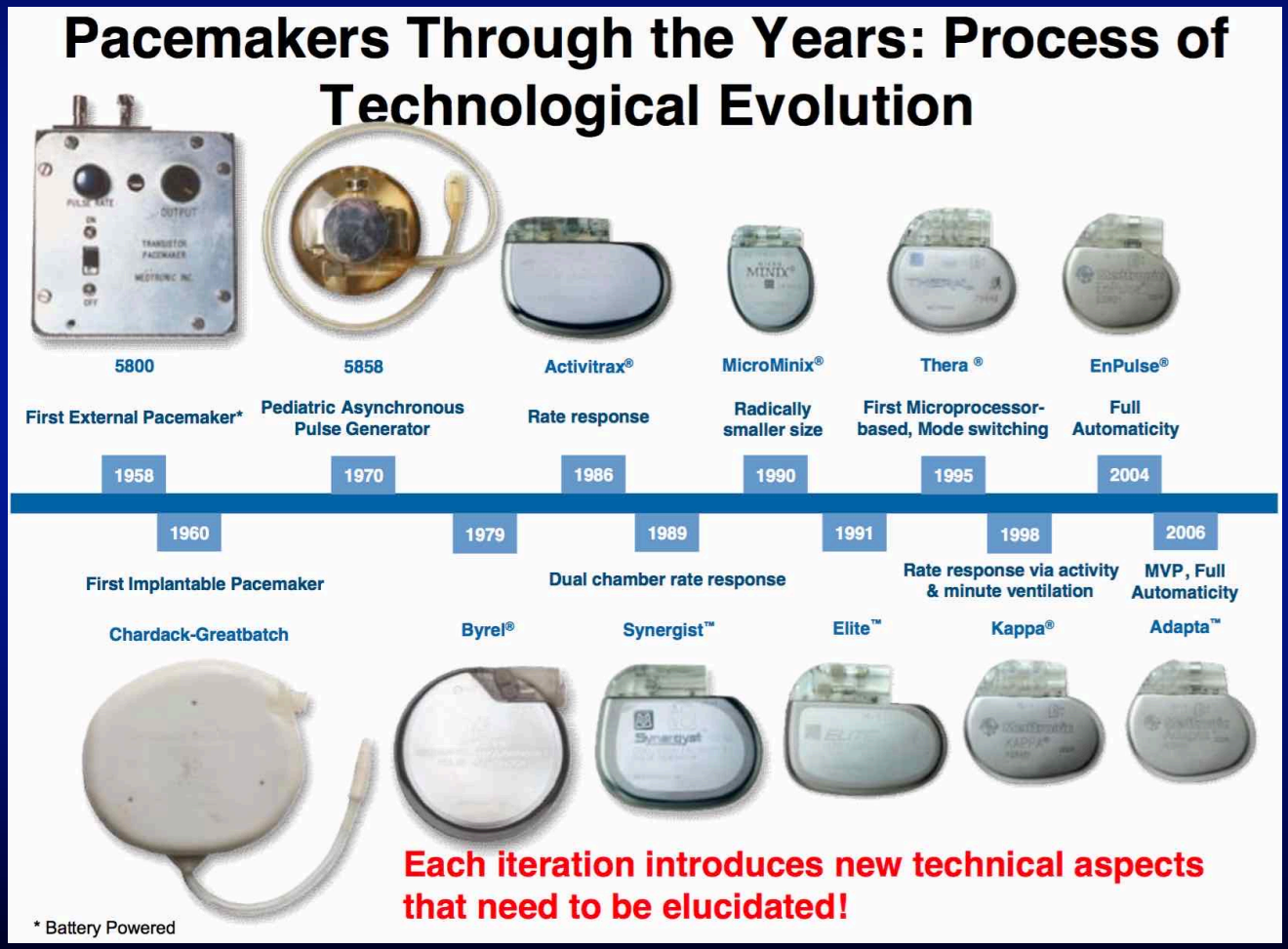
Conduction System Pacing

Kristin Ellison MD
KY ACC

9/10/2022

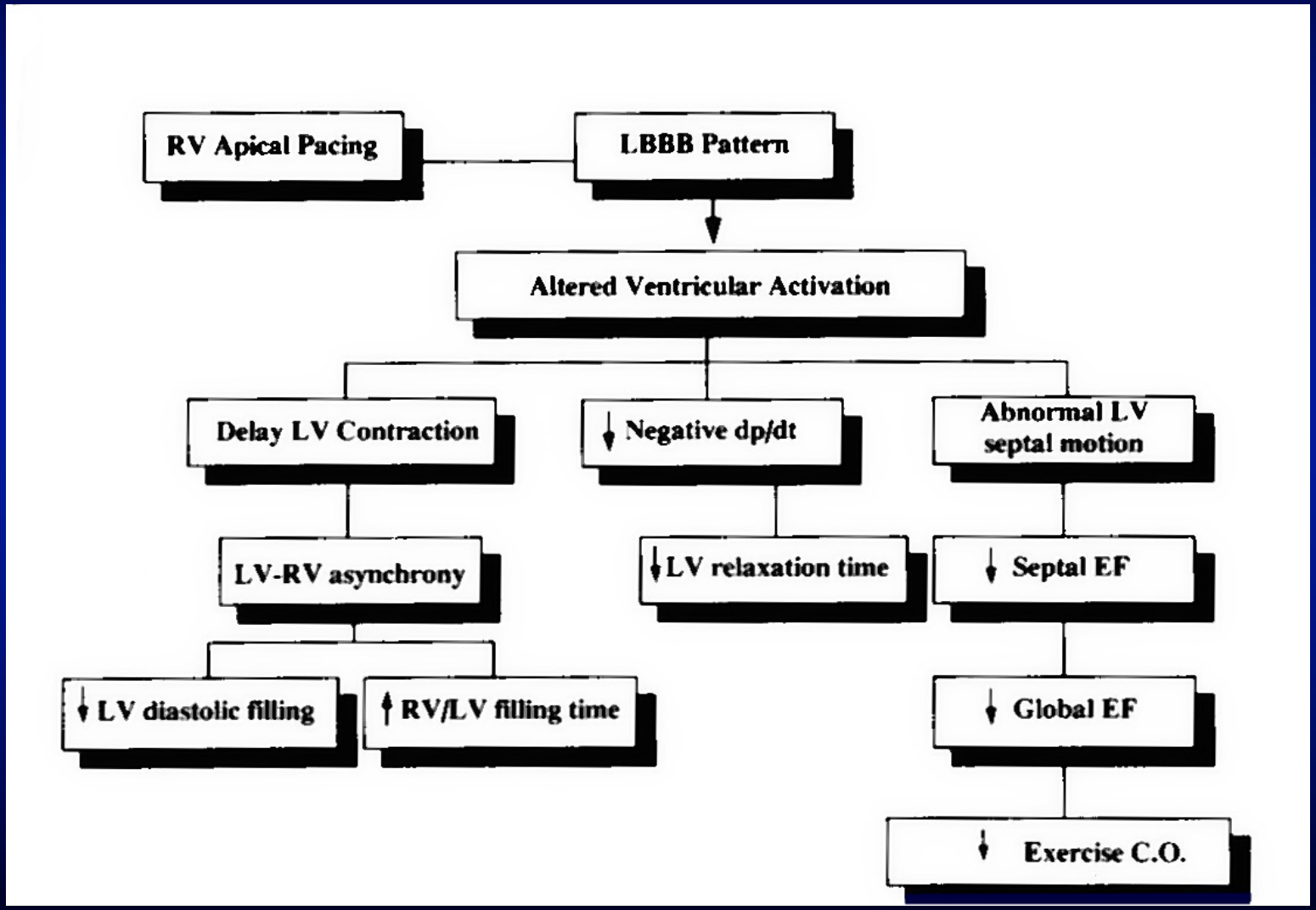
Device Time Line



Benefits of Dual Chamber Pacing

- Provides AV synchrony
- Lower incidence of atrial fibrillation
- Lower risk of systemic embolism and stroke
- Lower incidence of new congestive heart failure
- Lower mortality and higher survival rates

RV pacing mimics adverse ventricular hemodynamics of LBBB



Adapted from Grines CL. Circulation 1989;79:845

Cardiac Resynchronization Therapy or BiV Pacing

Cardiac resynchronization therapy (CRT) using biventricular (BiV) pacing is an integral part of the therapy for patients with HF with severely reduced ejection fraction and bundle branch block

The patients that benefit the most from BiV pacing are patients with severely reduced LV systolic function with a poor NYHA class and a wide left bundle branch block (LBBB) >/=150ms.

It is also indicated in low LVEF undergoing implantation of a pacemaker or implantable cardioverter defibrillator (ICD) with an anticipated requirement for a significant percentage (>40 %) of ventricular pacing

His Bundle Pacing

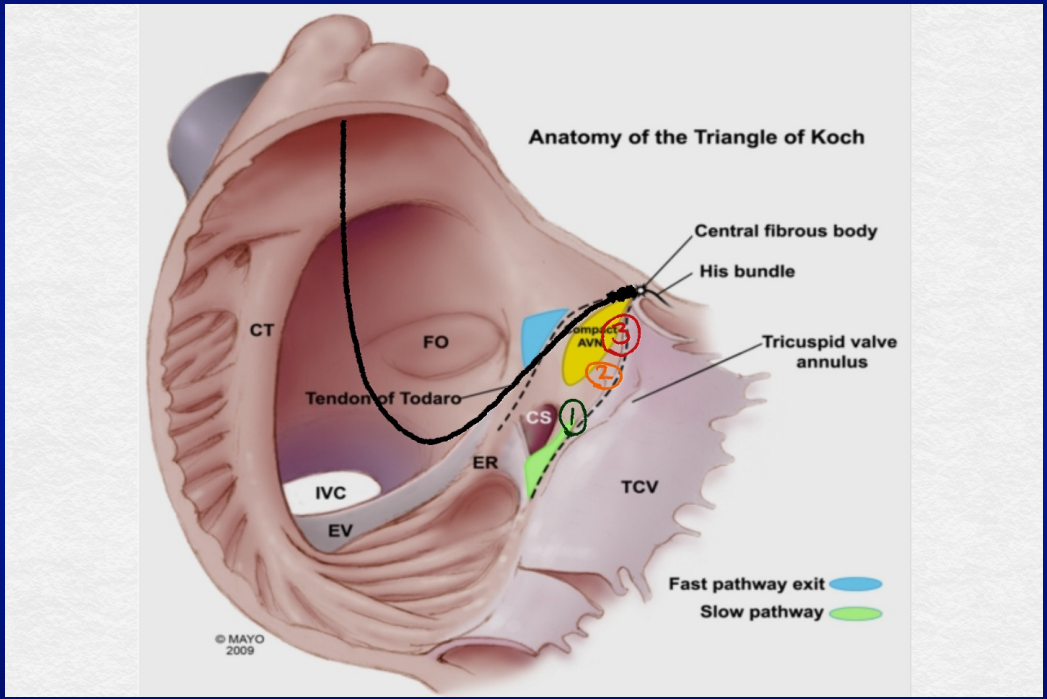
- Temporary His Bundle Pacing (HBP) was described for the first time in 1967 by Scherlag in dogs undergoing surgery. An epimyocardial pacing catheter positioned at the His bundle
- Subsequently, the same group published their experience on temporary recording of the His bundle in humans using intravascular endocardial catheter
- In 1970, Narula et al also demonstrated recordings and capture of HBP in man using a multipolar catheter positioned at the atrioventricular junction, above the septal leaflet of the tricuspid valve

