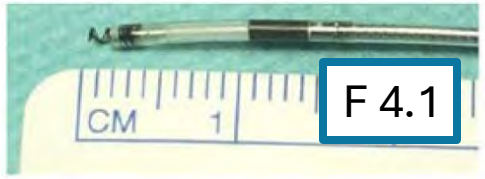


Lumen-less lead *vs*. stylet-driven lead(s)

LL

SDL

SelectSecure 3830 Medtronic



- electrically active fixed helix
- similar helix length
- smaller body diameter

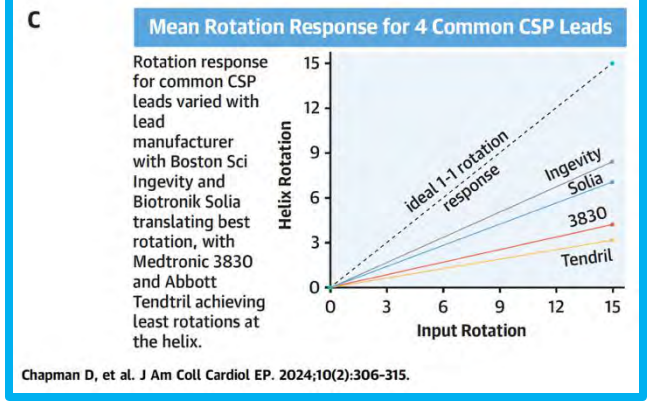
SoliaS Biotronik

- greater body diameter
- retractable helix – fragile!!

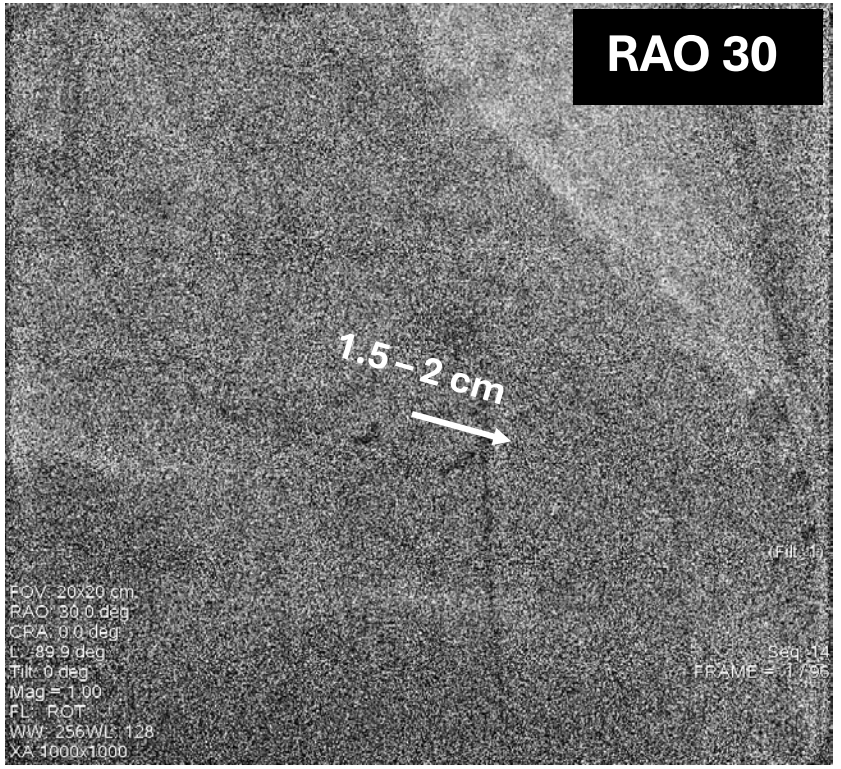
Ingevity Boston Scientific

- cont. pacing during implant
- add. stiffness and grip
- cont. assessment of pacing

Tendril 2825 Abbott



2. **Lead positioning** to reach the LBBAP



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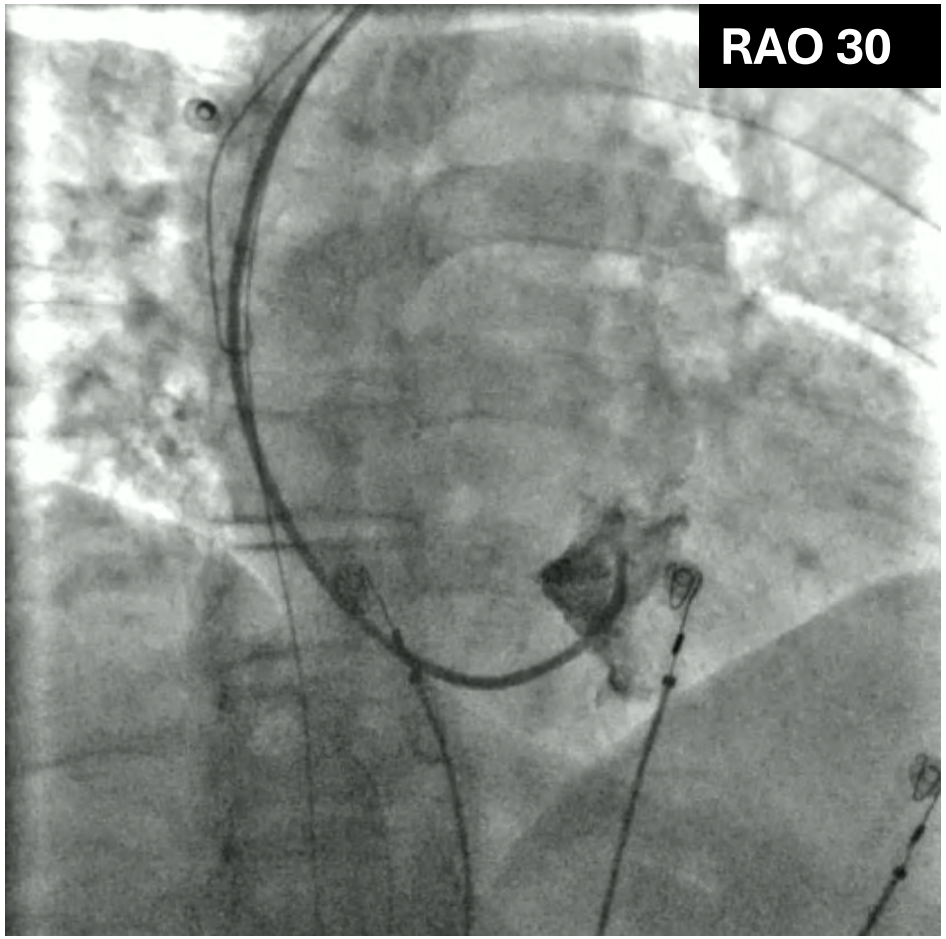

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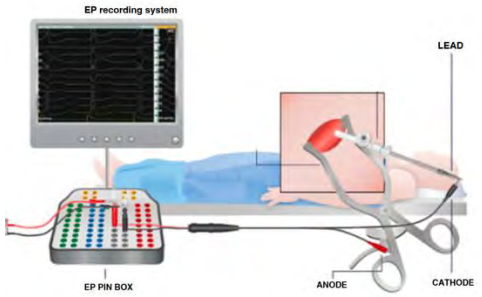
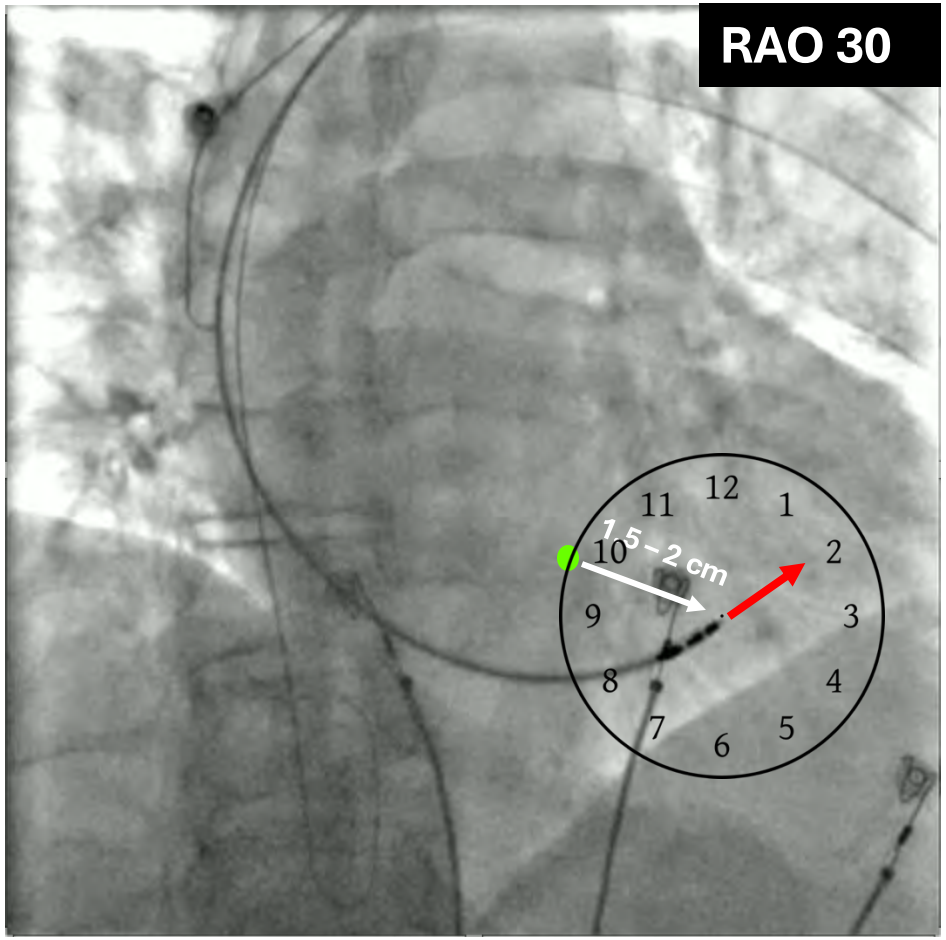
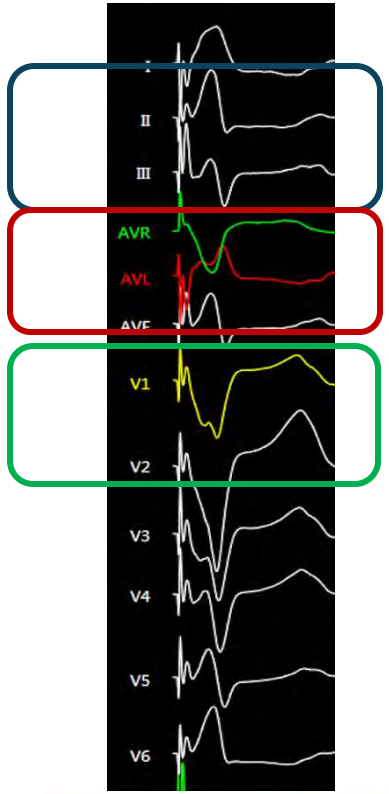
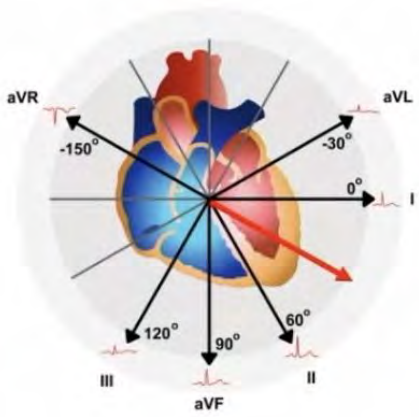
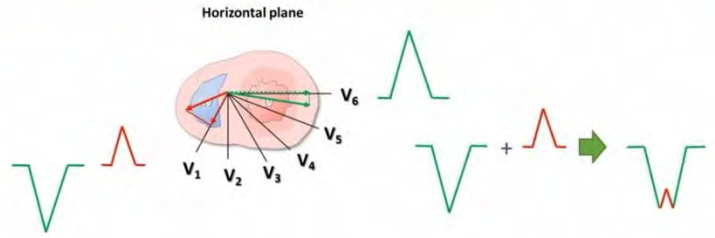








- Notch is a sign of the activation of RV base



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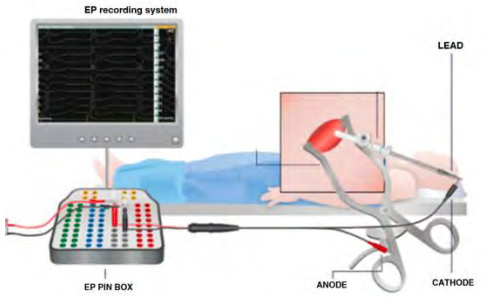
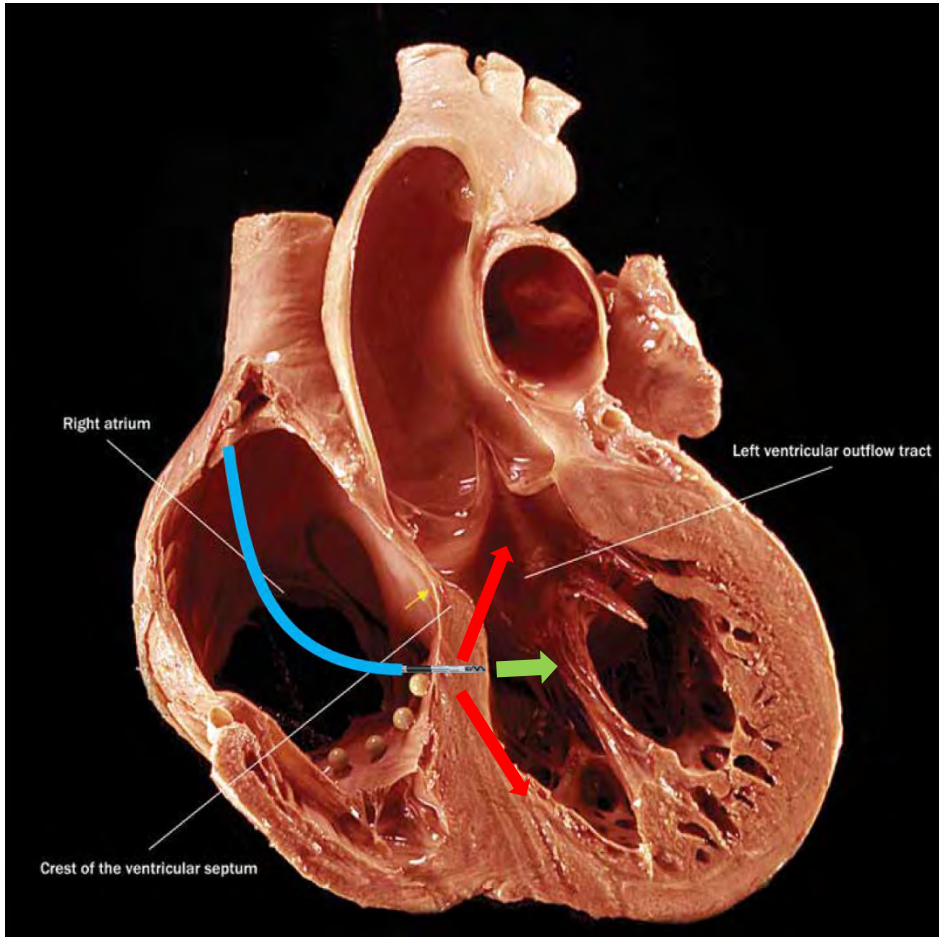
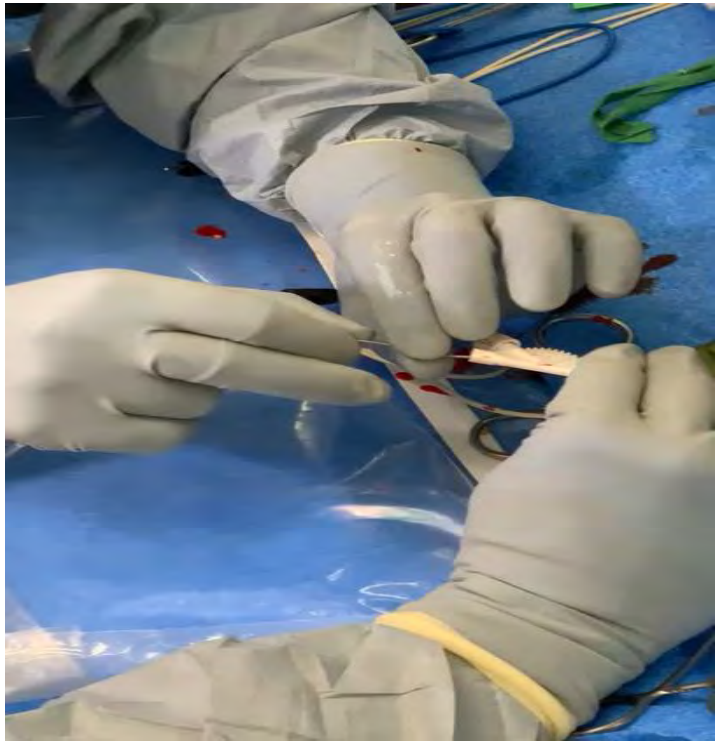
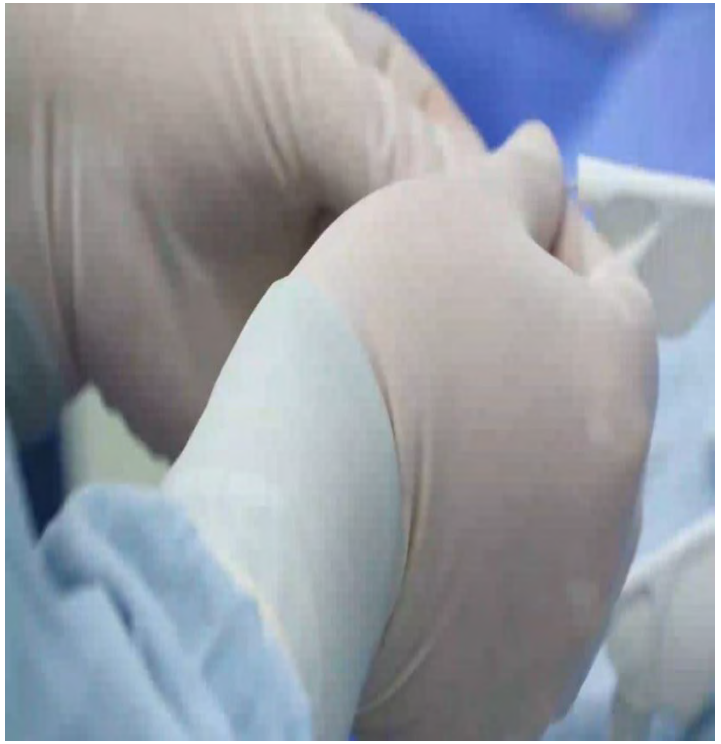




