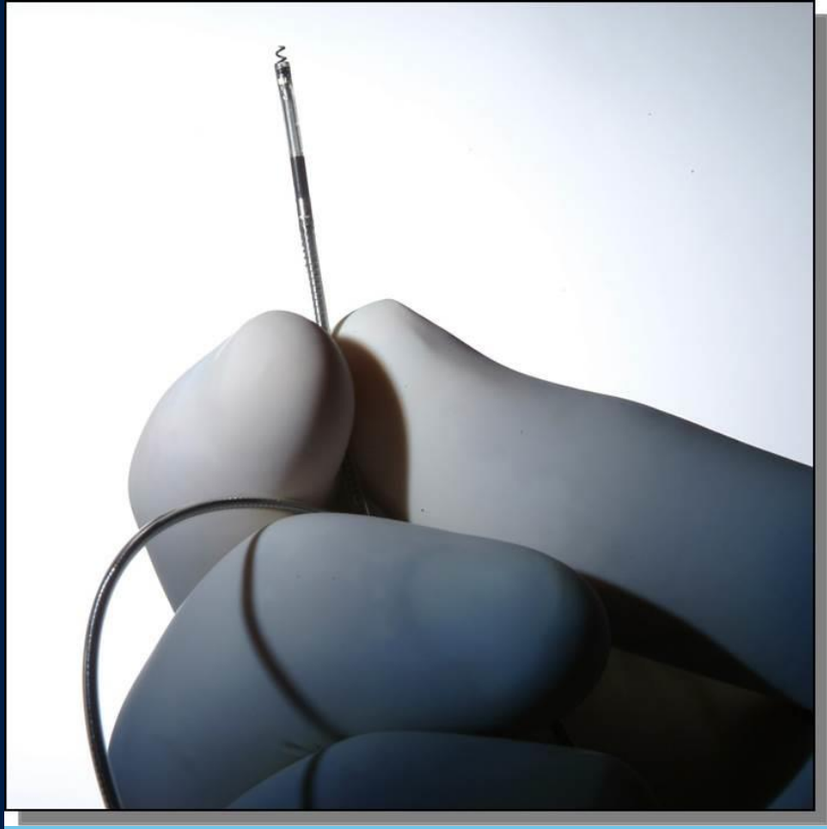
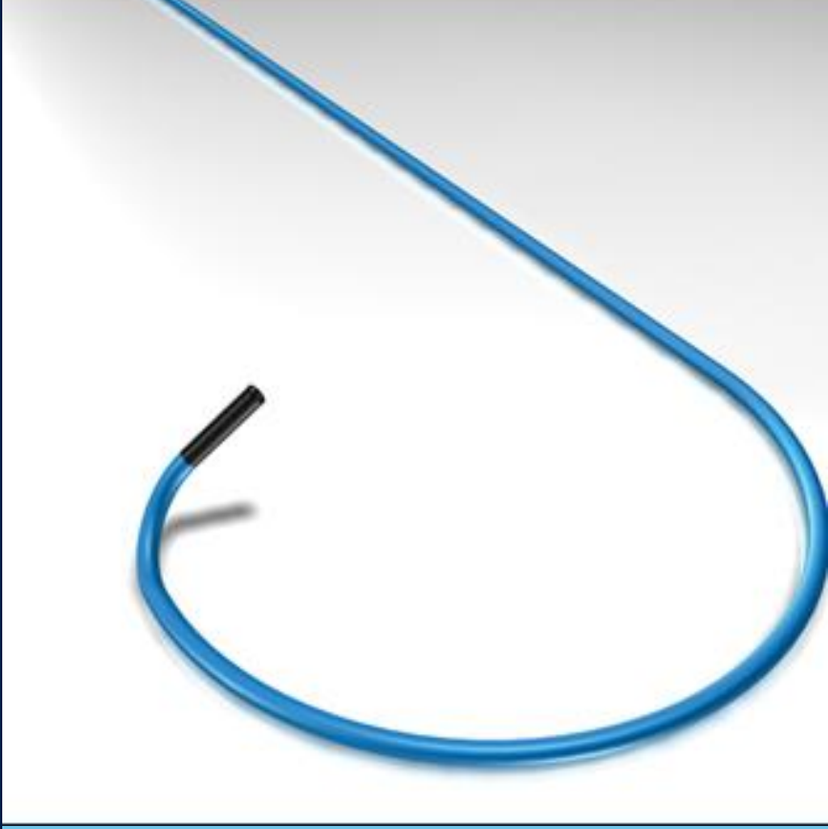
HIS PURKINJE SYSTEM PACING (HPSP)