Scherlag et al. J Appl Physiol. 1967
Scherlag et al. Circulation. 1969
Narula et al. Circulation. 1970

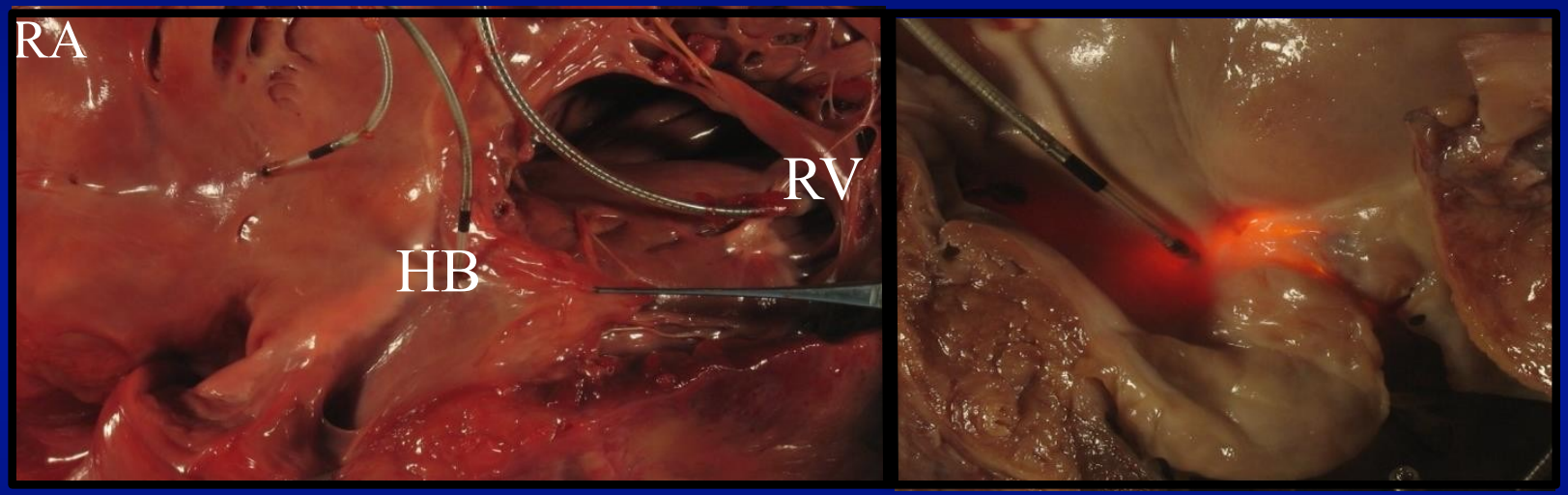
His Bundle Pacing

- Replicates normal physiology
- Lead is implanted on the AV septum. Less risk to Tricuspid valve and lead related perforation is negligible.
- Both AV and VV synchrony can be achieved at the same time.

Anatomy of AVN and His Bundle



Autopsy Analysis of the Implantation site of a Permanent selective Direct His Bundle Pacing Lead

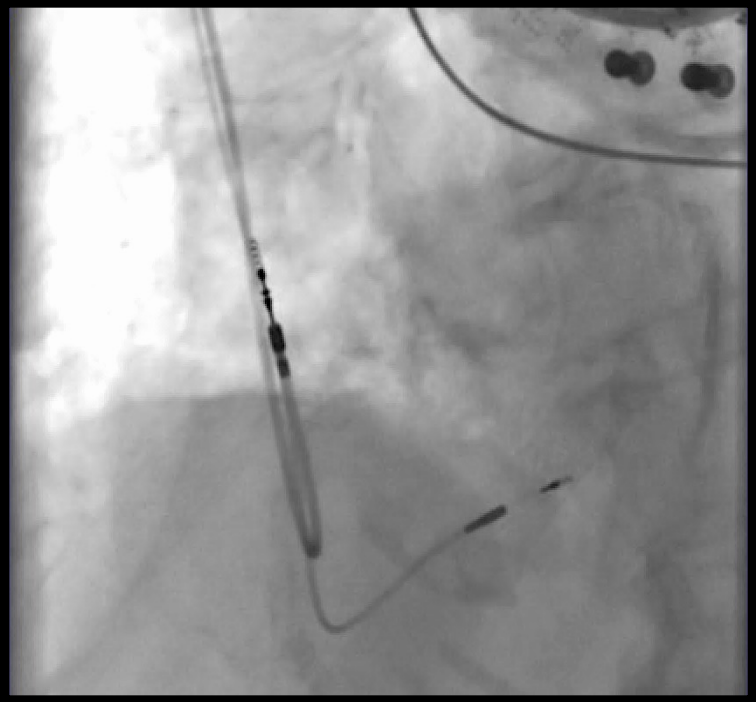


Lustgarten et al. Circ Arrhythm Electrophysiol 2012

Flouro Images of Atrial and His Bundle lead

RAO

LAO



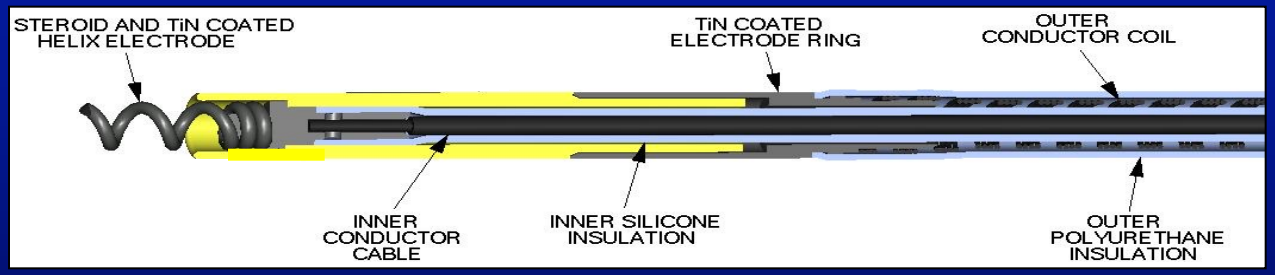
SelectSecure Lead Overview

MODEL 3830 LEAD DESIGN

3830 Lead

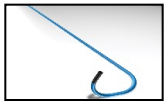
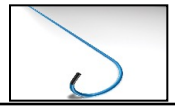
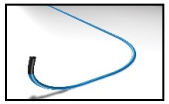
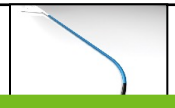
3830 Lead Specifications:

- 4.1 FR lead body diameter
- Bipolar
- Fixed screw helix
- Steroid eluting
- Polyurethane outer insulation
- Cable inner conductor