3. **Trans-septal screwing technique**





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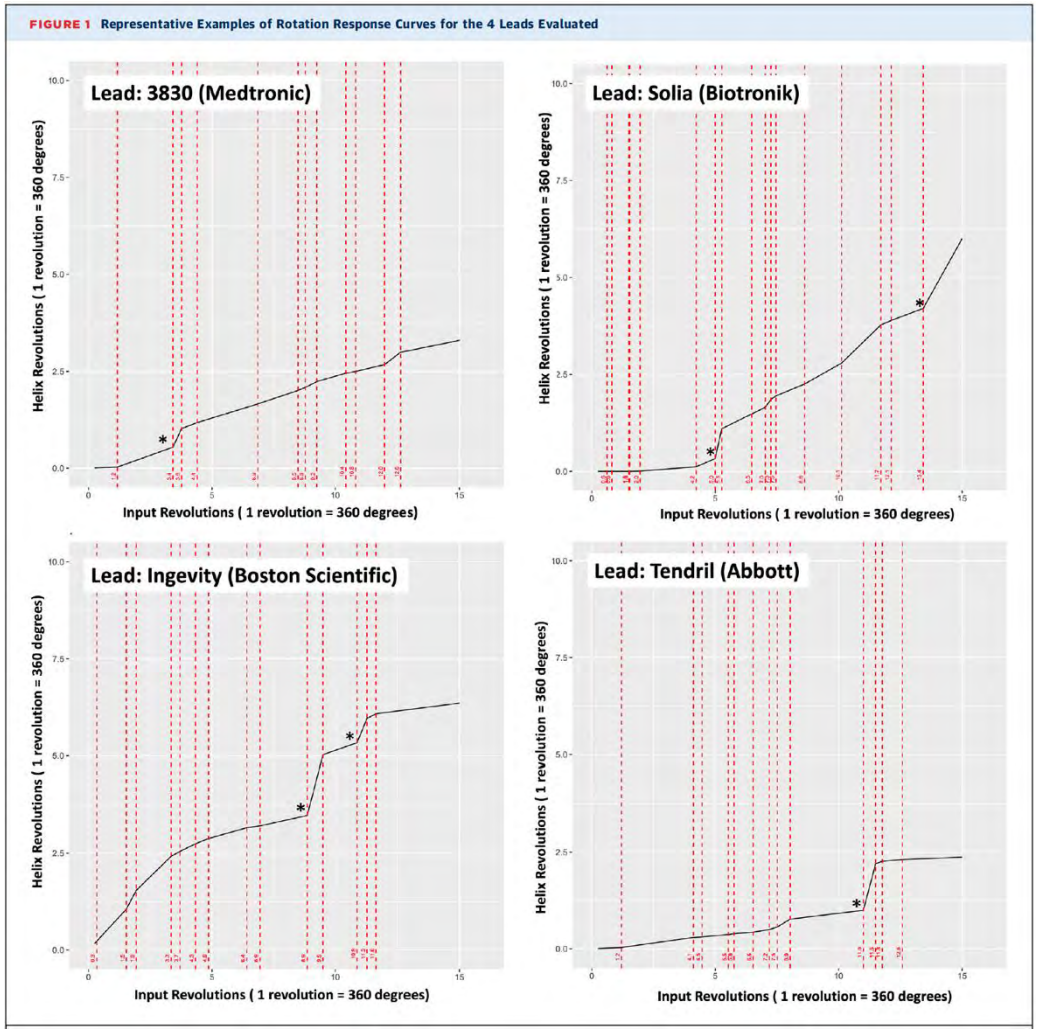
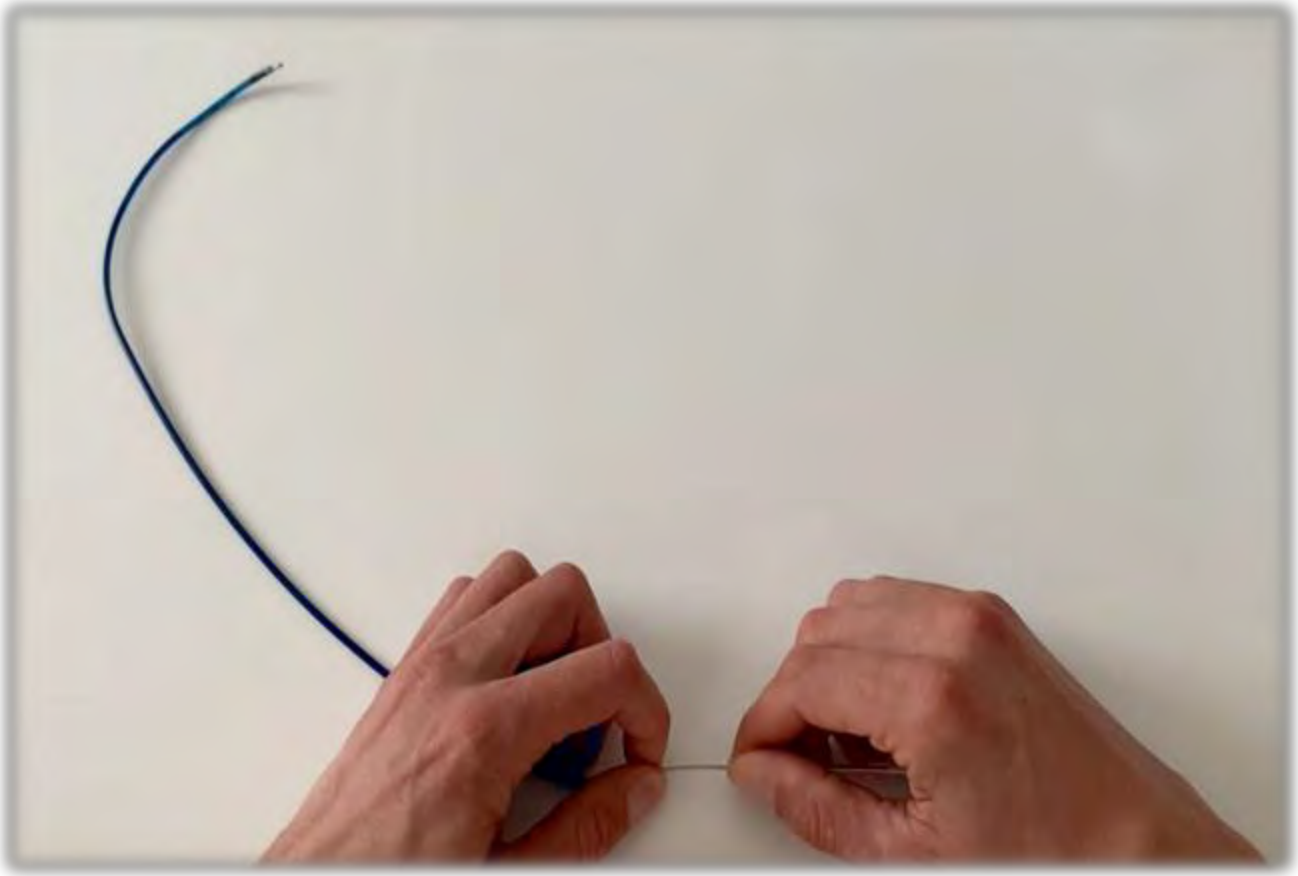
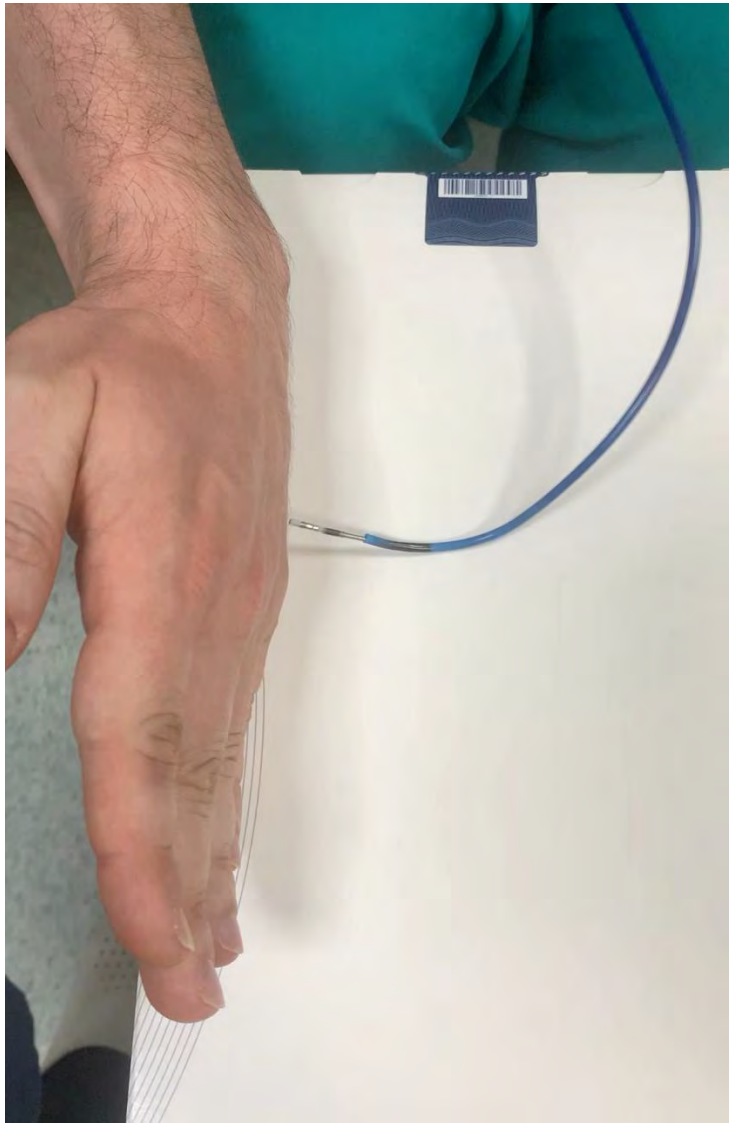


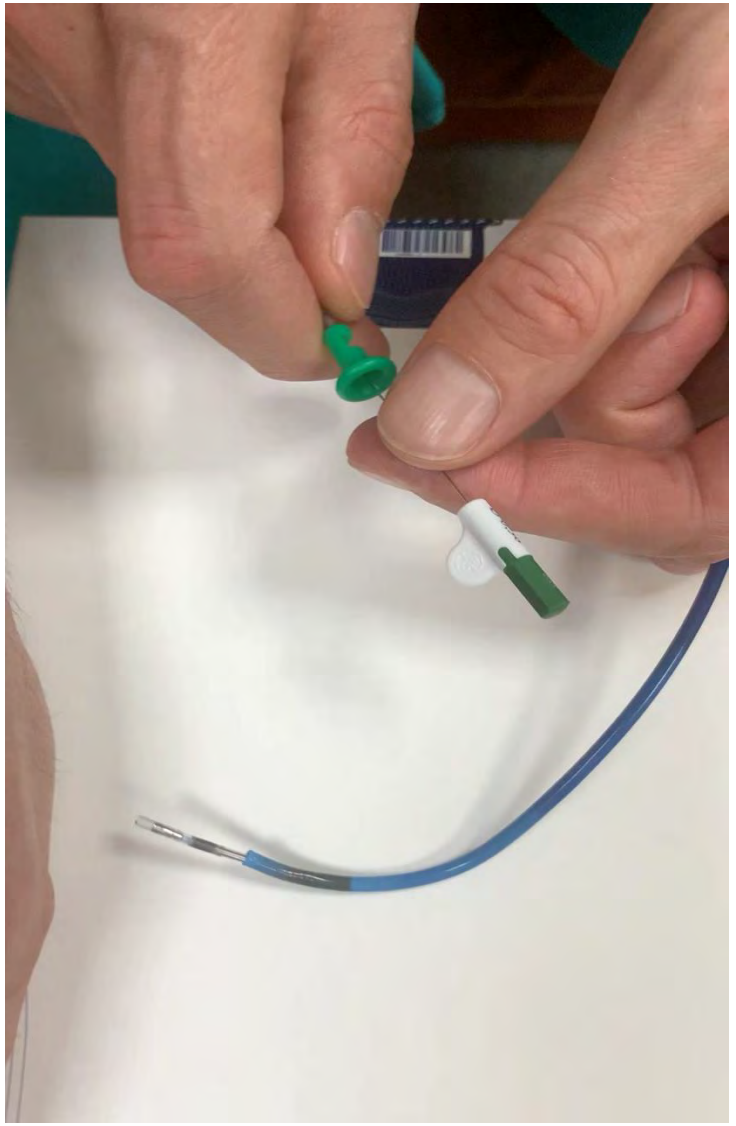
"**medium** paced + **constant** double handed whole lead body rotations"