Dr. Yuen Ho Chuen
Associate Consultant
Princess Margaret Hospital



AGENDA

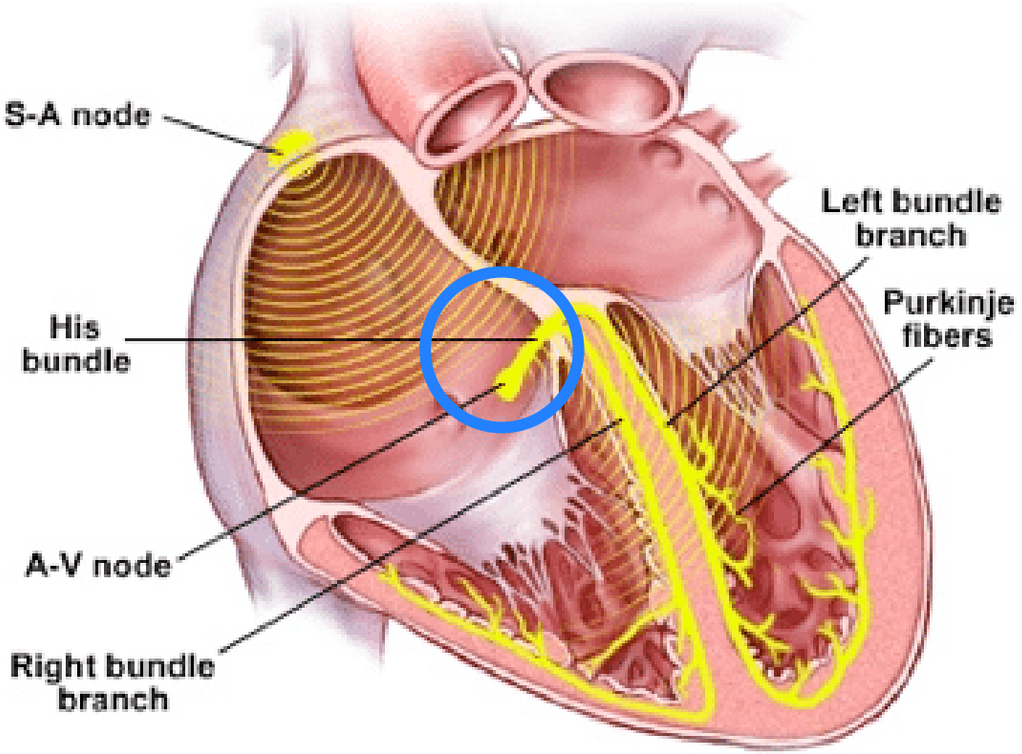
- Anatomy
- HIS Bundle Pacing & Left Bundle Pacing: WHY, WHAT and HOW?
- Pre-implant Preparation
- Implant procedure
- Summary



ANATOMY & PHYSIOLOGY
HIS PURKINJE SYSTEM STRUCTURE

Bundle of HIS (HB):

- a significant length of the His bundle rests on the right atrial-left ventricular part of the membranous septum
- average **length of 20mm and 4 mm in diameter**