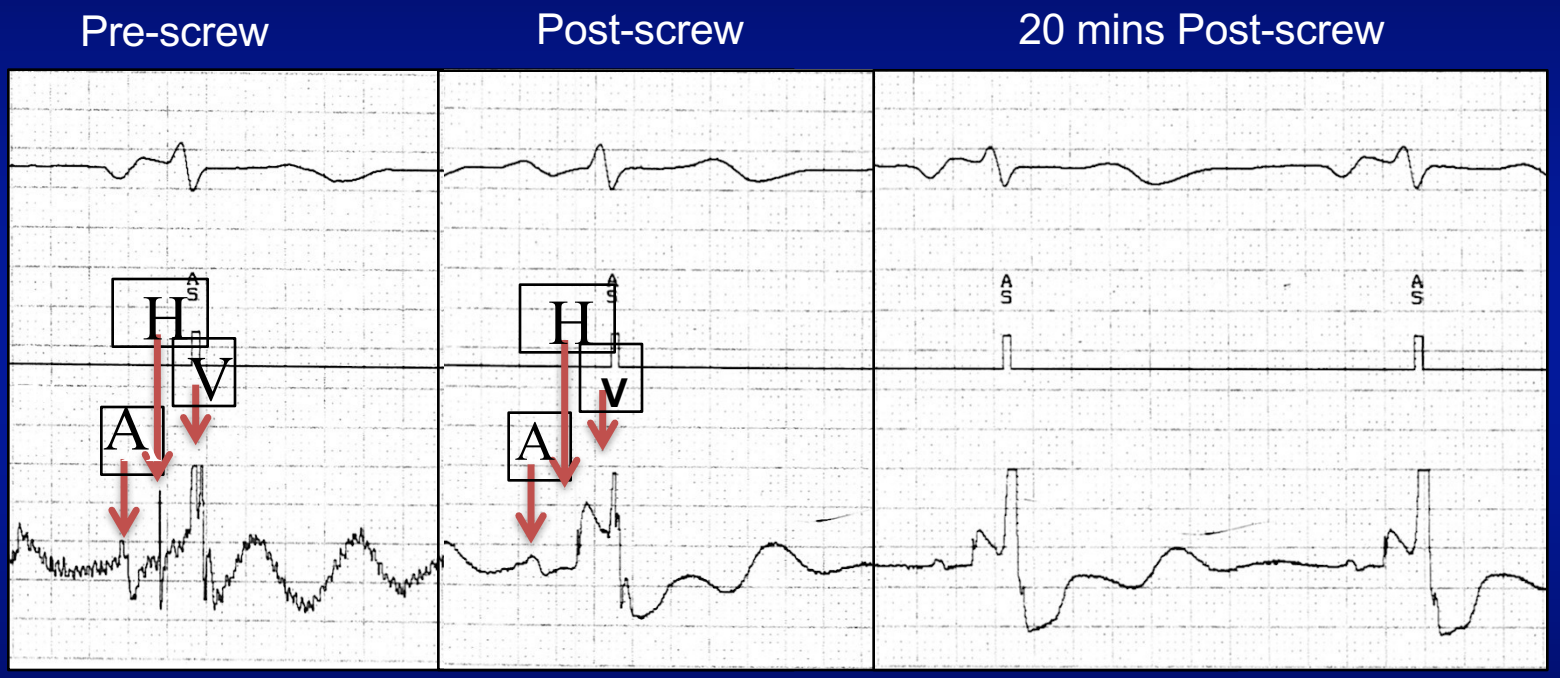
Cross-sectional view of 3830 lead

C315 Catheter Family Overview

Shape	Description	Compatible 3830 lengths	Lead Location
H20 	20 cm	49 cm or longer	Apex, triangle of Koch for smaller patients
J 	30 cm	59 cm or longer	Bachmann's bundle, high atrial septum, lateral free wall, RA appendage
S4 	30 cm	59 cm or longer	Bachmann's bundle, high atrial septum, low atrial septum
S5 	30 cm	59 cm or longer	Bachmann's bundle, high atrial septum, low atrial septum
S10 	40 cm	69 cm or longer	Right Ventricular Outflow Tract, mid-ventricular septum
H40 	40 cm	69 cm or longer	Apex, triangle of Koch
His 	**43 cm**	**69 cm or longer**	**Bundle of His**

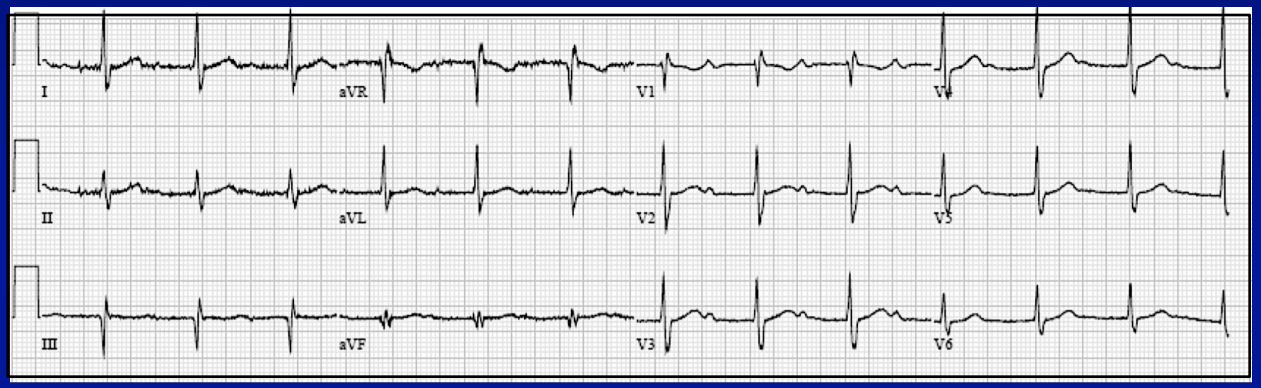
His Electrograms Pre and Post Screw In

Unipolar EGMs from analyzer



Selective His Bundle capture

Capture and conduction purely down the native His Purkinje axis without any local myocardial capture. Concordance of QRS and T wave complexes. The stim-QRS interval will be identical to the HV interval

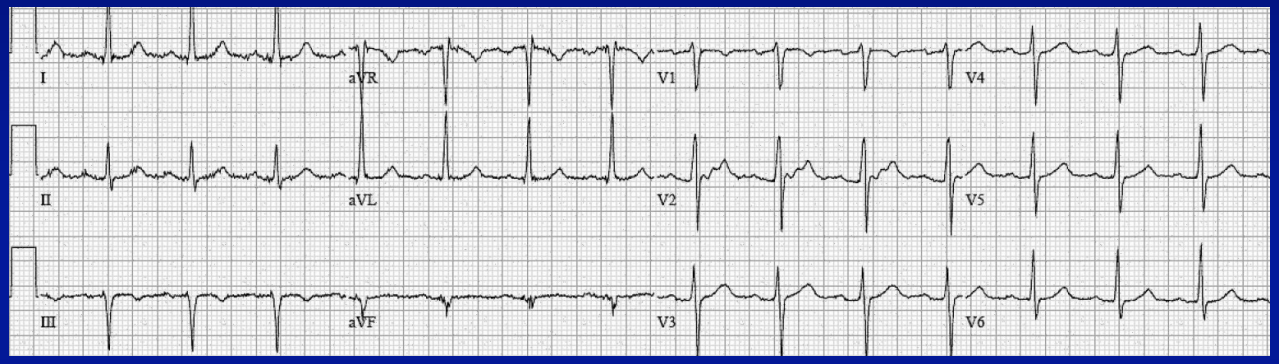


Baseline conduction

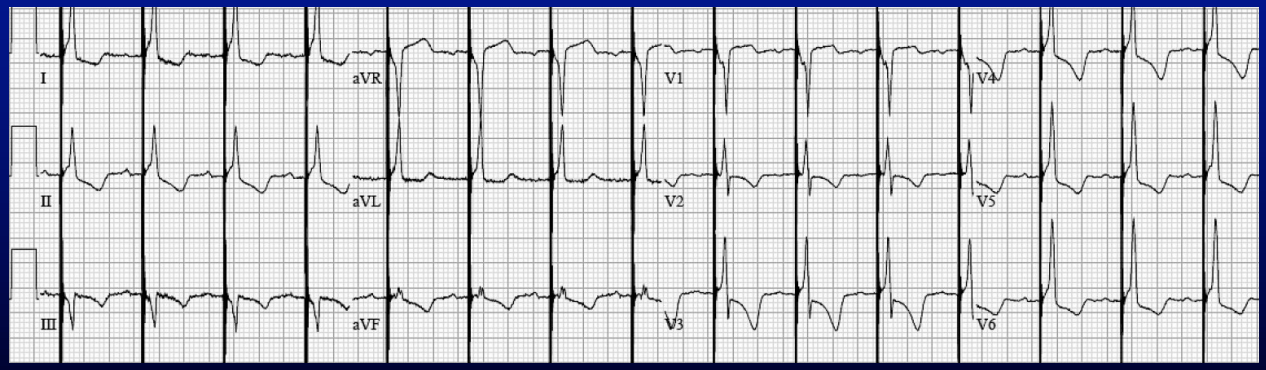
Selective capture

Non Selective capture

Capture of both the Hisian tissue and local myocardium (resulting in a “delta” wave appearance)