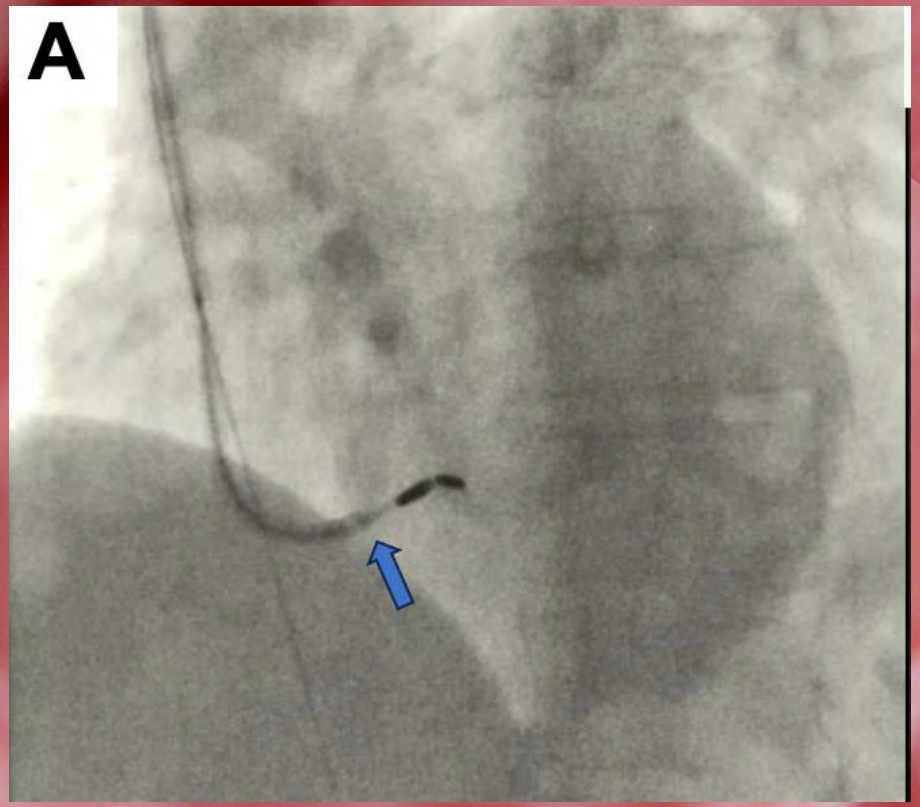
J Am Coll Cardiol EP 2024;10:306-315

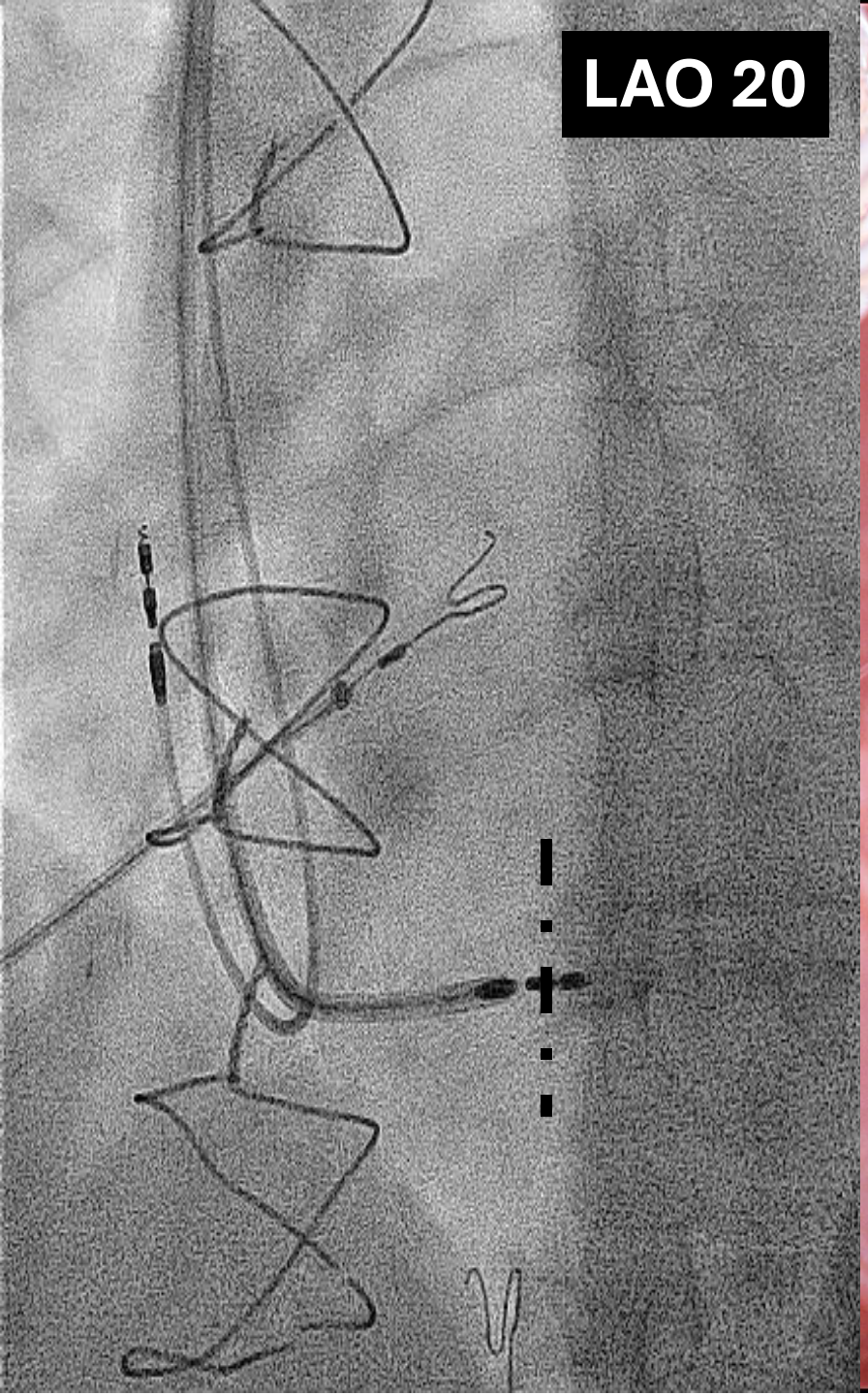
3. **Trans-septal screwing technique**

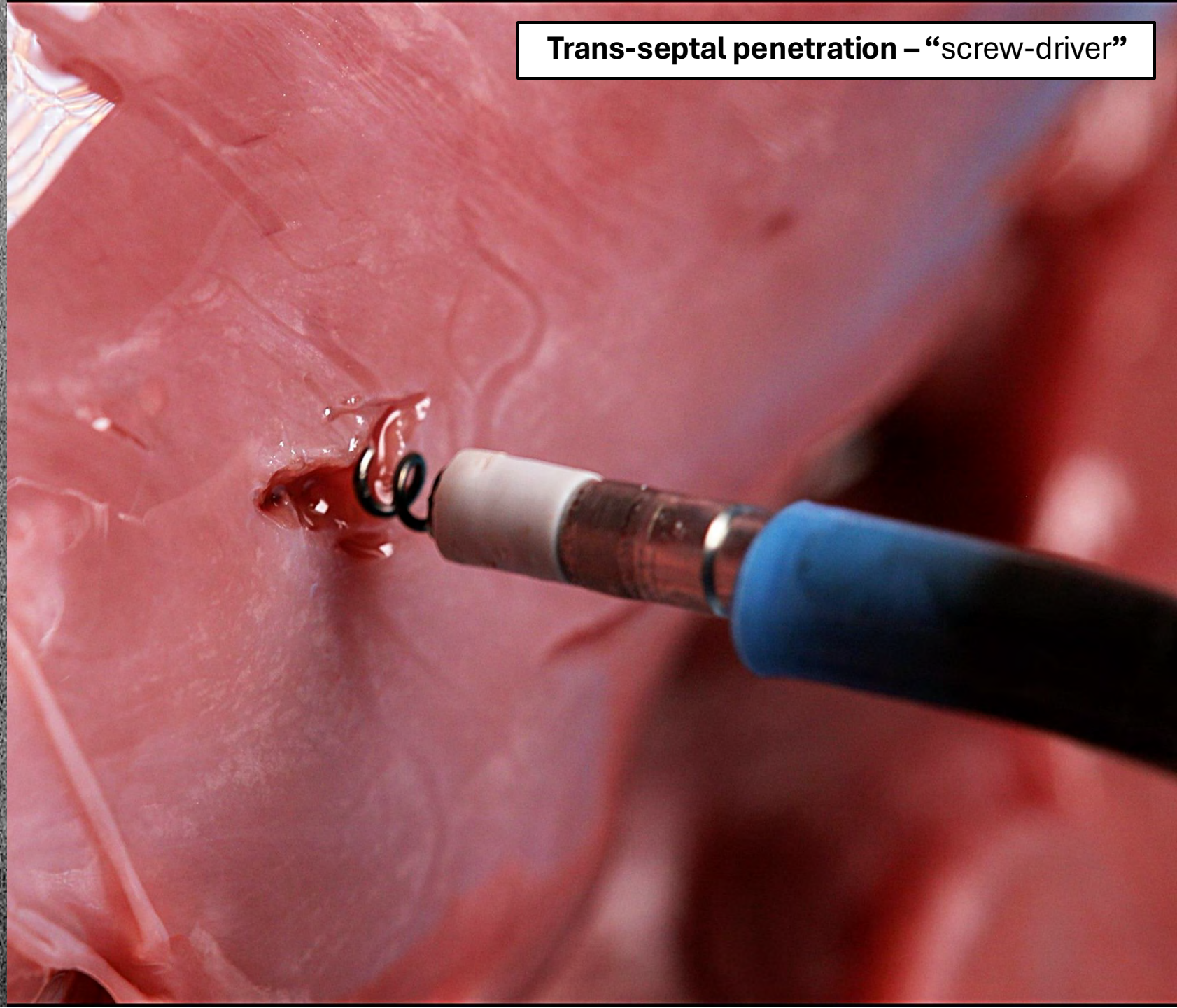


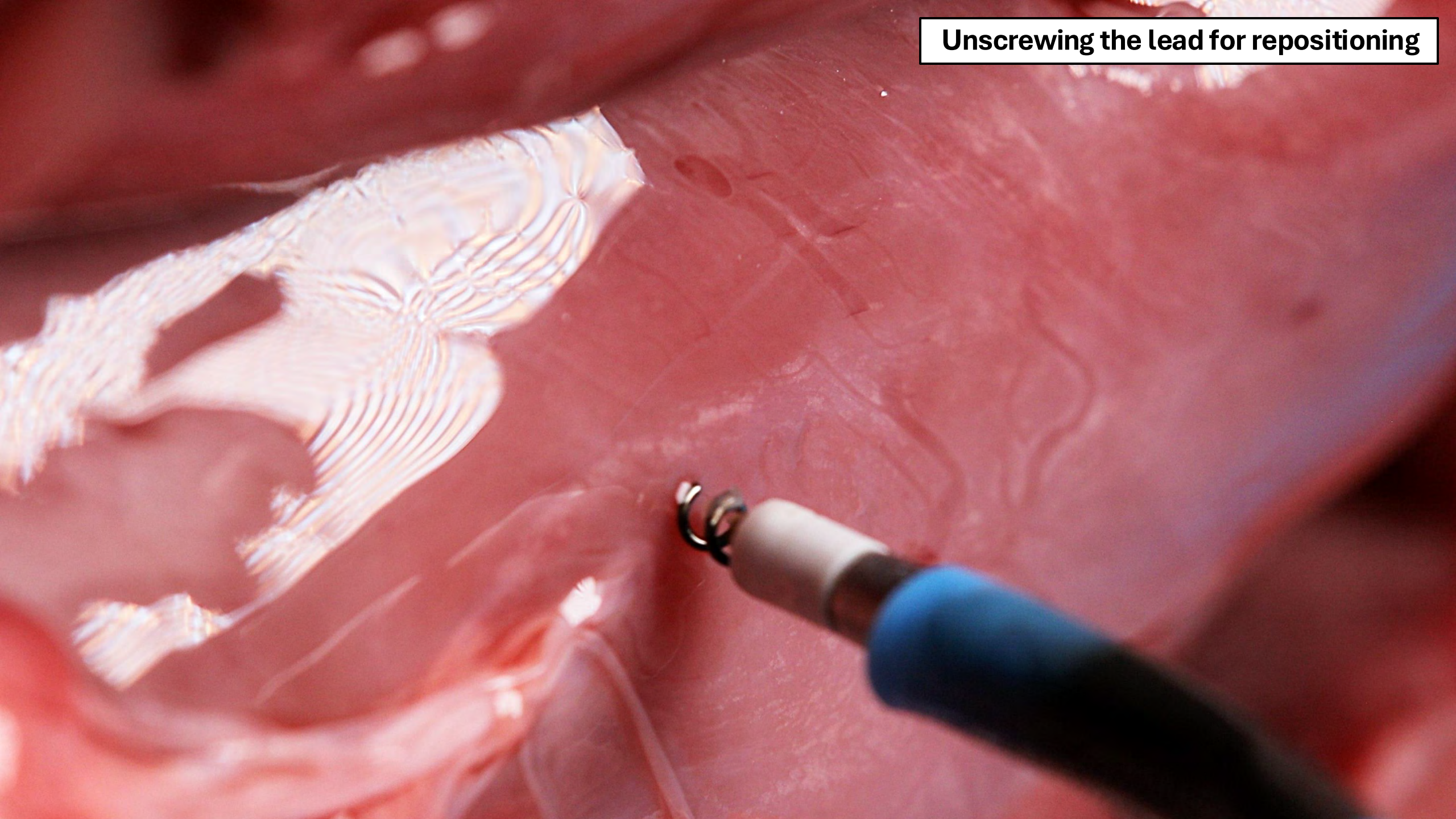


Unstable distal part of the lead – “buckling lead**”**



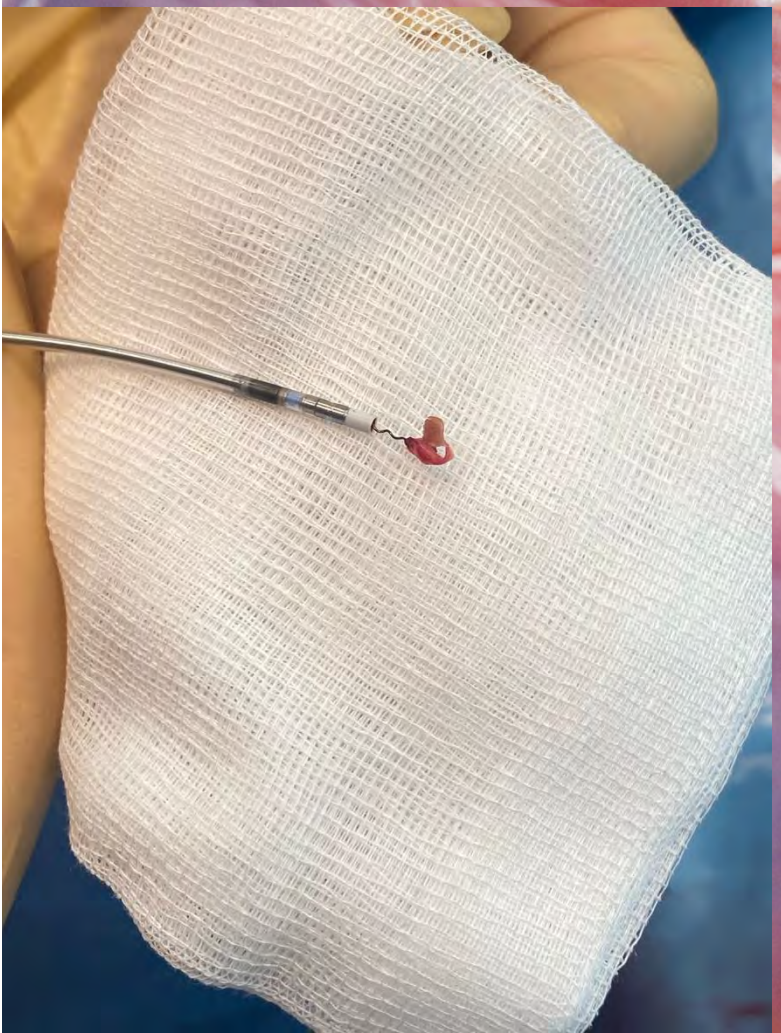

LAO 20