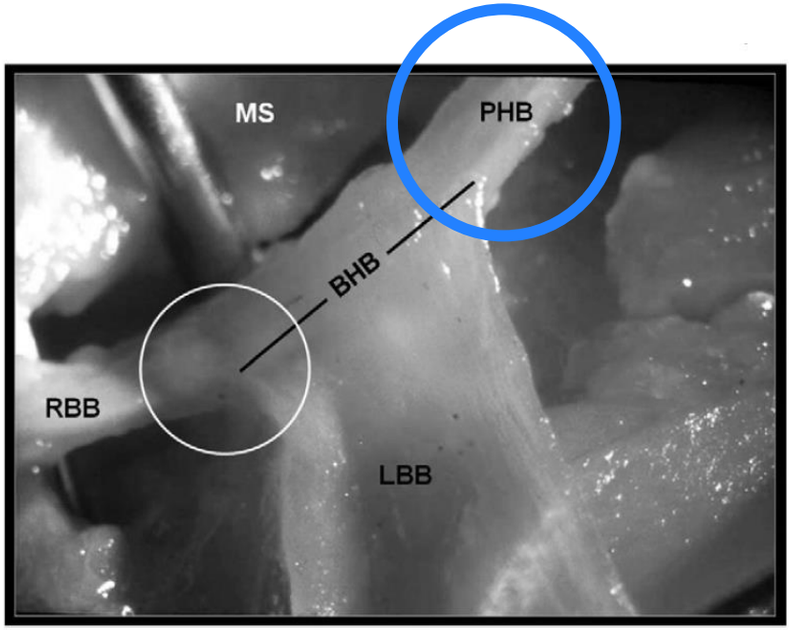
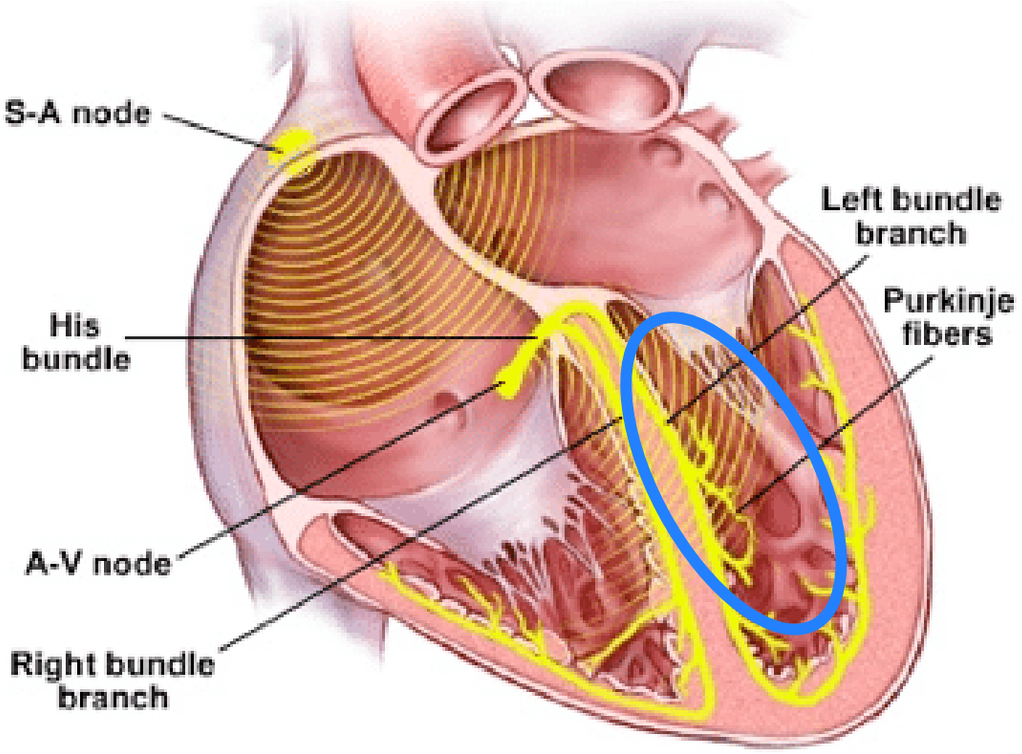


Fig. 5. Preparation with amplification under stereoscopic dissecting microscope of the penetrating portion of the bundle of His (PHB) and the left bundle branch (LBB) arising from the branching portion (BHB). The RBB (RBB) appears as a continuation of the bundle of His after the LBB has been given off. The circle points out the "pseudobifurcation". The membranous septum (MS) has been separated from the summit of the ventricular septum.

ANATOMY & PHYSIOLOGY
HIS PURKINJE SYSTEM STRUCTURE

Left Bundle Branch (LBB):

- the continuation of conducting fibers from the atrioventricular bundle of His
- forms within the interventricular septum at the junction of the membranous and muscular parts