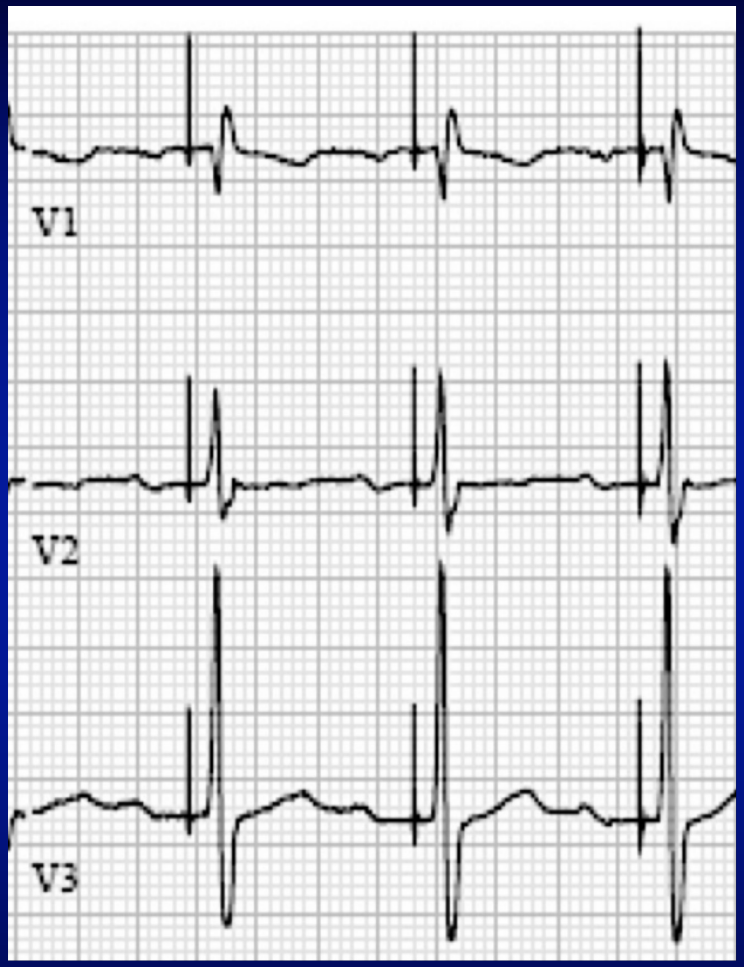


Baseline conduction

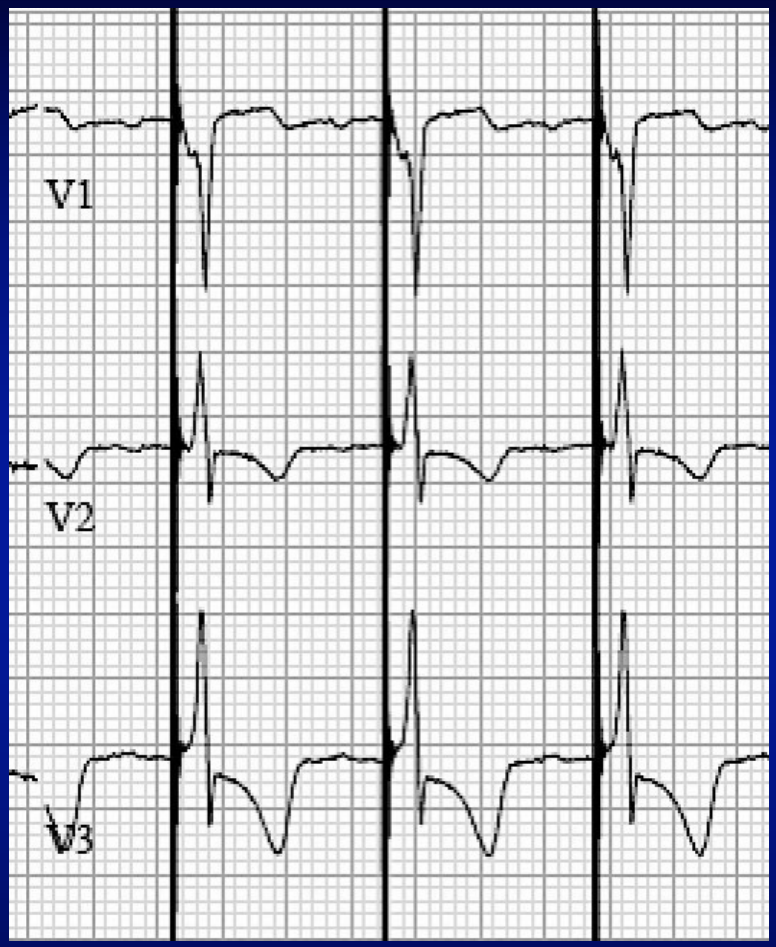


Non Selective His Bundle capture

Selective



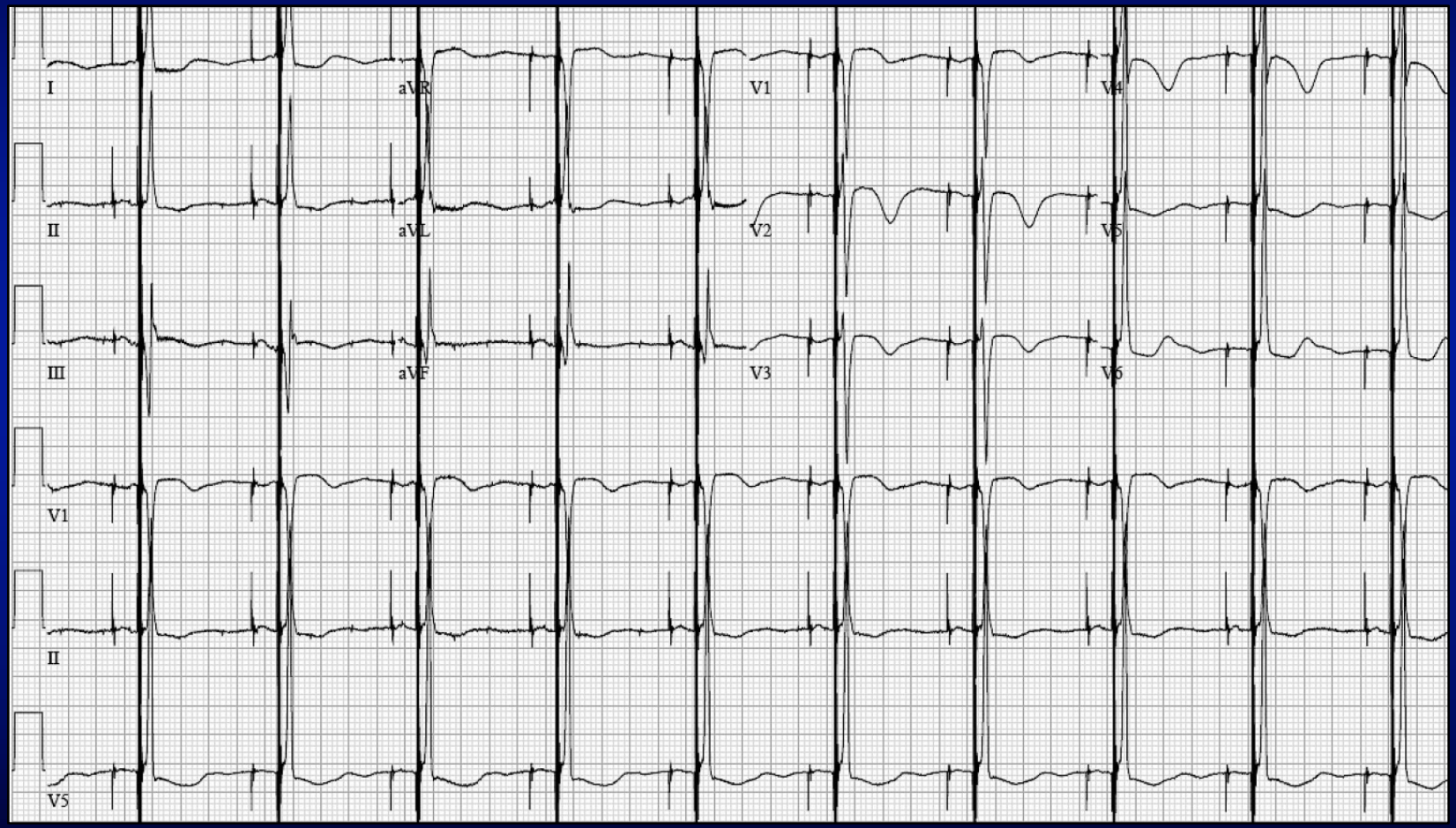
Nonselective



94 YO F with DCM worsening EF 20% NYHA Class III LBBB QRSd 176 milli sec

Post Implant EKG

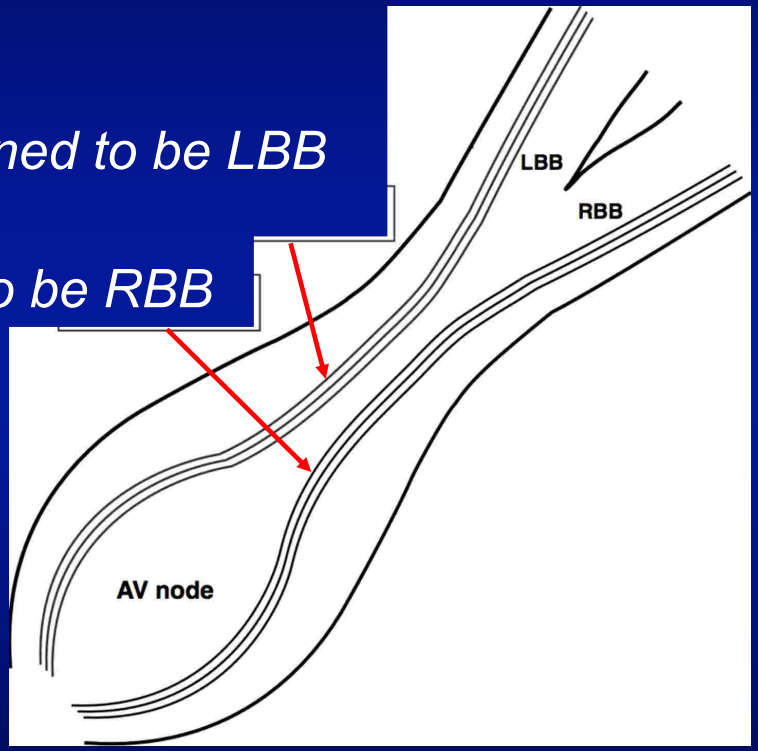
(paced QRSd 90ms)



longitudinal dissociation in the His Bundle

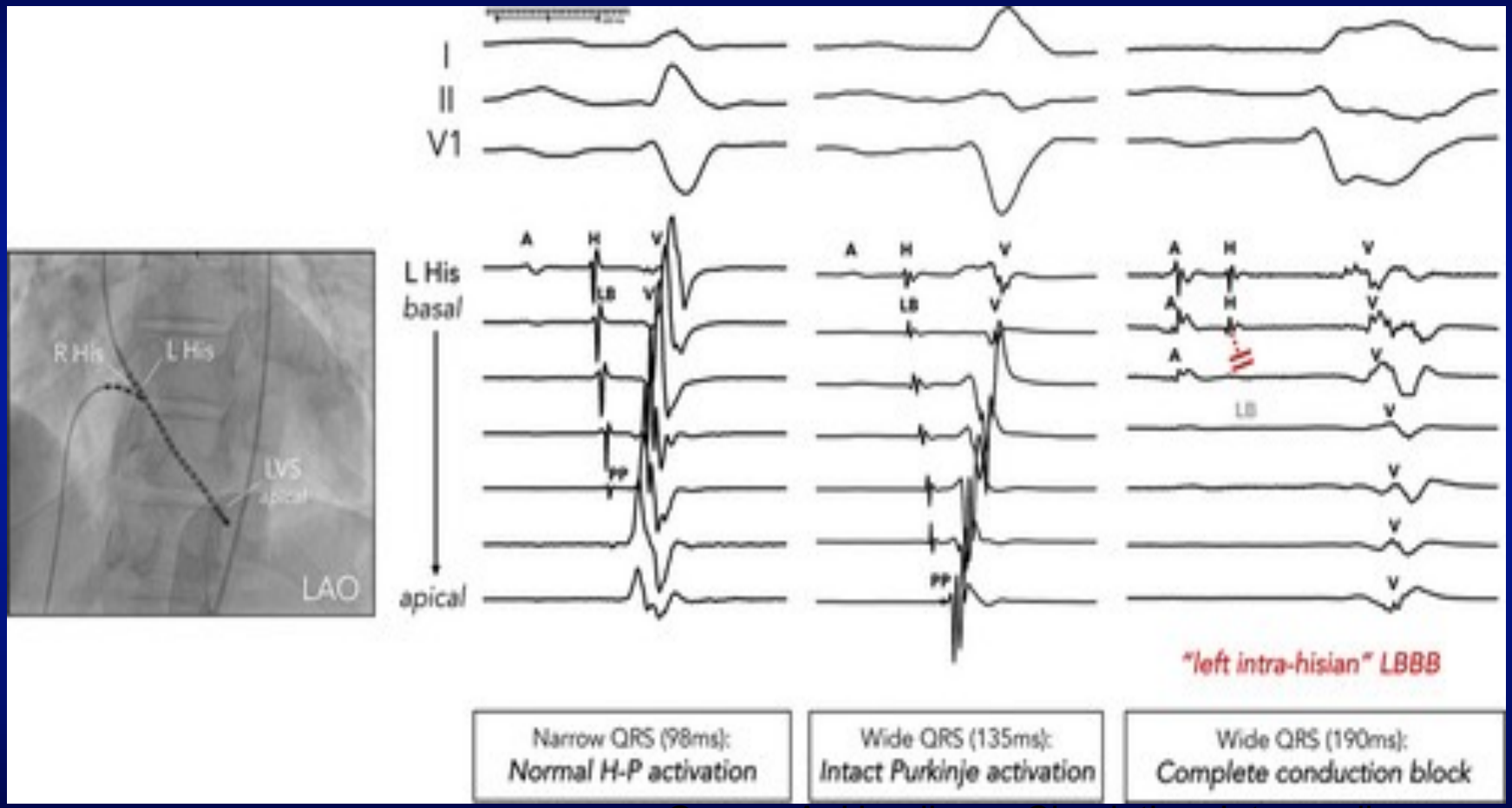
Fibers pre-destined to be LBB

Fibers pre-destined to be RBB



Intracardiac Delineation of Septal Conduction in Left Bundle-Branch Block Patterns Mechanistic Evidence of Left Intrahisian Block Circumvented by His Bundle Pacing

Examples of intracardiac septal conduction observed in patients with surface LBBB pattern.