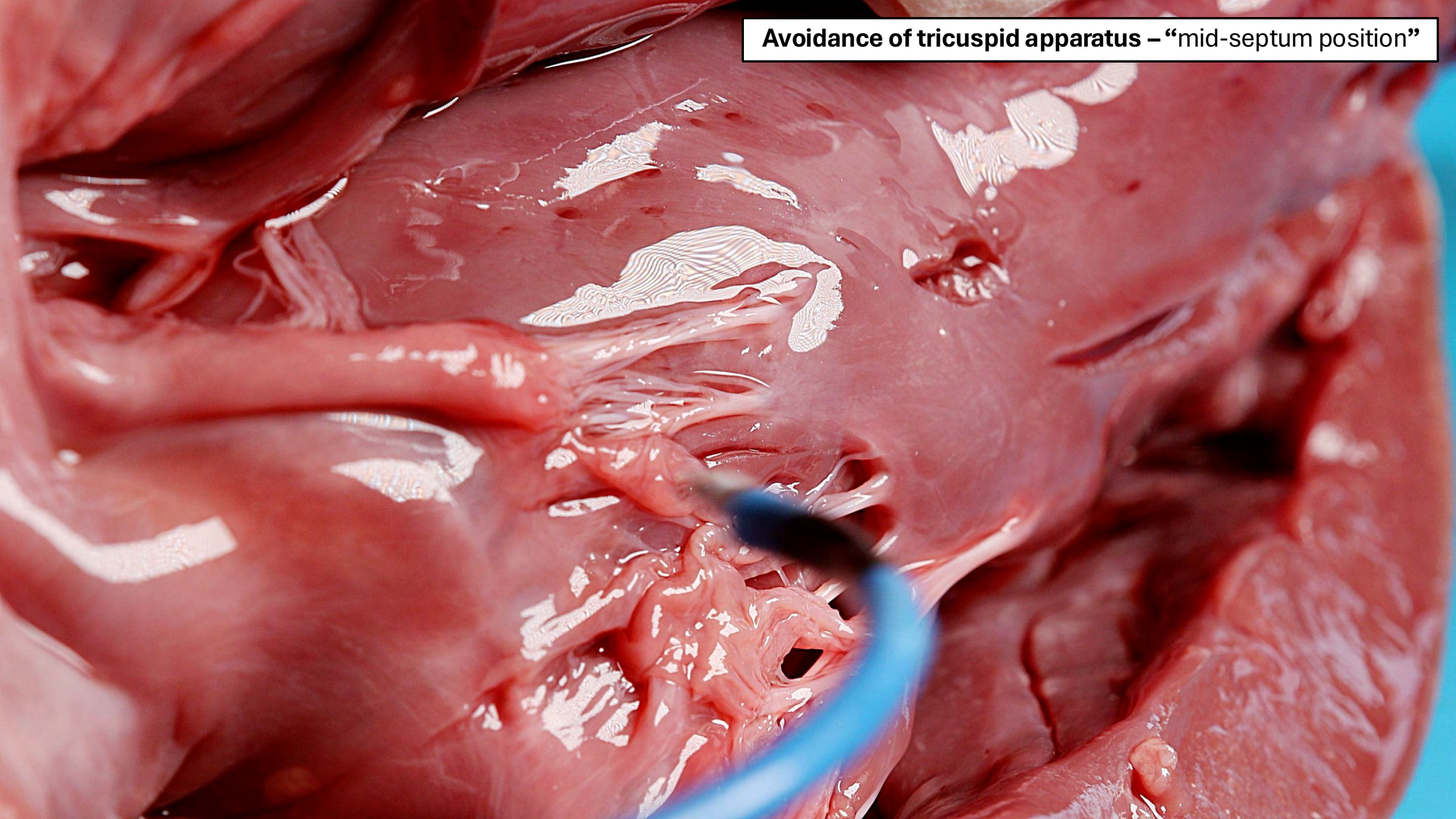

Trans-septal penetration – “screw-driver”

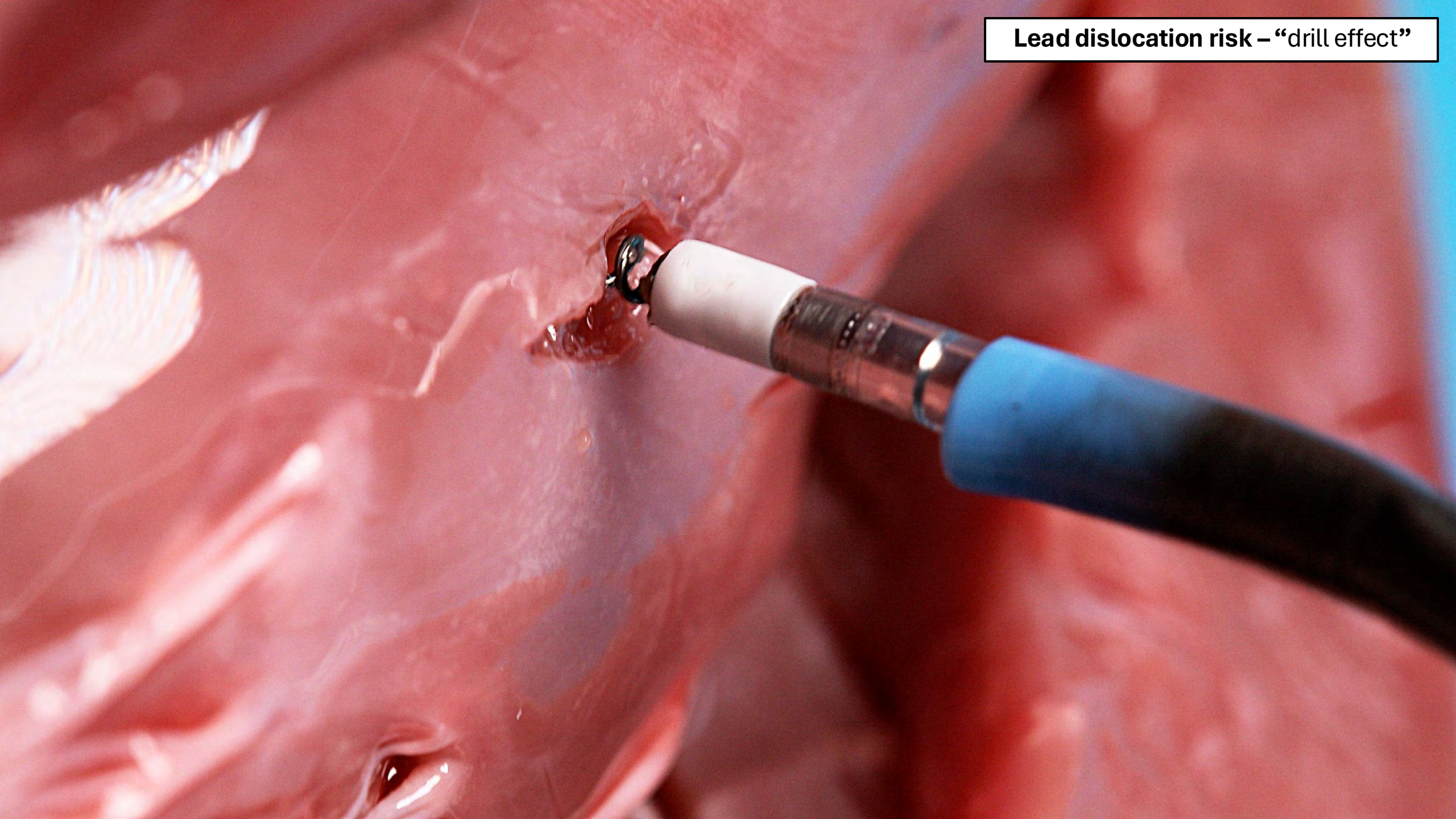


Unscrewing the lead for repositioning

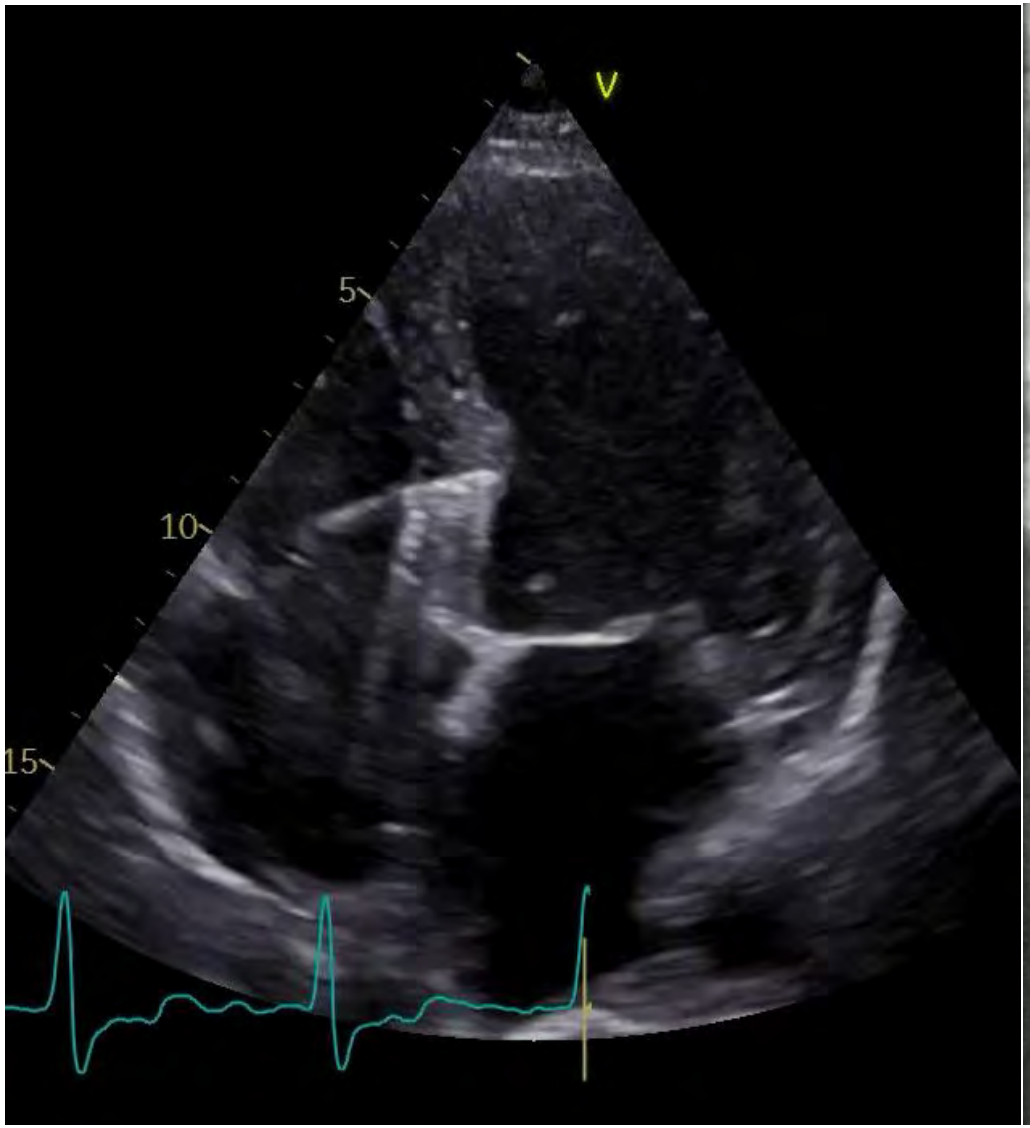
Avoidance of tricuspid apparatus – “entanglement of the lead”

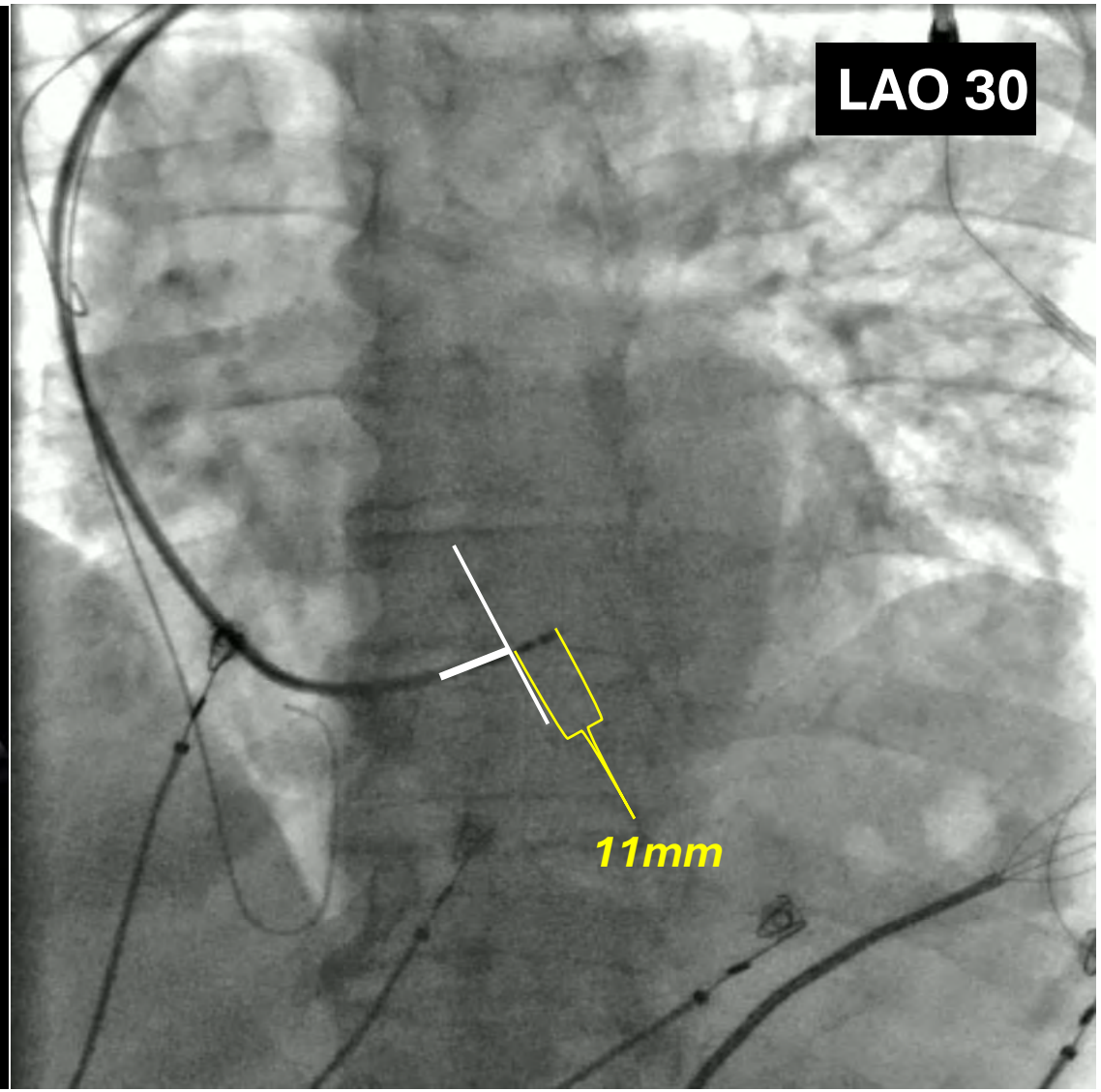



Avoidance of tricuspid apparatus – “mid-septum position”