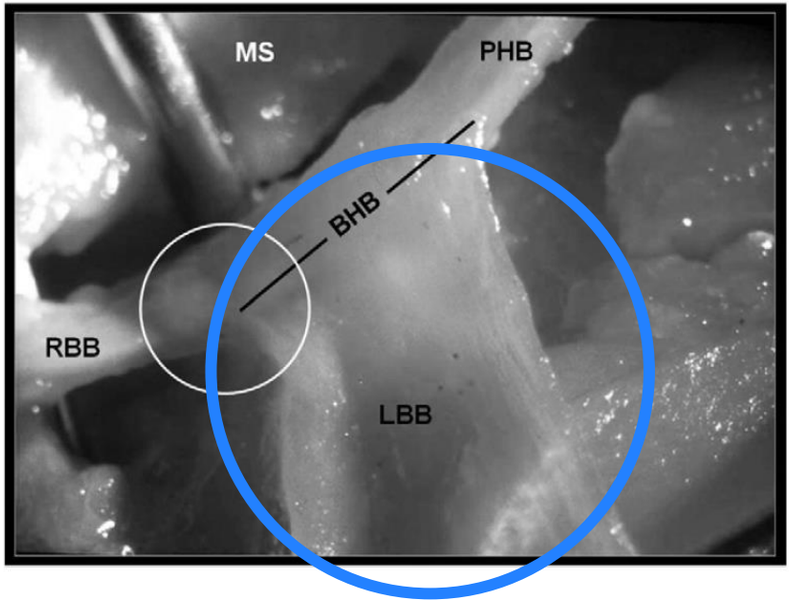


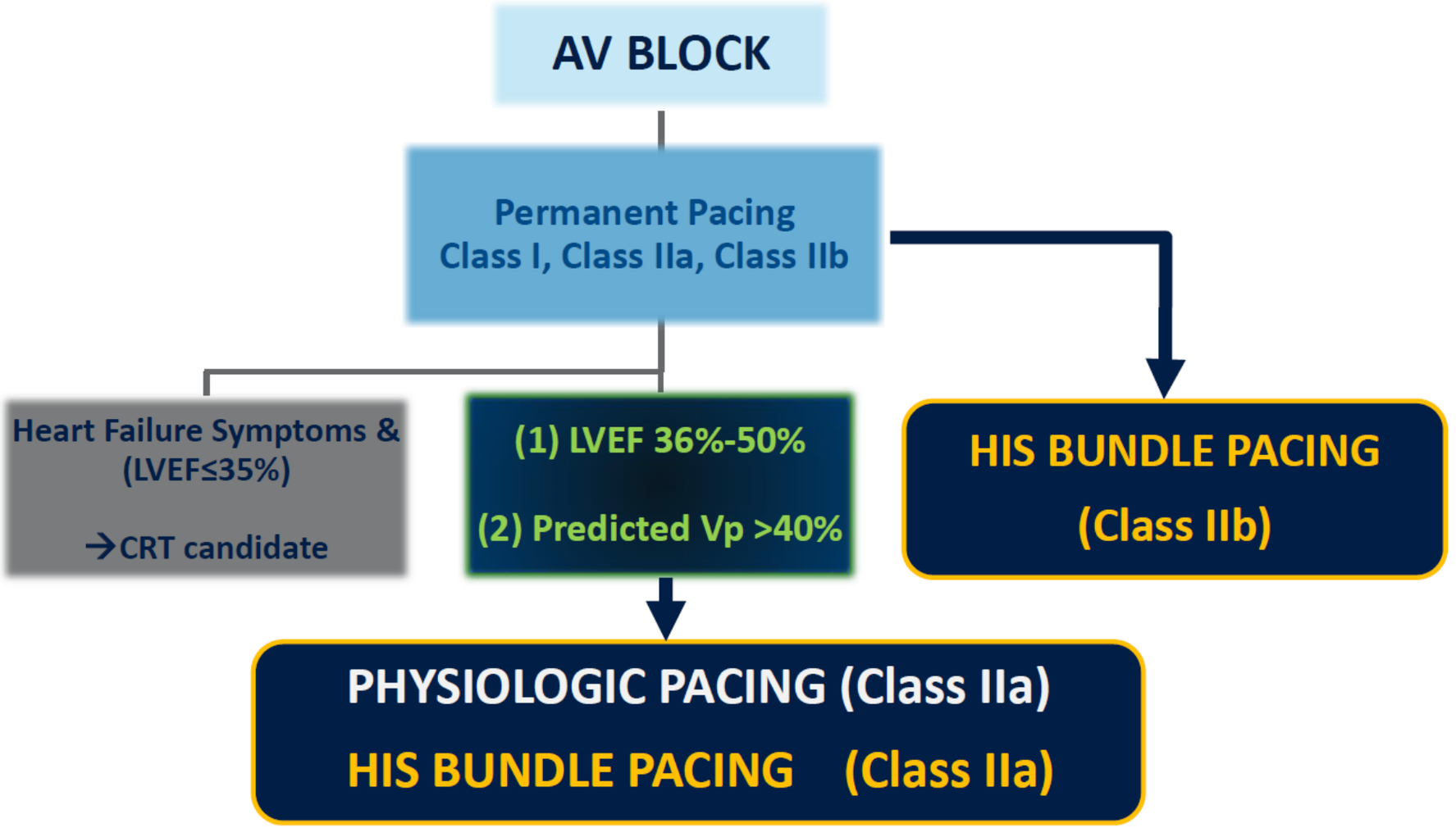
Fig. 5. Preparation with amplification under stereoscopic dissecting microscope of the penetrating portion of the bundle of His (PHB) and the left bundle branch (LBB) arising from the branching portion (BHB). The RBB (RBB) appears as a continuation of the bundle of His after the LBB has been given off. The circle points out the "pseudobifurcation". The membranous septum (MS) has been separated from the summit of the ventricular septum.