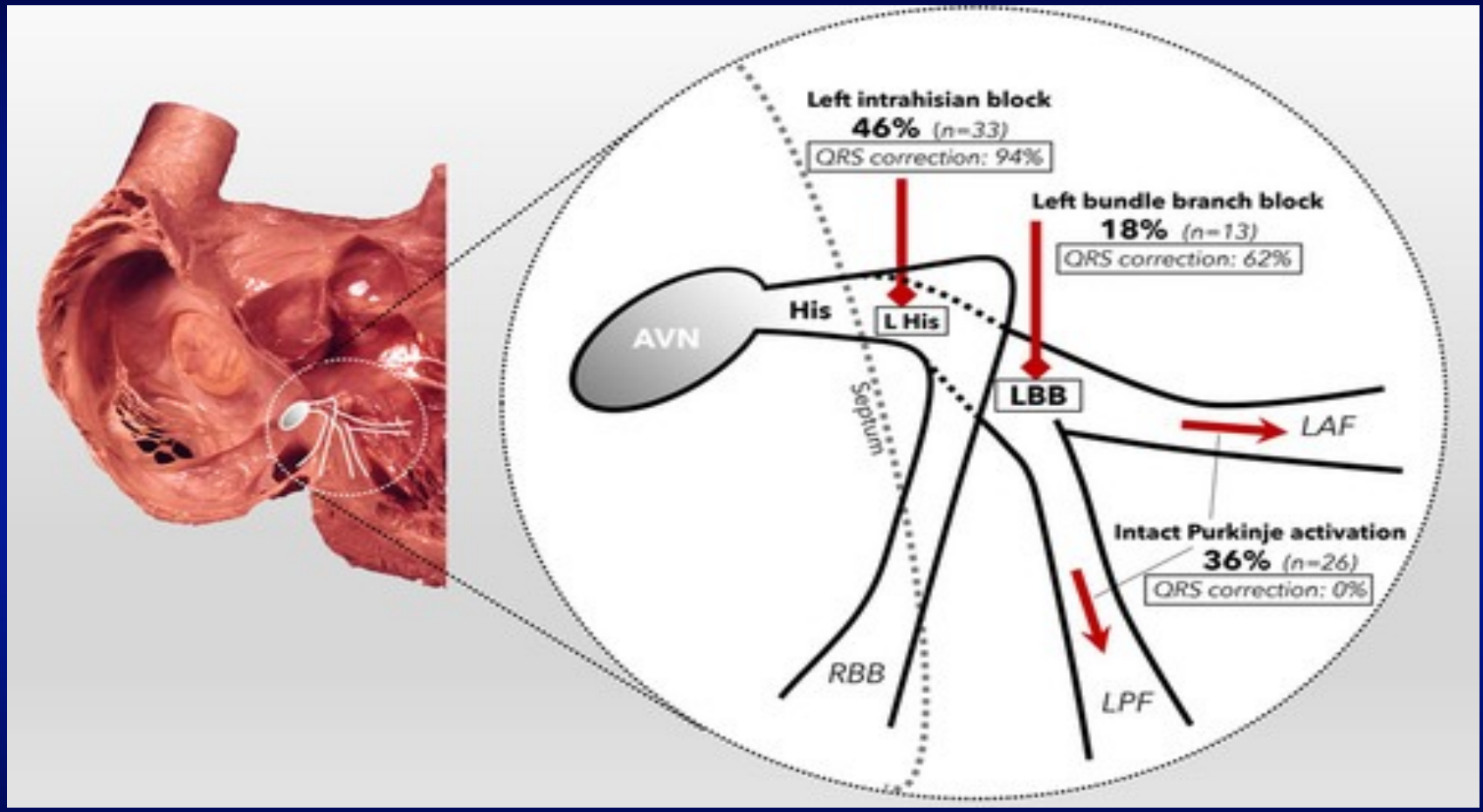


Gaurav A. Upadhyay, Circulation, Intracardiac Delineation of Septal Conduction in Left Bundle-Branch Block Patterns, Volume: 139, Issue: 16, Pages: 1876-1888, DOI:

Upadhyay et al.

Circulation. 2019;139:1876–1888

Sites of conduction block in patients with LBBB pattern with rate of response to corrective His bundle pacing.



Gaurav A. Upadhyay. Circulation. Intracardiac Delineation of Septal Conduction in Left Bundle-Branch Block Patterns, Volume: 139, Issue: 16, Pages: 1876-1888, DOI: (10.1161/CIRCULATIONAHA.118.036648)

Limitations of His Bundle pacing

1) High pacing threshold

2) Low R-wave amplitudes

3) Atrial Oversensing

4) Potential for distal conduction block

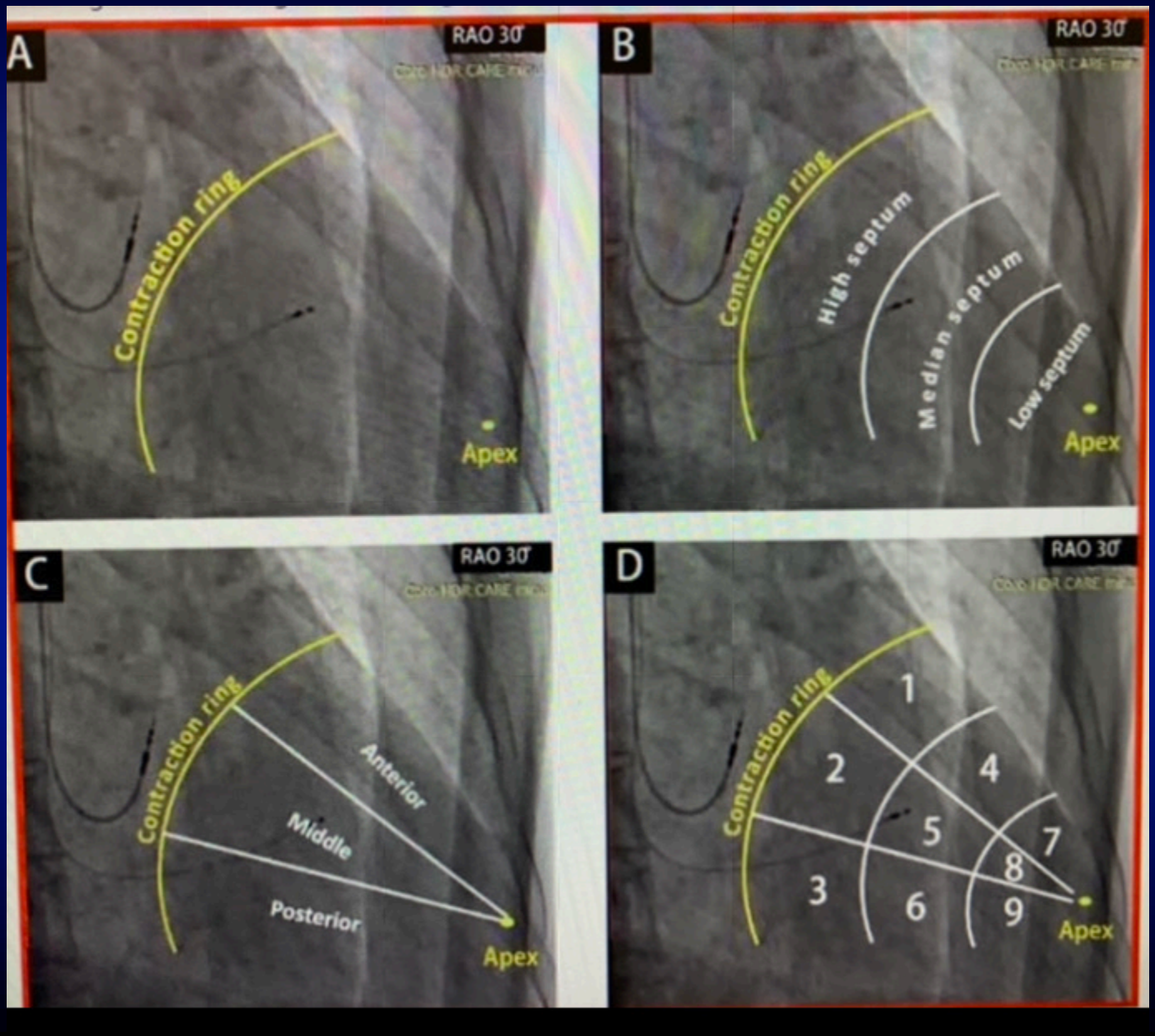
5) HBP was unable to normalize the QRS duration in almost half of patients with left bundle branch block (LBBB) in the His Bundle Pacing vs. Coronary Sinus Pacing for Cardiac Resynchronization Therapy (His-SYNC) study

Limitations in His Bundle pacing have led to development of left bundle branch pacing (LBBP)