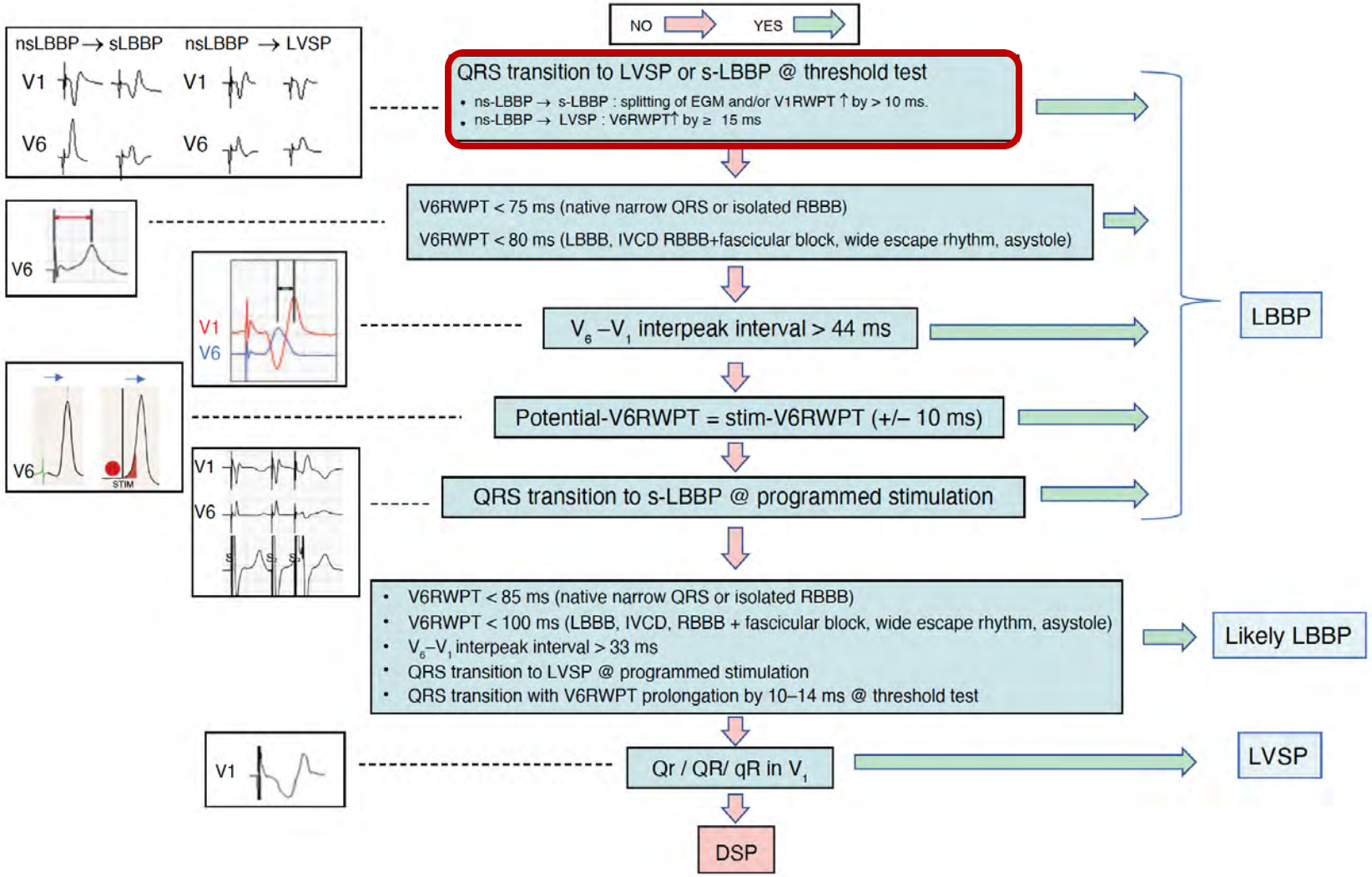

Lead dislocation risk – “drill effect”

3. **Trans-septal screwing technique**



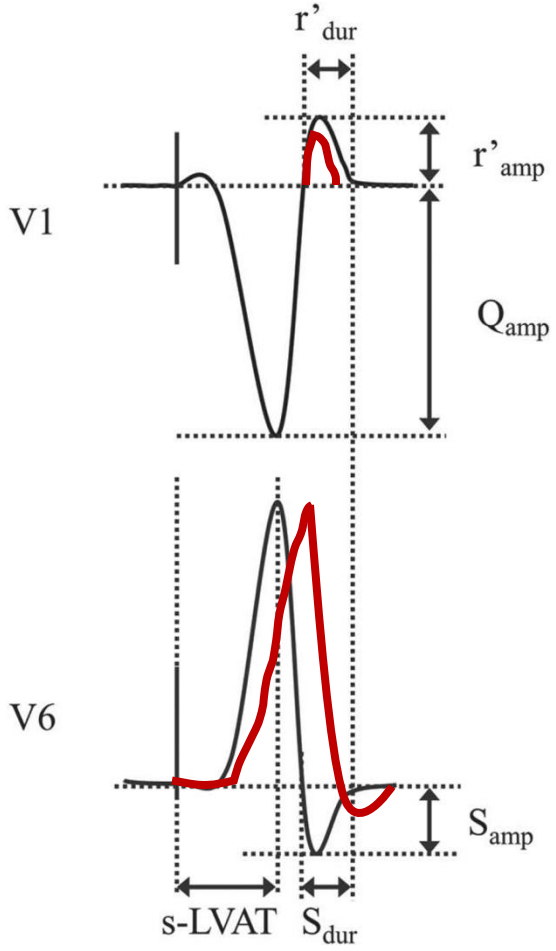


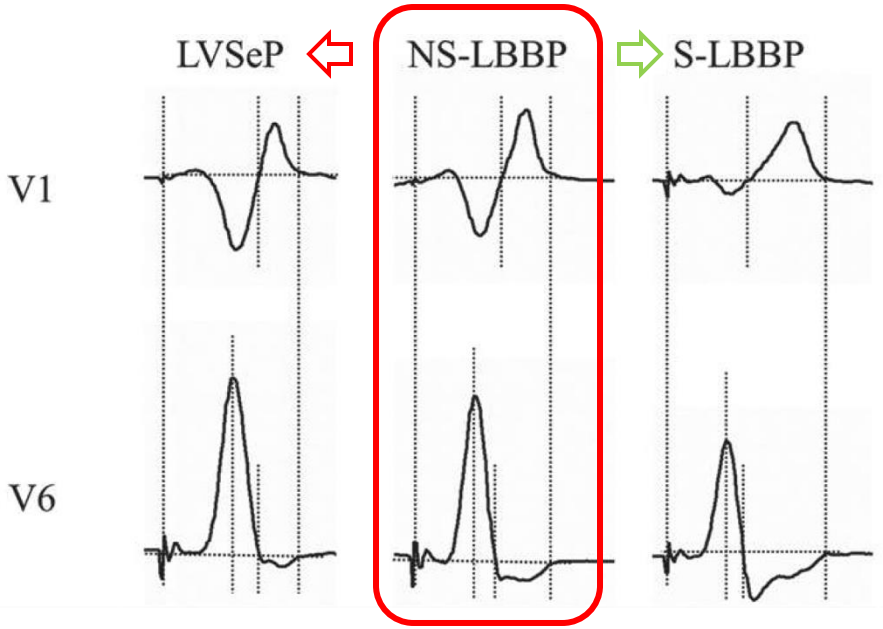
4. **Basic EP**



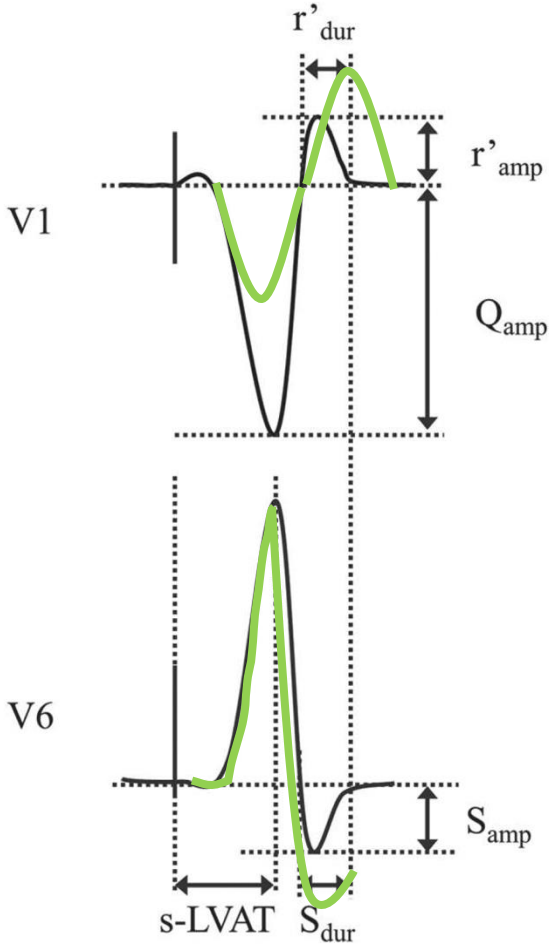
- Burri H, Jastrzebski M, et al. EHRA clinical consensus statement on conduction system pacing implantation. Europace. 2023; 25: 1208-1236

ASSESSMENT OF **QRS TRANSITION (V1/V6)**



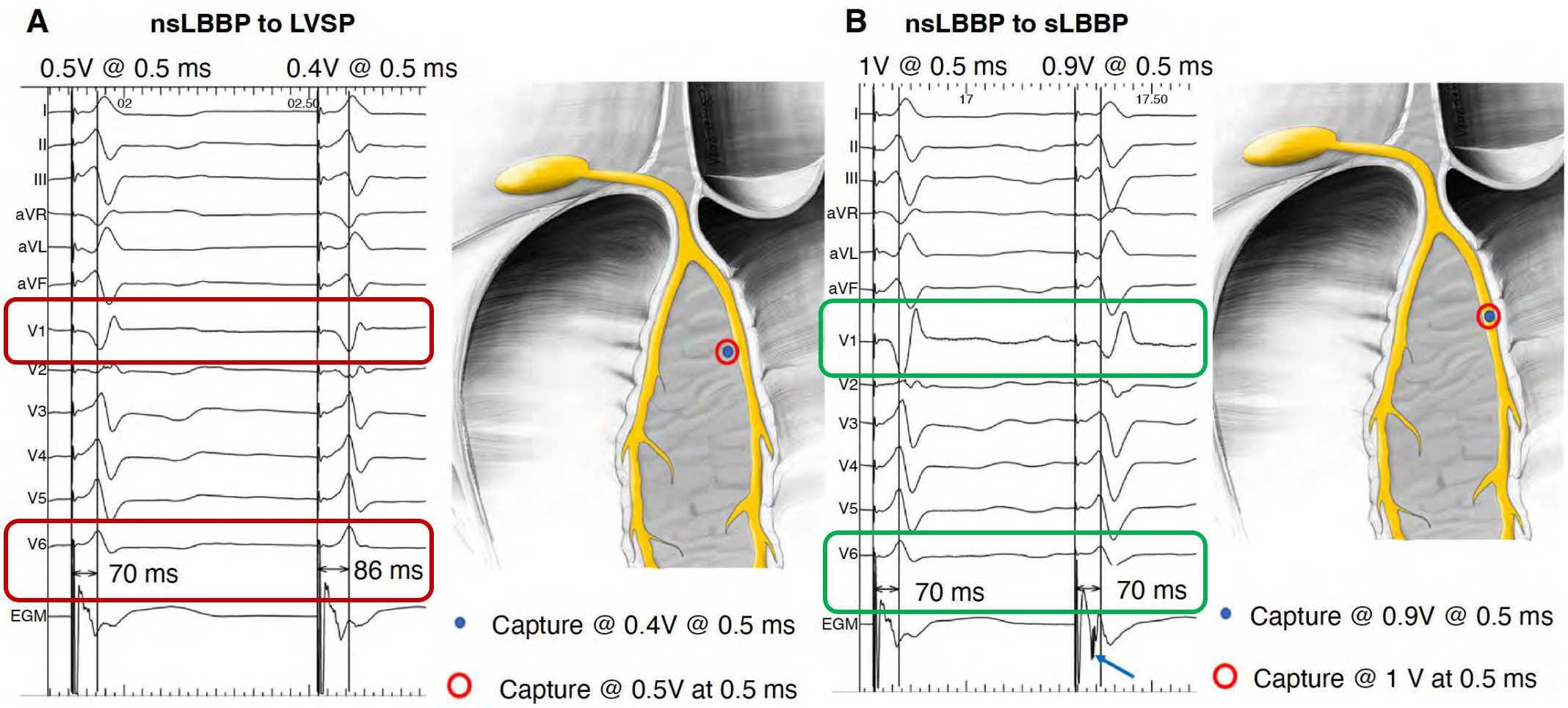


*Threshold test should be conducted in **unipolar pacing mode** at a **constant rate** with output slowly decreased until LOC!!*



Pacing Clin Electrophysiol. 2021;1–8.

ASSESSMENT OF **QRS TRANSITION (V1/V6)**



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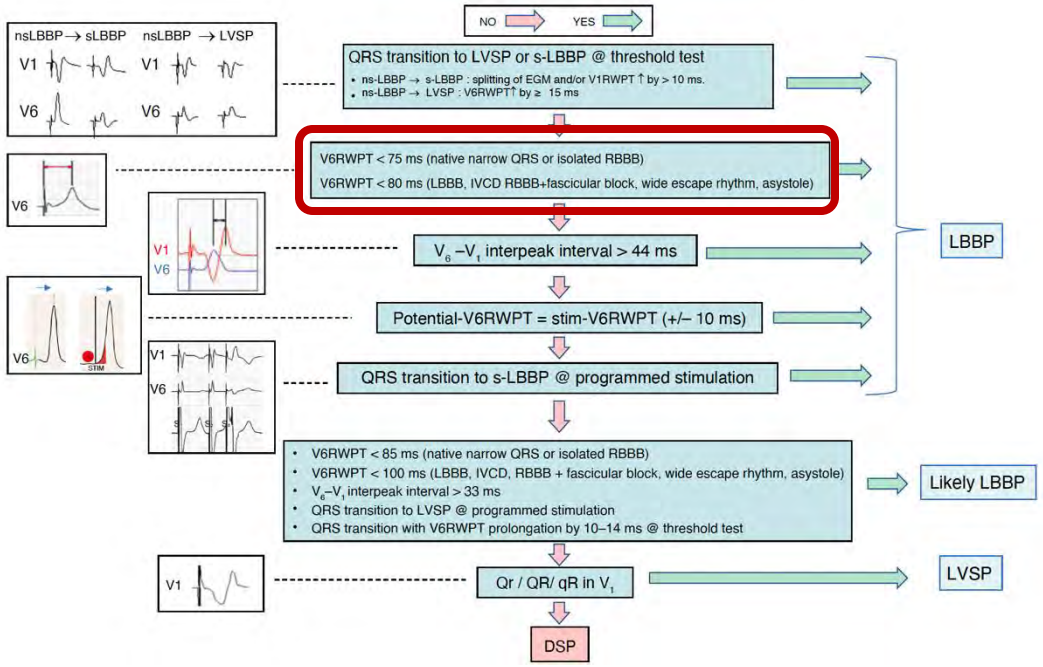
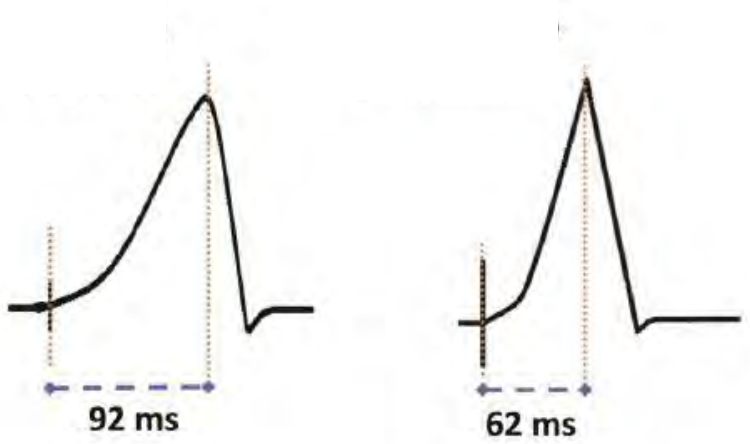
4. **Basic EP**



V6RWPT (nonLBBB) < ***75 ms***
V6RWPT (LBBB, IVCD) < ***80 ms***

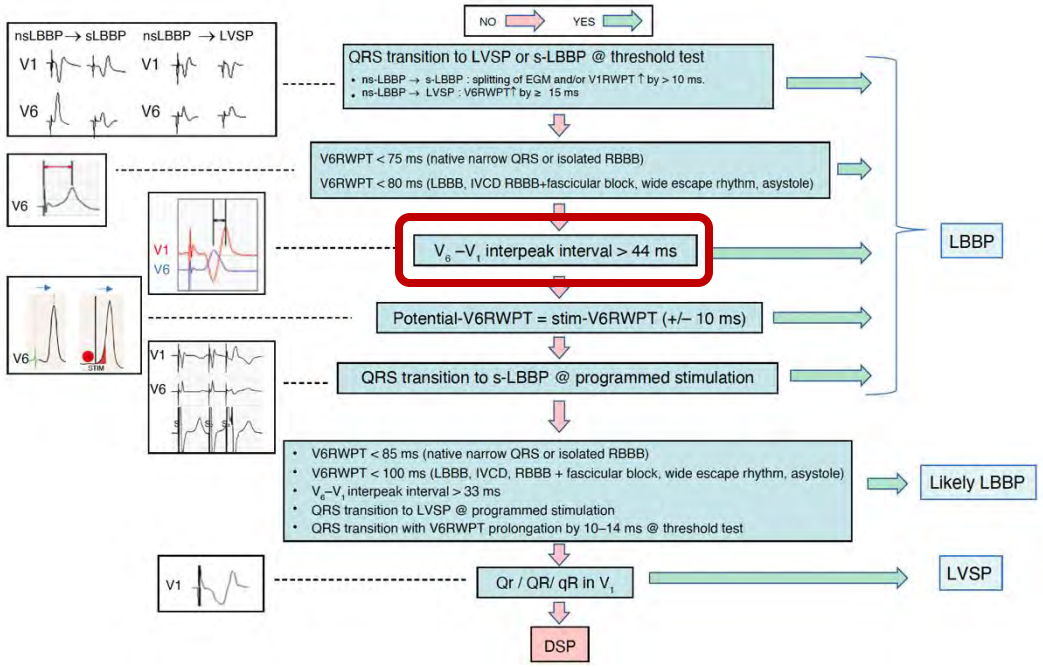


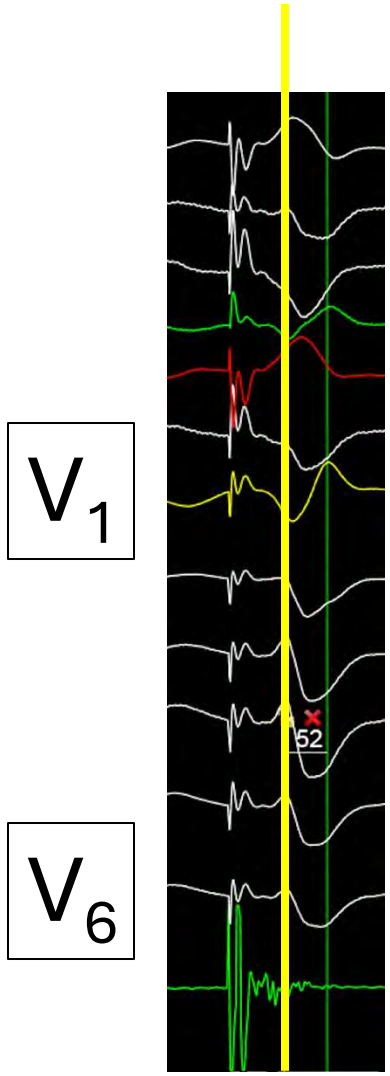
V_6 RWPT

Long V6RWPT might be caused:
- initial latency
- slower propagation via diseased HPS
- substantial LV dilatation

COMBINATION of these factors

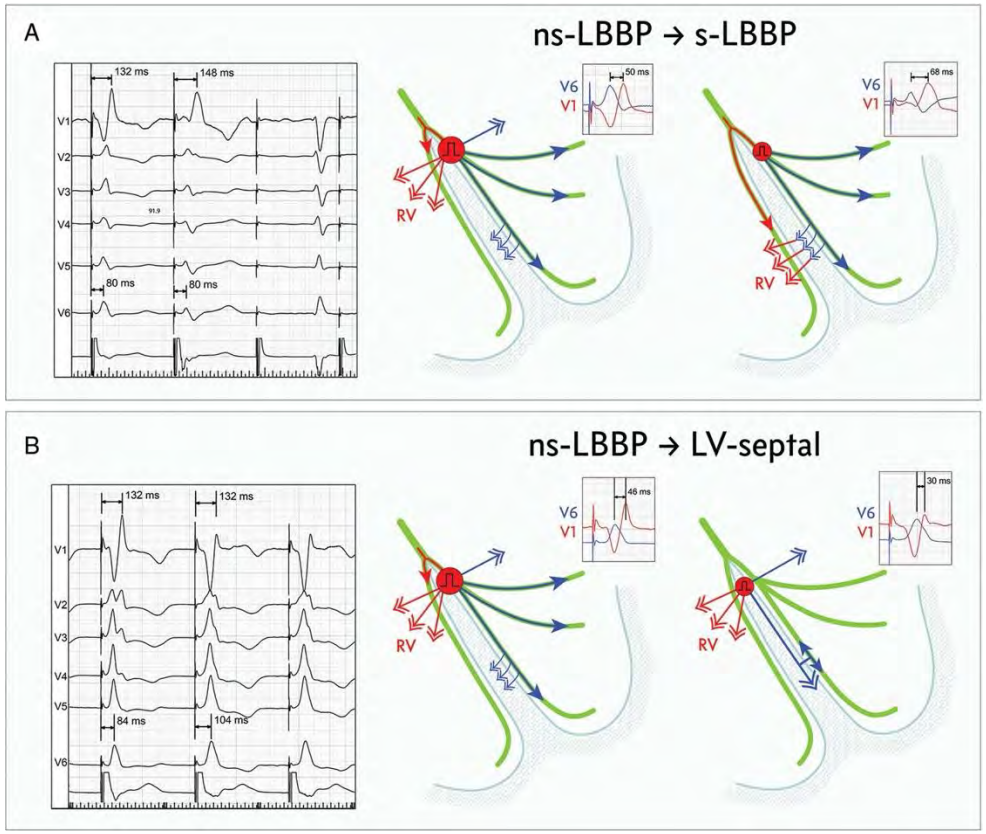
4. **Basic EP**

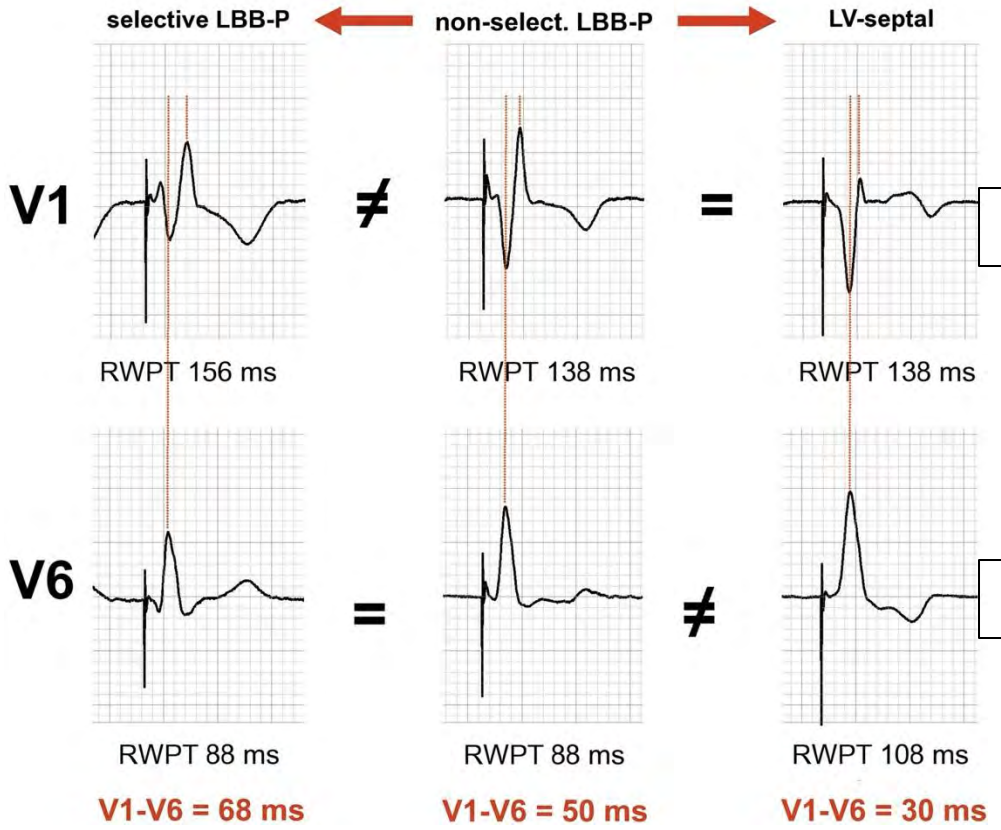




V_6-V_1 > ***44 ms***

V_6-V_1 interpeak interval > ***44 ms***





RV activation delay

LV activation delay

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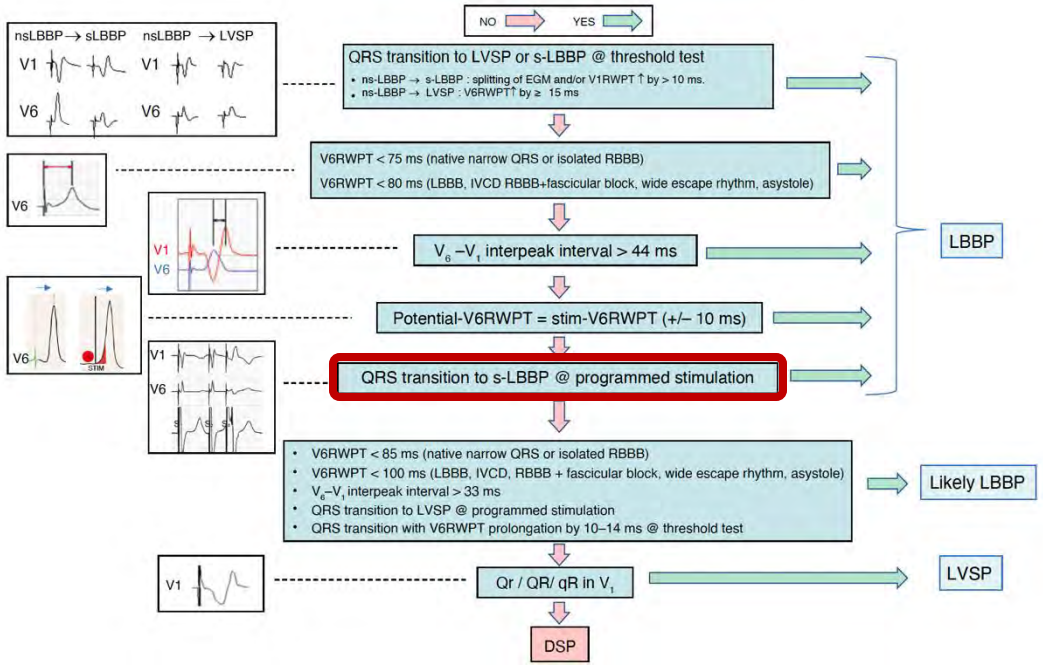
4. Basic EP


nsLBBP → sLBBP
nsLBBP → LVSP
V1
V6
NO
YES
QRS transition to LVSP or s-LBBP @ threshold test
• ns-LBBP → s-LBBP : splitting of EGM and/or V1RWPT ↑ by > 10 ms.
• ns-LBBP → LVSP : V6RWPT↑ by ≥ 15 ms
V6RWPT < 75 ms (native narrow QRS or isolated RBBB)
V6RWPT < 80 ms (LBBB, IVCD RBBB+fascicular block, wide escape rhythm, asystole)
V6 –V1 interpeak interval > 44 ms
Potential-V6RWPT = stim-V6RWPT (+/– 10 ms)
QRS transition to s-LBBP @ programmed stimulation
LBBP
• V6RWPT < 85 ms (native narrow QRS or isolated RBBB)
• V6RWPT < 100 ms (LBBB, IVCD, RBBB + fascicular block, wide escape rhythm, asystole)
• V6–V1 interpeak interval > 33 ms
• QRS transition to LVSP @ programmed stimulation
• QRS transition with V6RWPT prolongation by 10–14 ms @ threshold test
Likely LBBP
Qr / QR/ qR in V1
LVSP
DSP


1000
390
290

Programmed stimulation rationale - **ERP**

To obtain selective response with S2 or S3, it is recommended to use pacing protocols that **shorten refractoriness of the LBB** and **prolong refractoriness of the septal myocardium**.