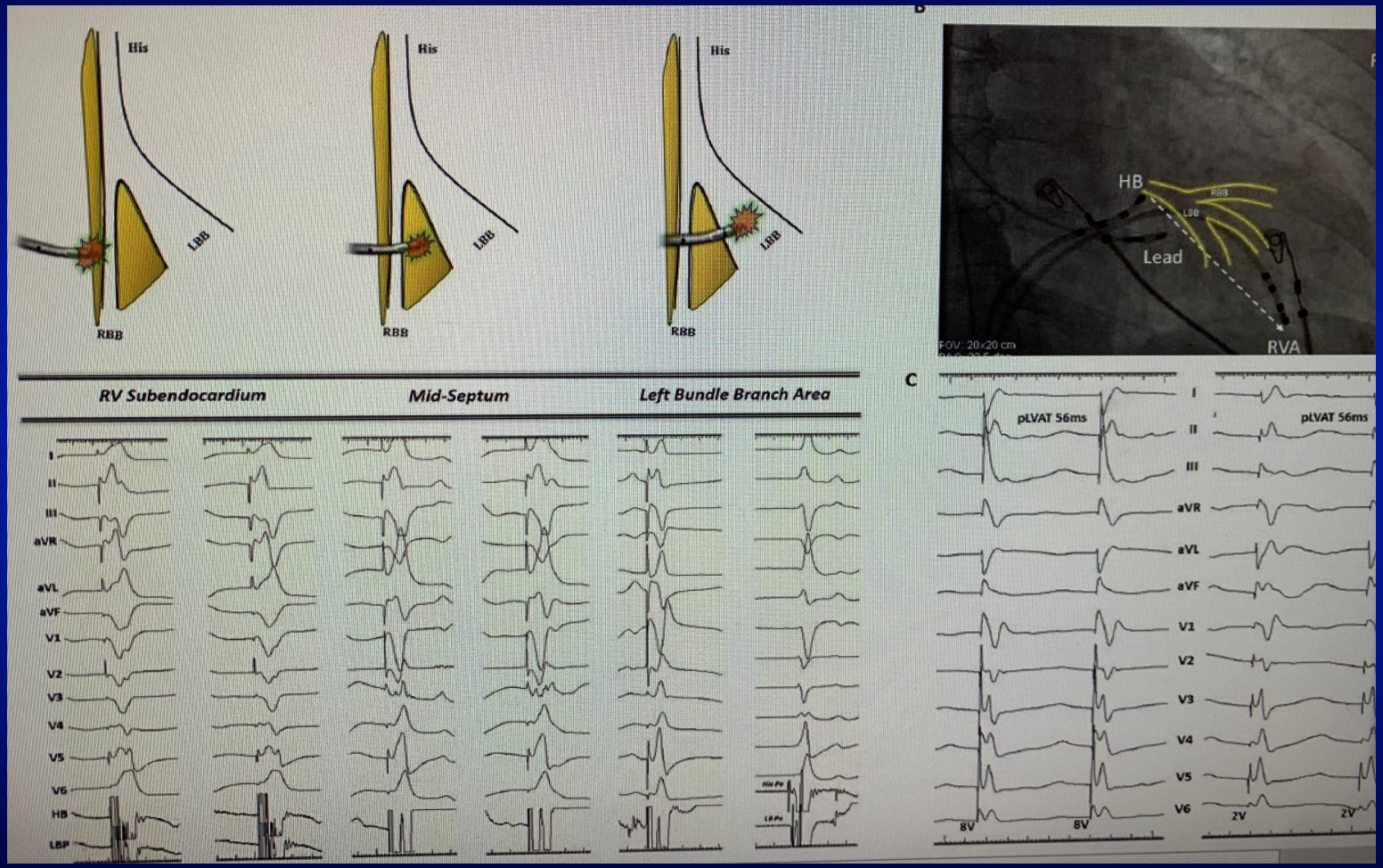
This novel pacing modality delivers physiological pacing and ensure electrical synchrony of the left ventricle. The LBBP technique was first reported by Huang et al. in 2017 and due to its many advantages over His bundle pacing has become the preferred method of conduction system pacing.

The pacing lead frequently activates the myocardium of left septum and criteria are evolving regarding septal capture and left bundle capture and this technique is therefore termed Left Bundle Area Pacing