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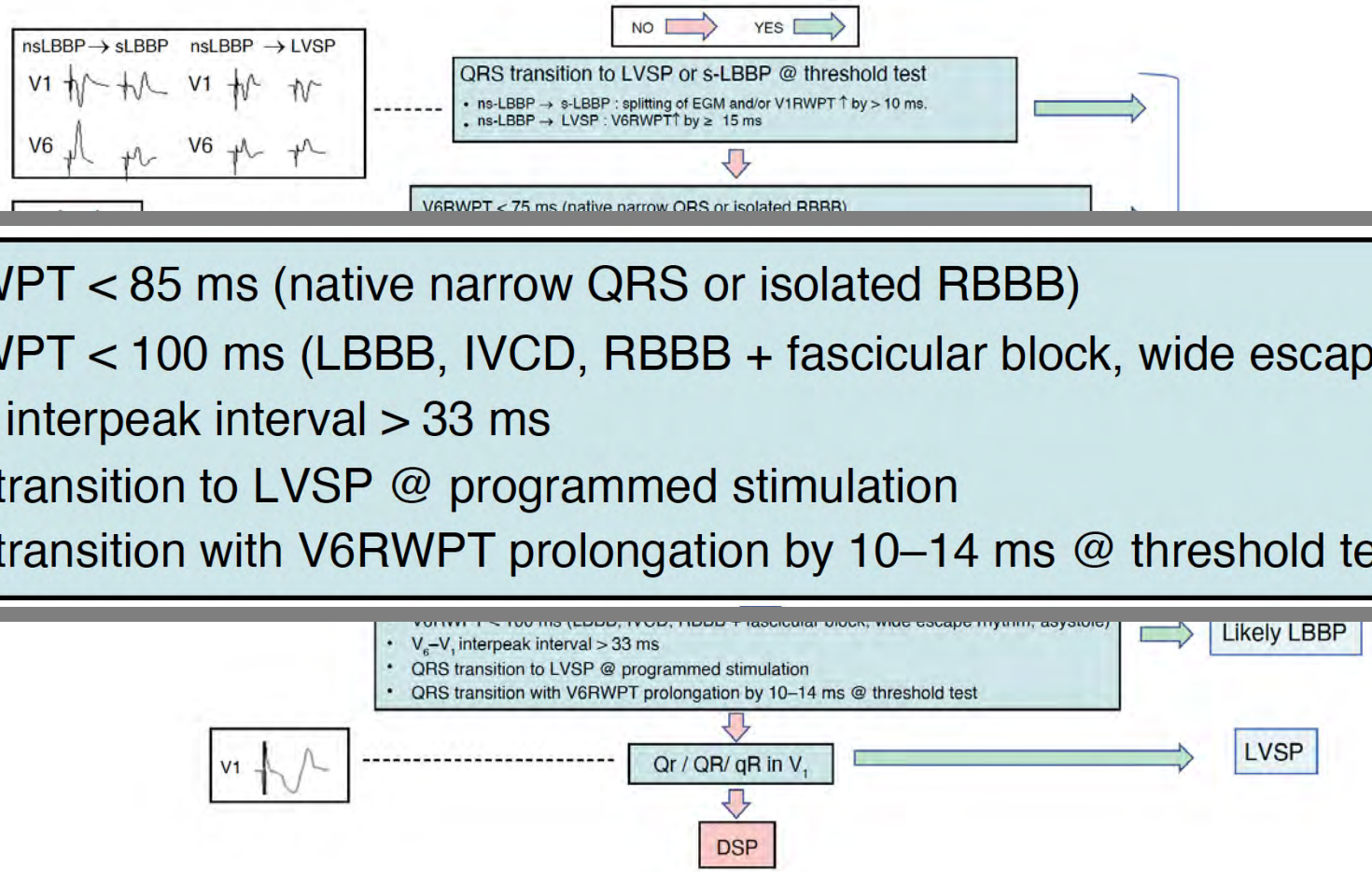
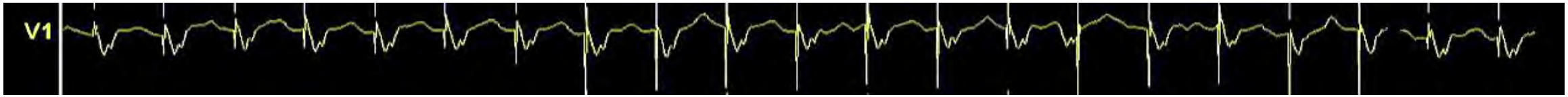
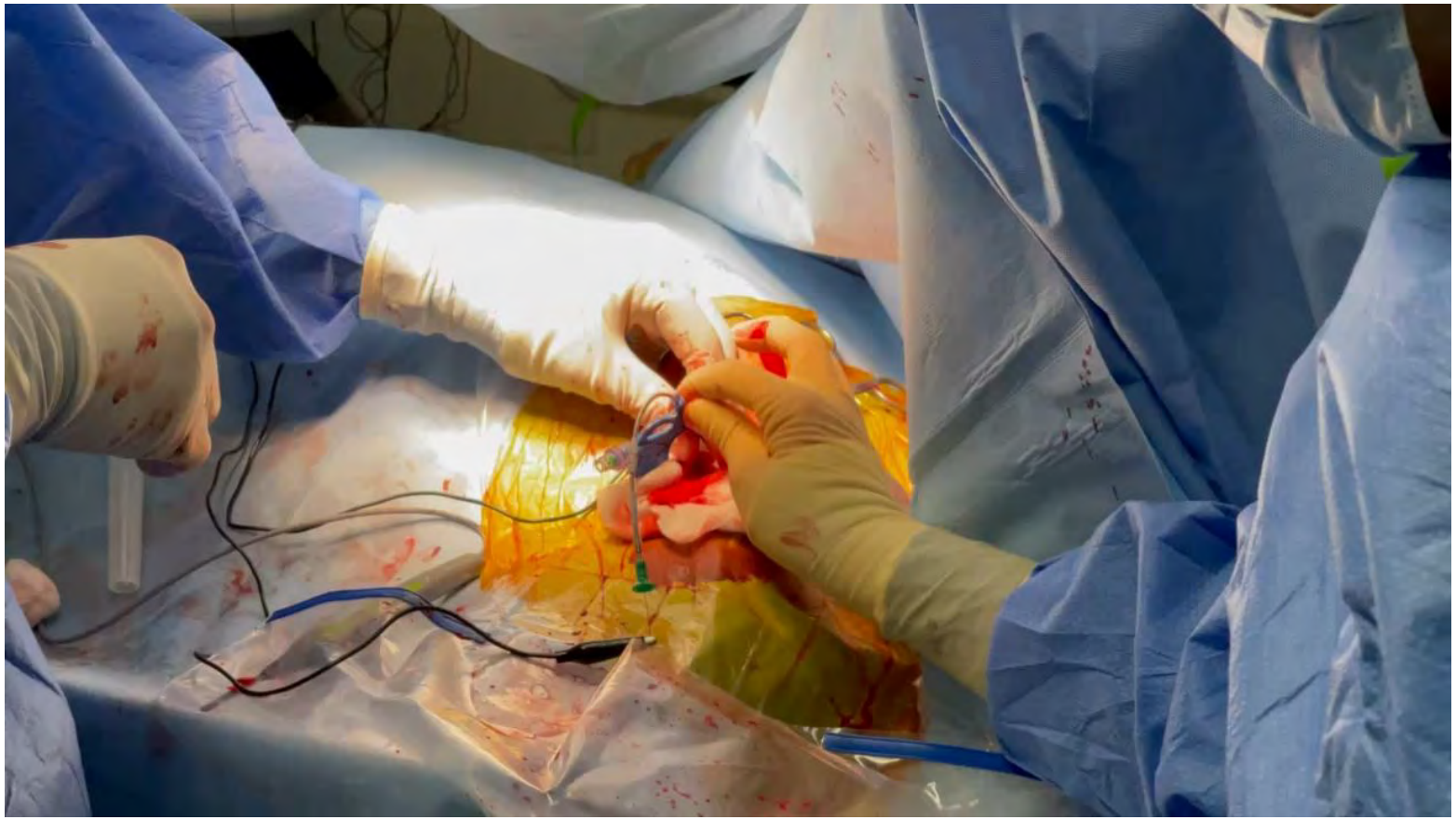
4. **Basic EP –** *GRAY areas*



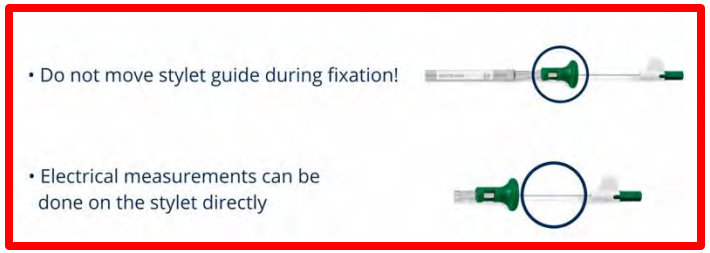
4. Basic EP – ***Clinical practice***





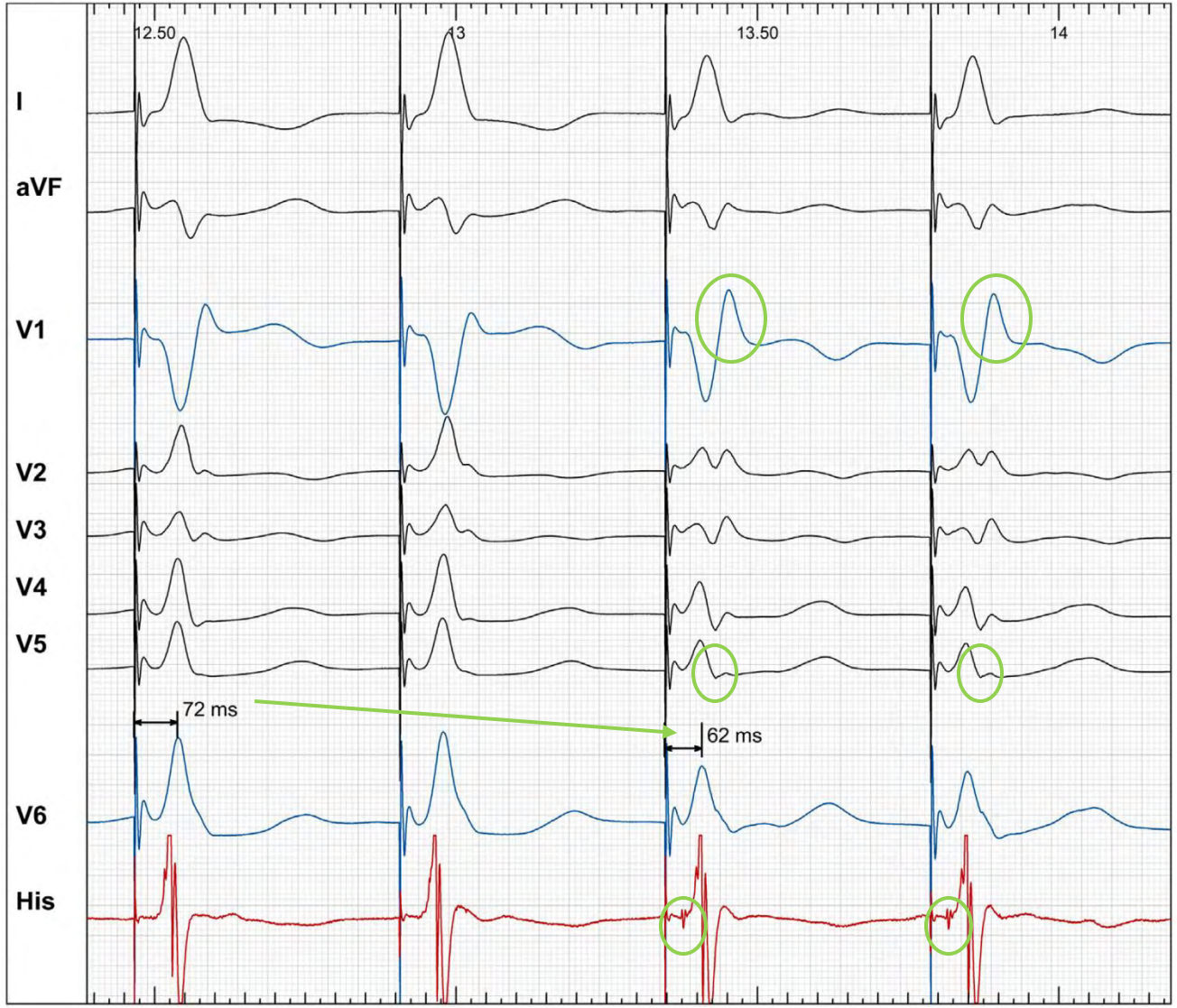
CONTINUOUS PACING**!**

= CONT. MONITORING



CONTINOUS ASSESSMENT of **QRS morphology**

Penetration of the septum is a gradual process, whereas **LBB capture** is a **sudden phenomenon!**



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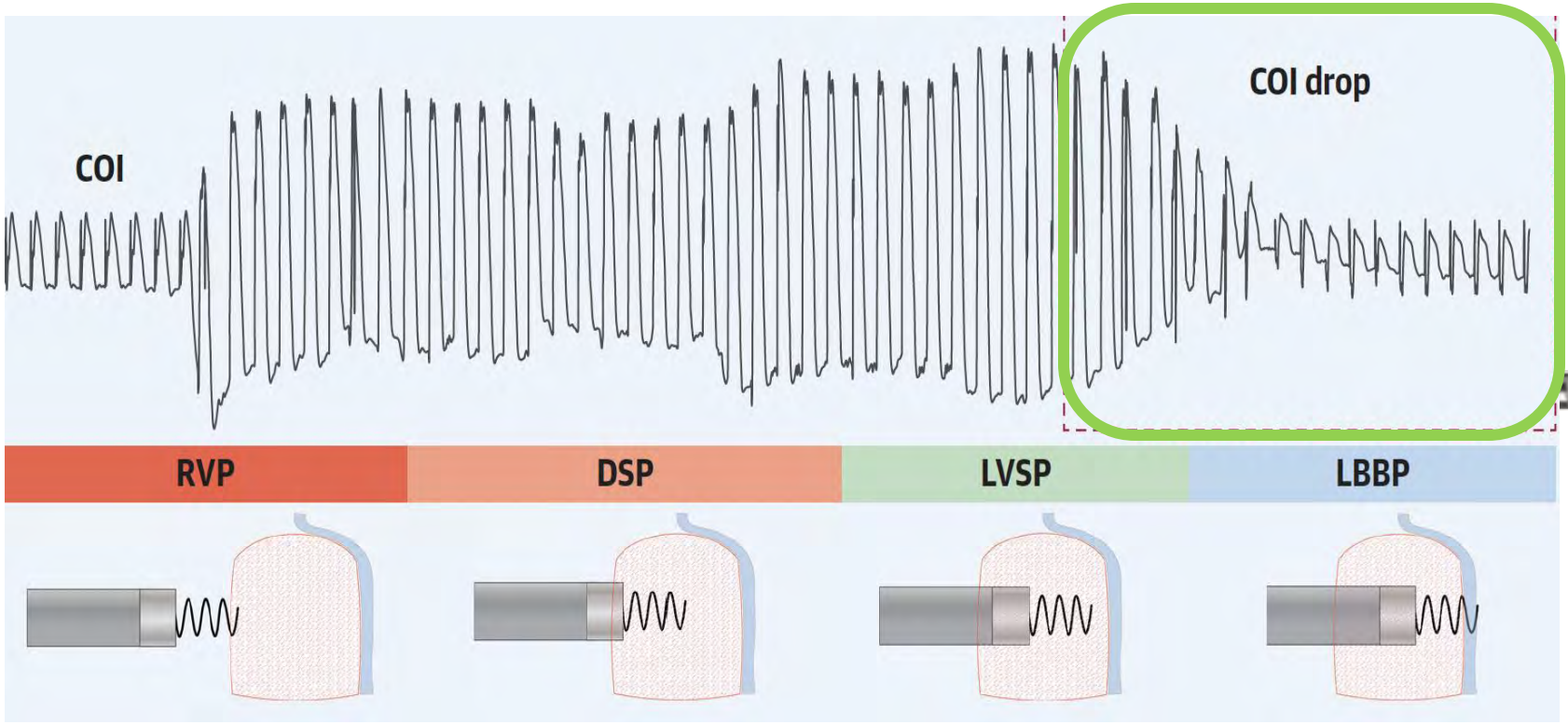
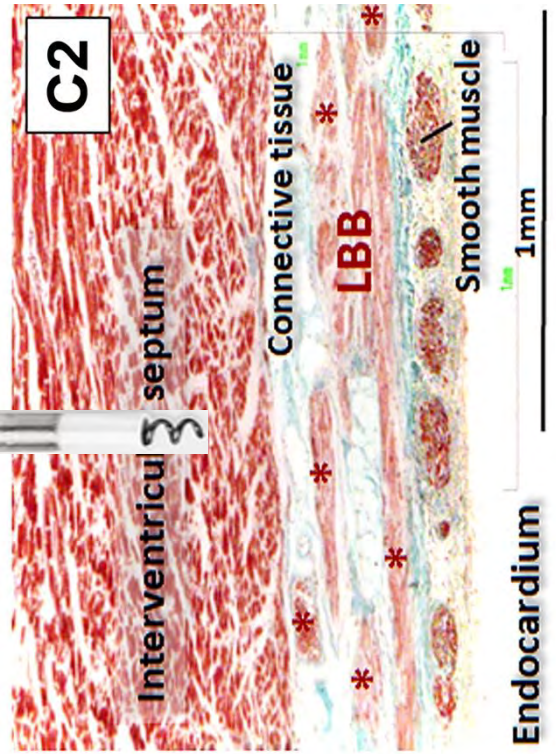
CONTINOUS ASSESSMENT of **current of injury (COI)**

Penetration of the septum is a gradual process, whereas **LBB capture** is a **sudden phenomenon!**