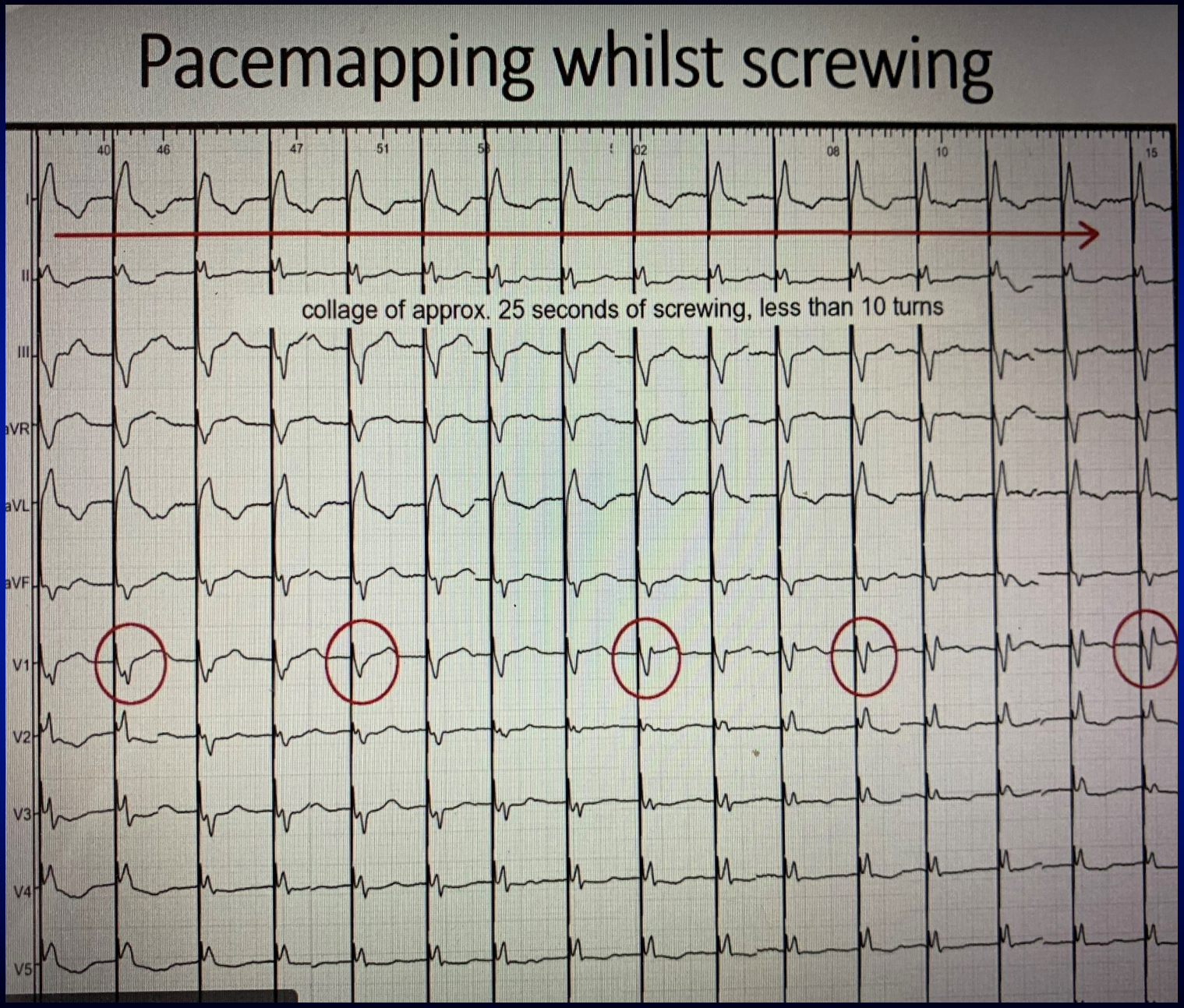
Anatomic Localization for LB Pacing



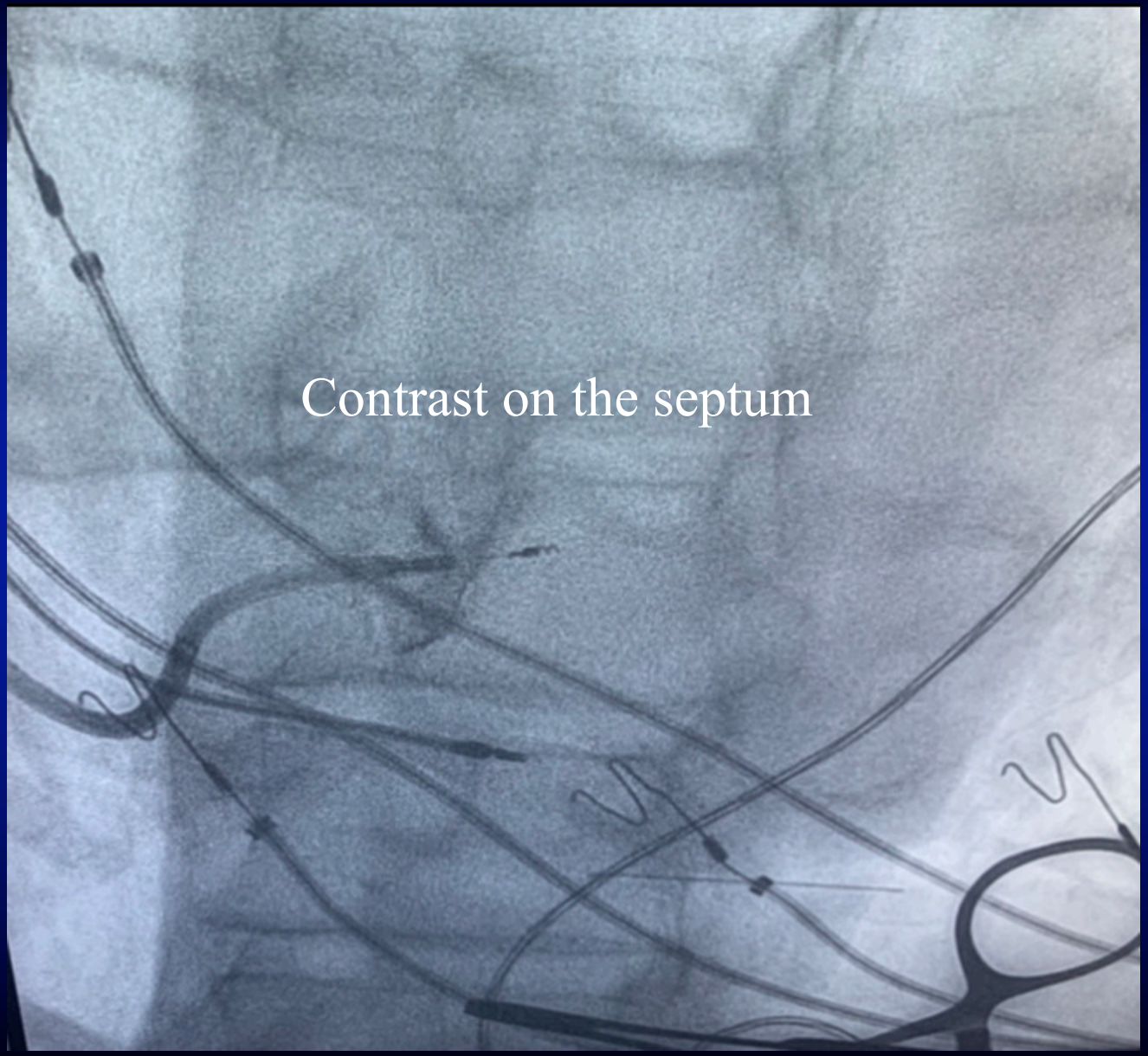
Right to Left Transeptal Pacing



Pacemapping whilst screwing



LAO 30



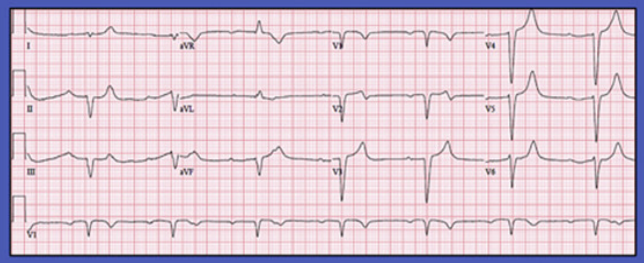
Evidence of LB Capture

- Transition from nonselective to selective LBB capture (changes in QRS morphology, appearance of discrete local electrogram, without change in peak LV activation time) during threshold testing or
- Transition from nonselective LBB capture to LV septal capture (changes in QRS morphology, no change in local electrogram, with increase in peak LV activation time) during threshold testing
- Abrupt shortening of LVAT (>10 ms) during lead implantation, with increasing output
- Short retrograde stim-His interval <35 ms during unipolar pacing
- Anterograde distal left conduction system potential (<25 ms) during LBBP
- Programmed stimulation demonstrating selective LBB or LV septal capture
- Peak LVAT <80 ms (arbitrary)

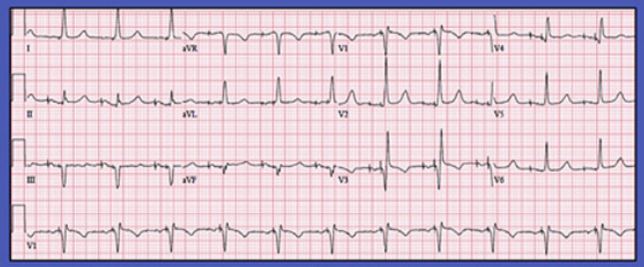
Clinical outcomes of left bundle branch area pacing compared to right ventricular pacing: Results from the Geisinger-Rush Conduction System Pacing Registry

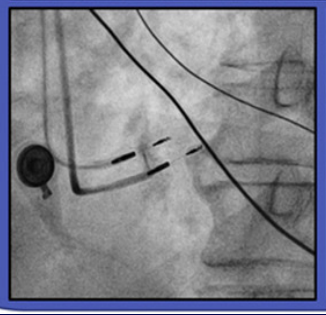
Parikshit S. Sharma MD, MPH, FHRS
, Neil R. Patel MD, MPH
, Venkatesh Ravi MD
, Dipen V. Zalavadia MD
, Sujitraj Dommaraju MD
, Varun Garg MD
, Timothy R. Larsen DO
, Angela M. Naperkowski ASN, CCRN, RCIS, RN, FHRS, CCDS, CEPS
, Jeremiah Wasserlauf MD, MS
, Kousik Krishnan MD, FHRS
, Wilson Young MD, PhD
, Parash Pokharel MD
, Jess W. Oren MD
, Randle H. Storm MD
, Richard G. Trohman MD, MBA, FHRS
, Henry D. Huang MD
, Faiz A. Subzposh MD
and Pugazhendhi Vijayaraman MD, FHRS

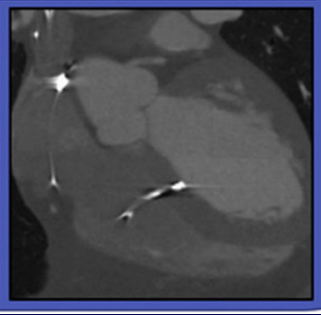
Clinical Outcomes Of Left Bundle Branch Area Pacing Compared To Right Ventricular Pacing: Results From The Geisinger-Rush Conduction System Pacing Registry



Left Bundle Branch Area Pacing

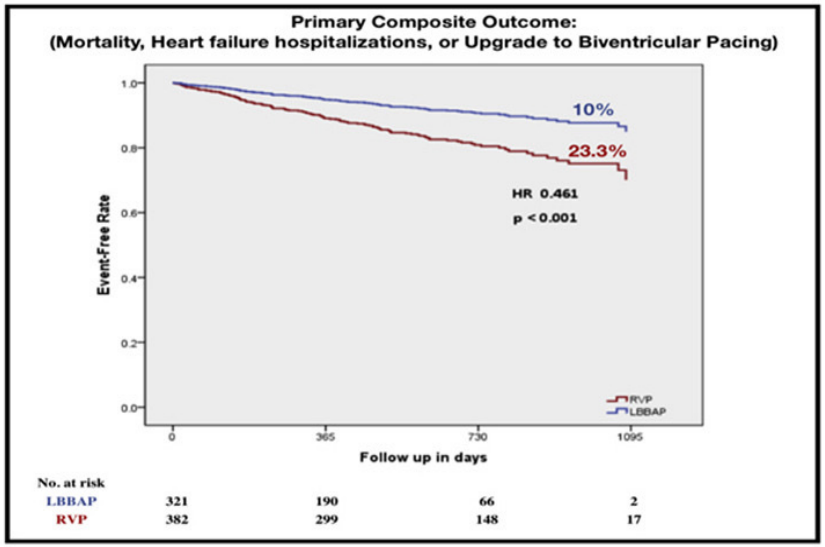






703 patients with pacemaker implantations met inclusion criteria

LBBAP	RVP
(321 pts)	(382 pts)



Left bundle branch area pacing outcomes: the multicenter European MELOS study

Key Question

What is the success rate of left bundle branch area pacing (LBBAP) in bradyarrhythmia or heart failure? What is the predominant LBBAP capture type? What is the incidence of complications related to ventricular transeptal route?

Key Finding

Implantation success rate for bradyarrhythmia and heart failure indications was 92.4% and 82.2%, respectively. The predominant LBBAP capture type was left bundle fascicular capture (69.5%). Complications specific to the LBBAP lead occurred in 8.3%, mainly acute septal perforation without clinical consequences.

Take Home Message

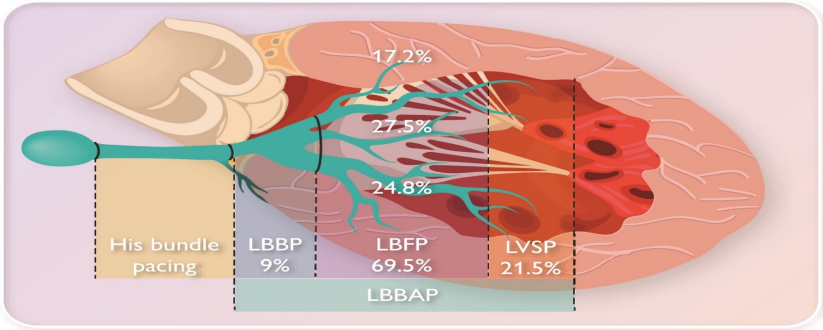
LBBAP is feasible as a primary pacing strategy for any pacing indication. This study redefines LBBAP from a proximal to more a straightforward distal conduction system pacing technique. Success rate in heart failure patients and safety need to be improved.

MELOS — MULTICENTER EUROPEAN LEFT BUNDLE BRANCH AREA PACING OUTCOMES STUDY

Prospective, multicenter, registry-based observational study

2533 Participants

14 European centres



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%

Independent predictors of LBBAP lead implantation failure

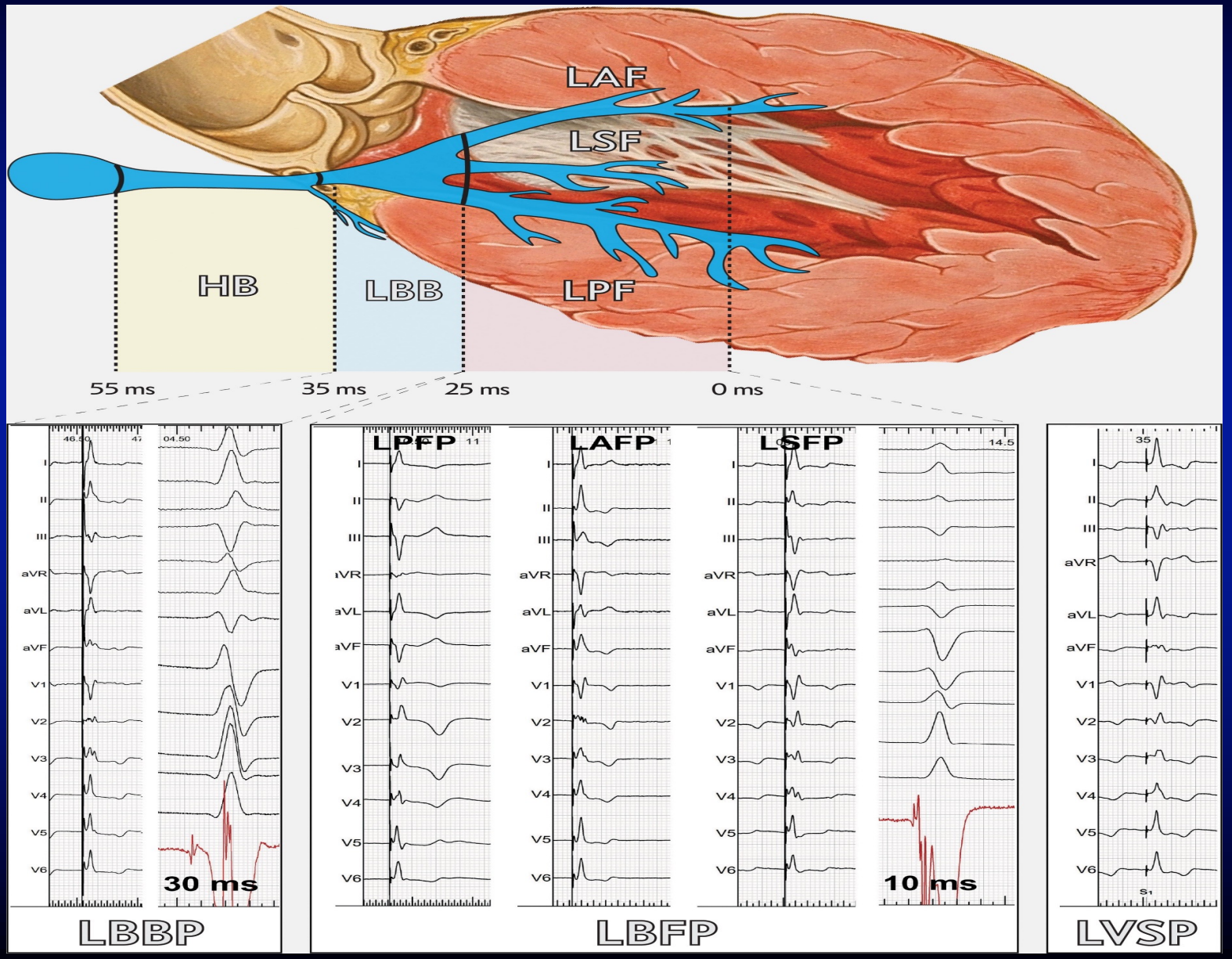
Heart failure indication	OR 1.49, 95% CI 1.01–2.21
Baseline QRS duration, per 10 ms	OR 1.08, 95% CI 1.03–1.14
LVEDD, per 10 mm increase	OR 1.53, 95% CI 1.26–1.86