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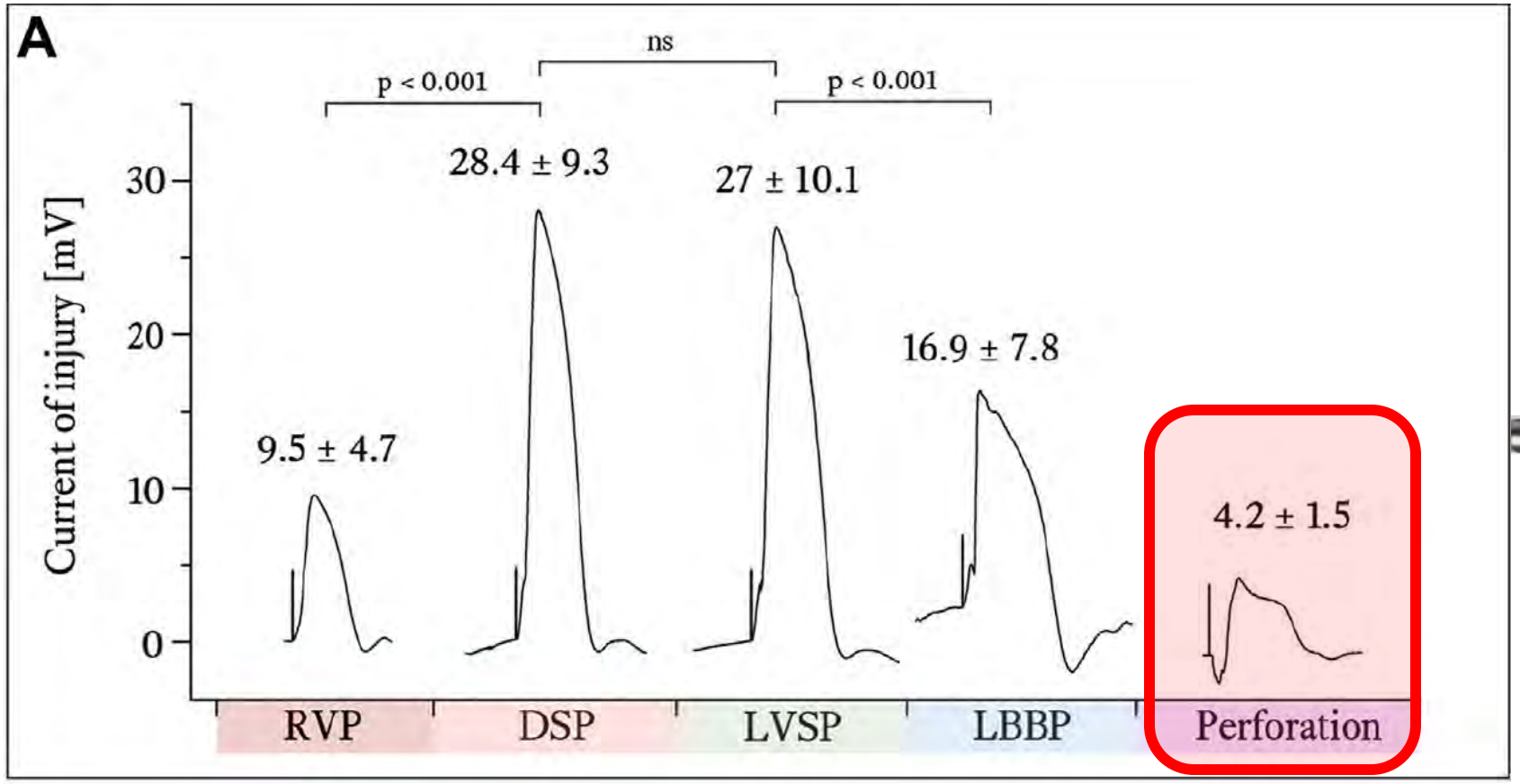
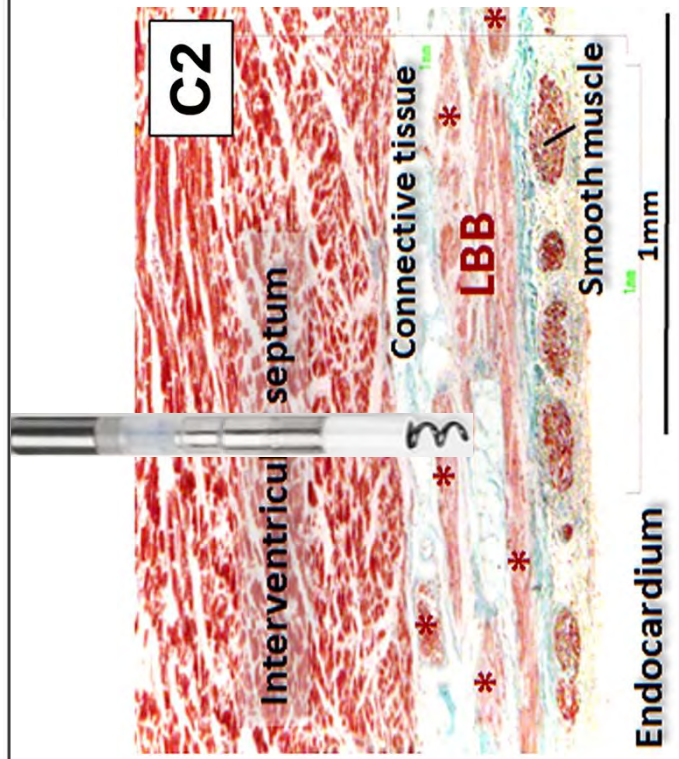
CONTINOUS ASSESSMENT of **current of injury (COI)**

Penetration of the septum is a gradual process, whereas **perforation** is a **sudden phenomenon!**





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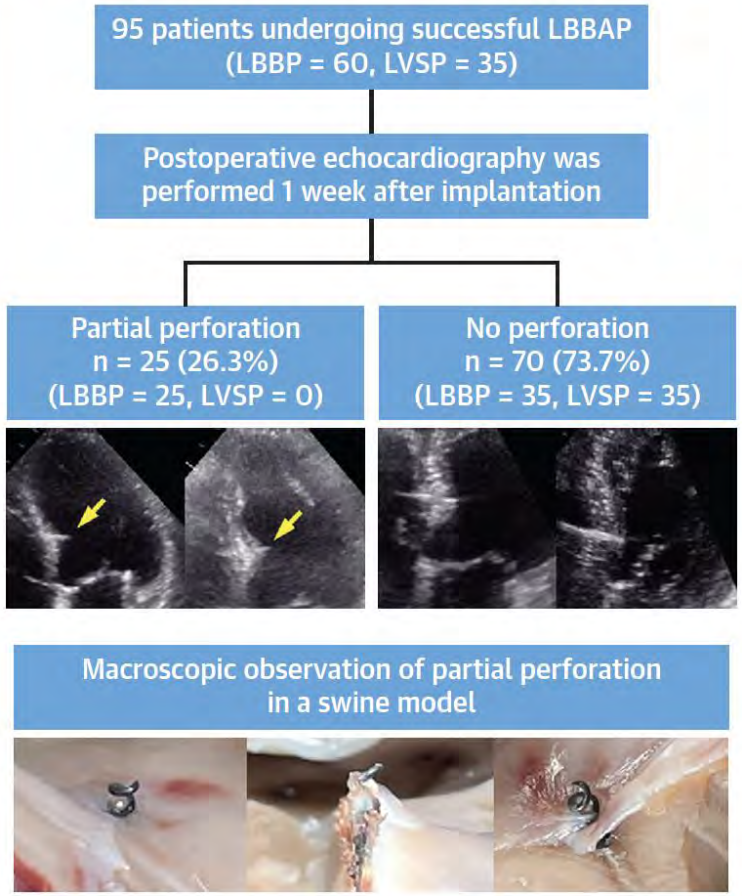
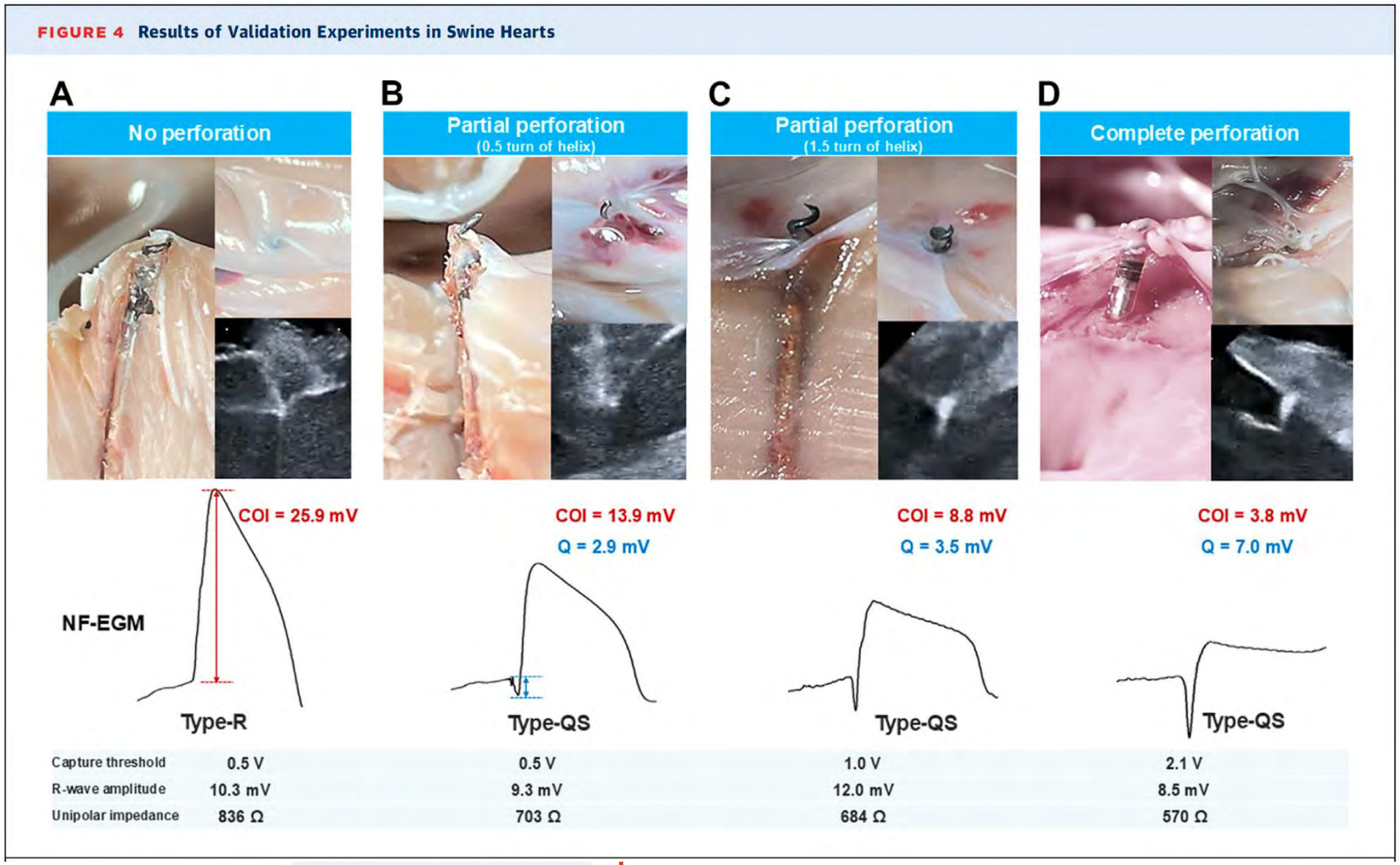
CENTRAL ILLUSTRATION Clinical Outcomes and Electrophysiological Characteristics of PP

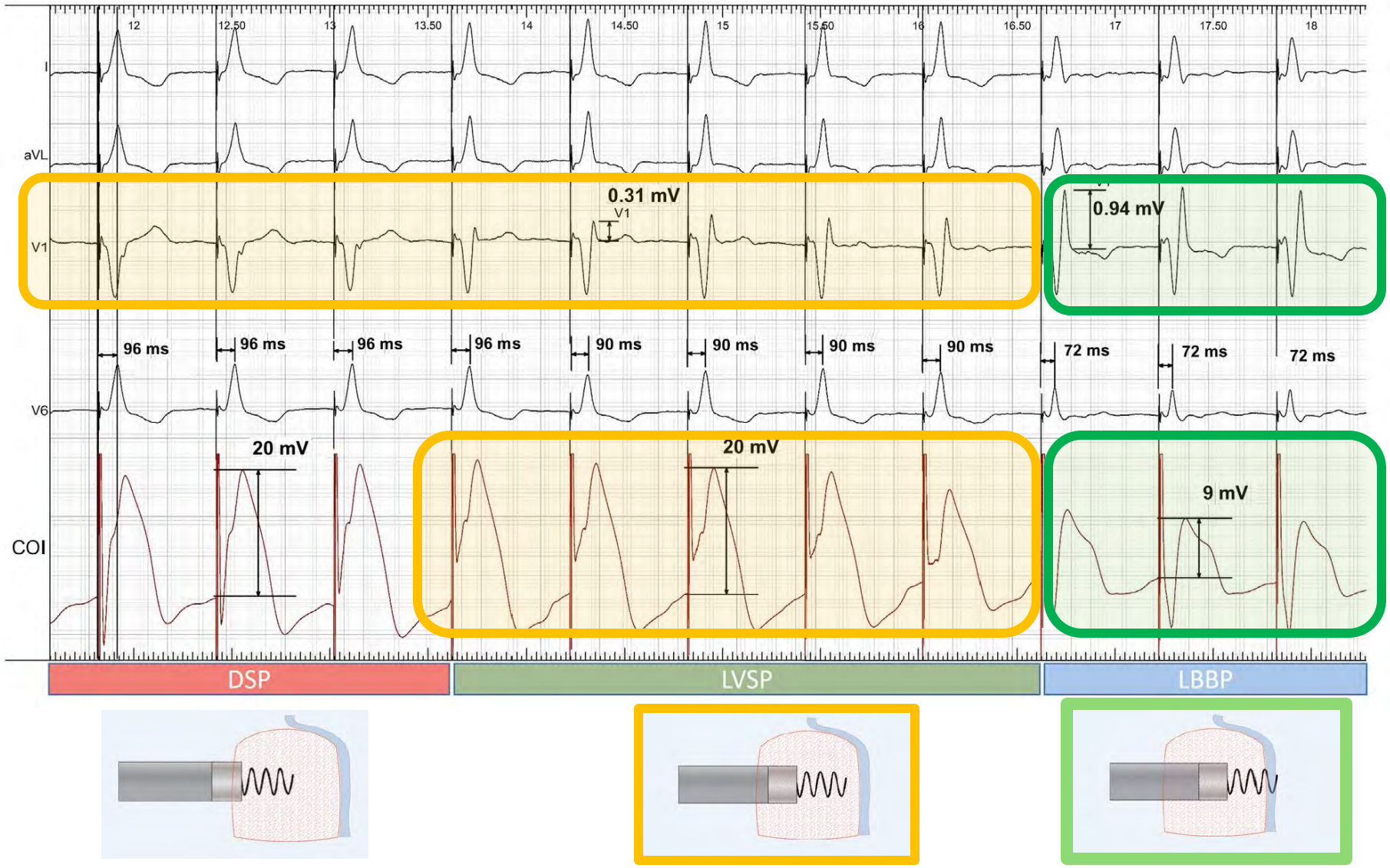




Kato H, et al. JACC Clin Electrophysiol. 2025;■(■):■-■.

Partial perforation (PP) was confirmed on postoperative echocardiography in 26.3% of patients who underwent left bundle branch area pacing (LBBAP), occurring only in patients who achieved left bundle branch pacing (LBBP). Freedom from clinical outcomes was comparable between the patients with and without PP. The type-QS morphology of the nonfiltered unipolar electrogram (NF-EGM) and a myocardial current of injury (COI) amplitude of <14.5 mV could be used to diagnose PP with high specificity. LVSP = left ventricular septal pacing.

4. Basic EP – ***Decision making acc. to COI***



CONCLUSIONS

- LBBAP is a “physiological” pacing modality
- compared to HBP it is “*easier*” to perform, but more difficult to confirm
- knowledge of anatomy, lead behaviour, implant technique, and basic EP is needed to successfully perform LBBAP
- **continuous pacing** and monitoring improves procedural success and safety

YOU
FOR
YOUR
ATTENTION