•*Eur* Marek Jastrzębski et al

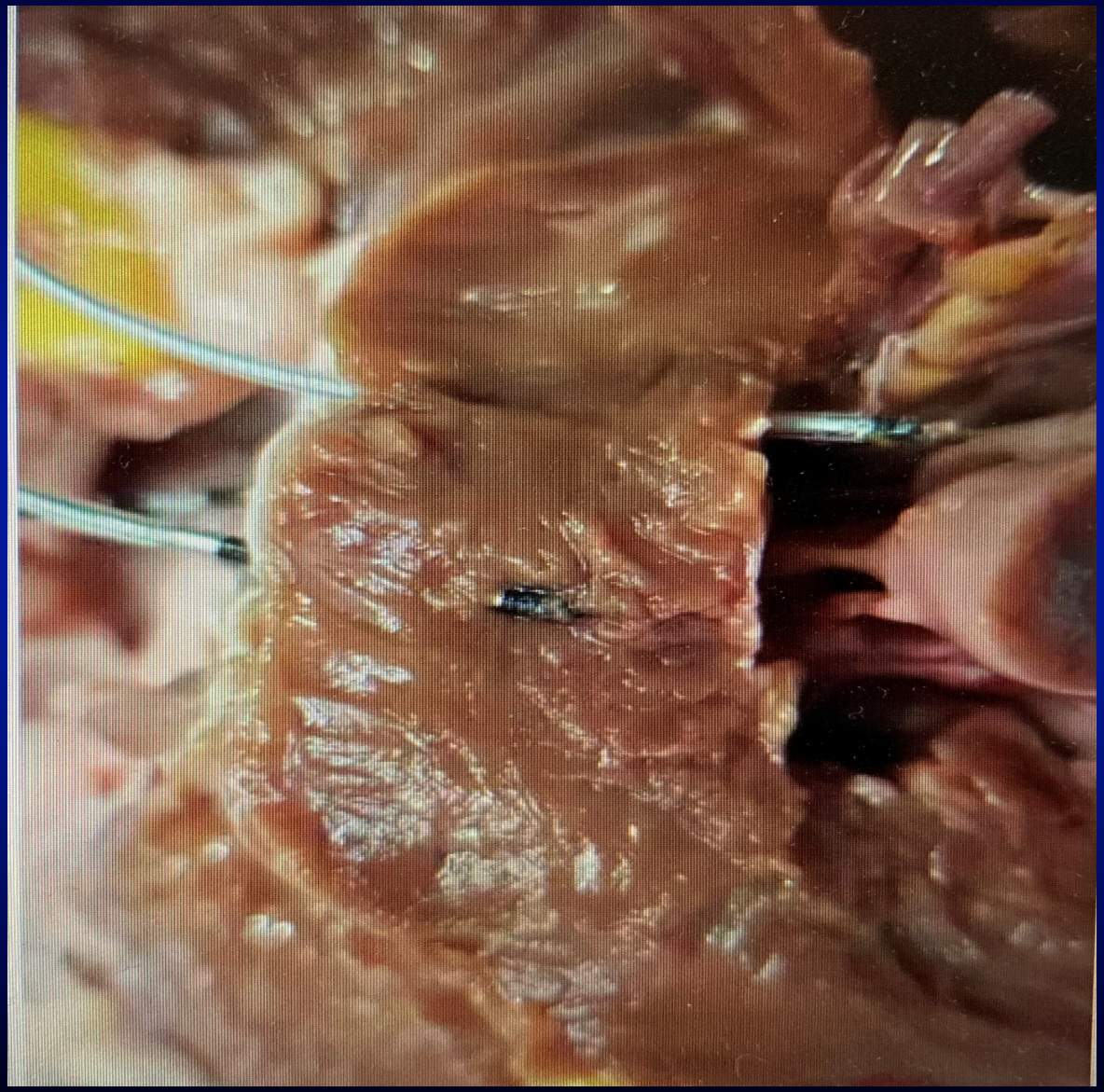
•European Heart Journal (2022) 00, 1–14

https://doi.org/10.1093/eurheartj/ehac445

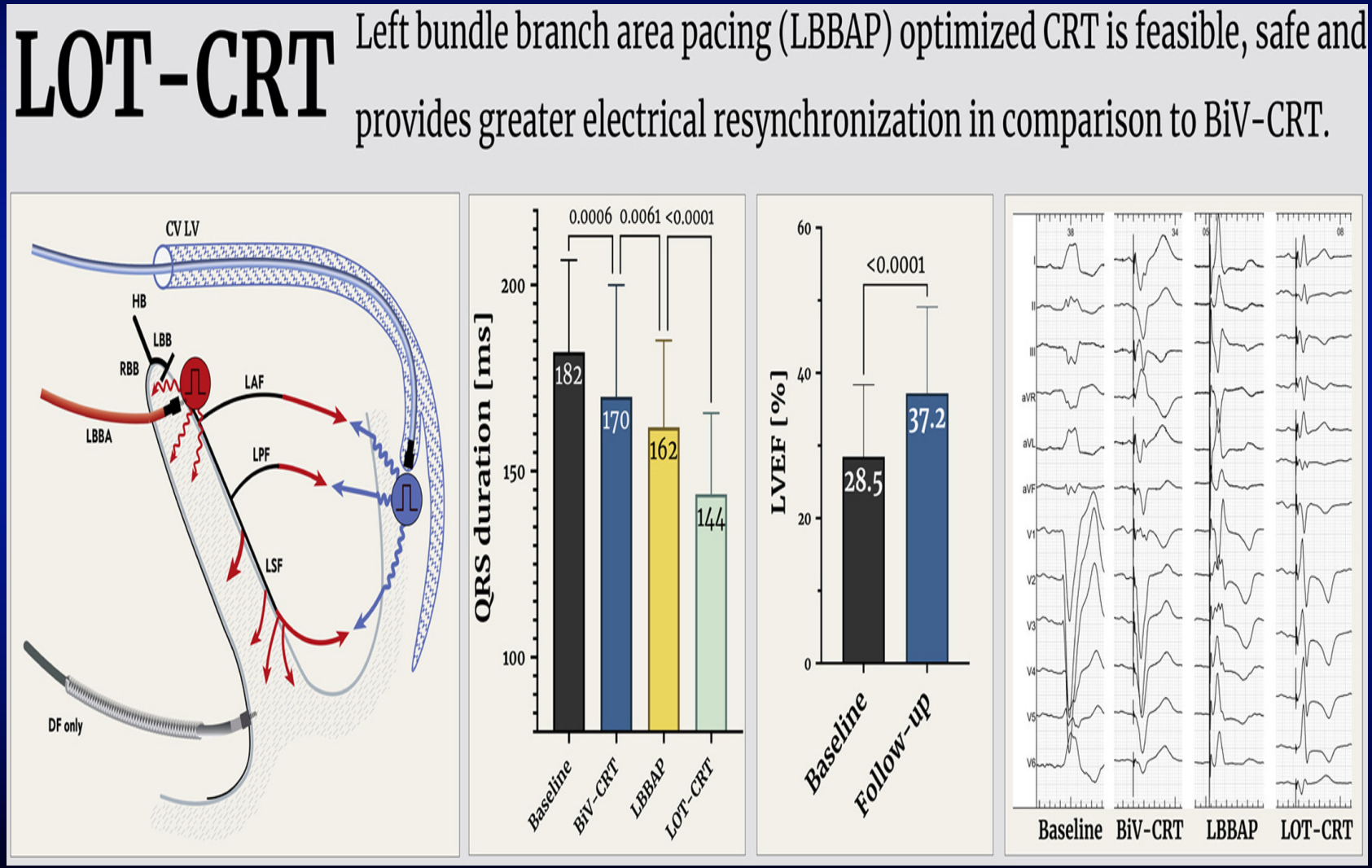
Figure 1 Examples of paced electrocardiogram patterns and endocardial electrograms during left bundle branch area ...



Septal Perforation



Left bundle branch–optimized cardiac resynchronization therapy (LOT-CRT): Results from an international LBBAP collaborative study group



Conclusion

1) Conduction system pacing is feasible and safe
2) Provides physiologic ventricular activation that is superior to RVA pacing
3) Conduction system pacing can be utilized for CRT and may be superior to BiV pacing

Questions/Limitations

1) LBAP creates intraventricular dyssynchrony
2) Questions remain regarding durability of lead implanted deep in the ventricular septum
3) Ability to extract these lead in the future