HIS BUNDLE PACING & LEFT BUNDLE PACING: WHY, WHAT AND HOW?

HIS BUNDLE PACING (HBP) IN PACEMAKER

2018 ACC/AHA/HRS GUIDELINE ON BRADYCARDIA AND CARDIAC CONDUCTION

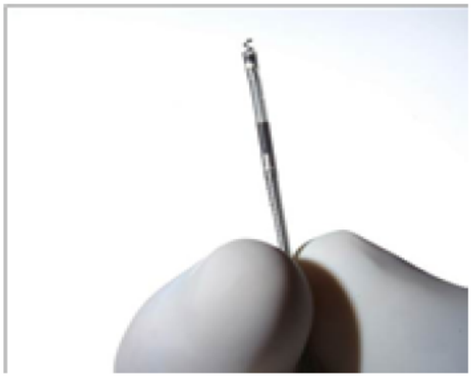
Recommendations for Permanent Pacing Techniques and Methods for
Chronic Therapy/Management of Bradycardia Attributable to Atrioventricular Block

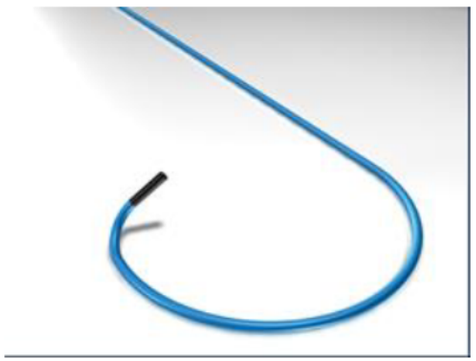


HIS BUNDLE PACING (HBP) IN PACEMAKER

Permanent His-bundle pacing: a systematic literature review and meta-analysis (Europace 2018)

Medtronic SelectSecure™ MRI SureScan™ 3830 Lead





Medtronic C315HIS Catheter

1438

patients

*QRS 114 ± 3ms

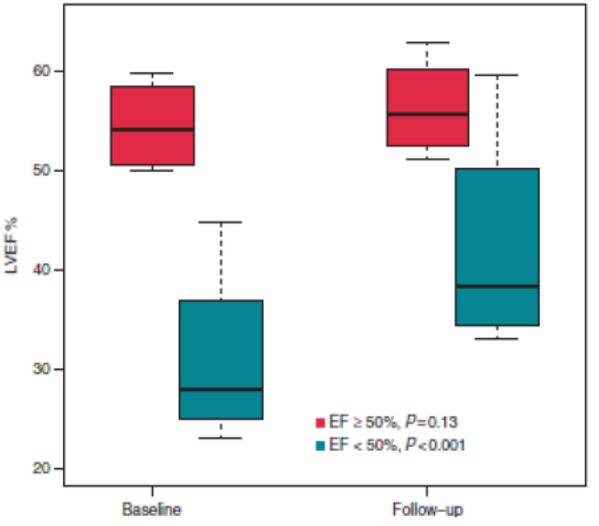
*62.1% with AVB

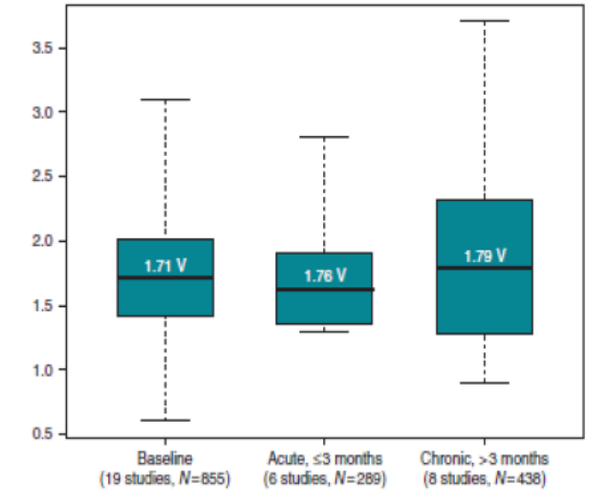
92.1%

implant success

LVEF

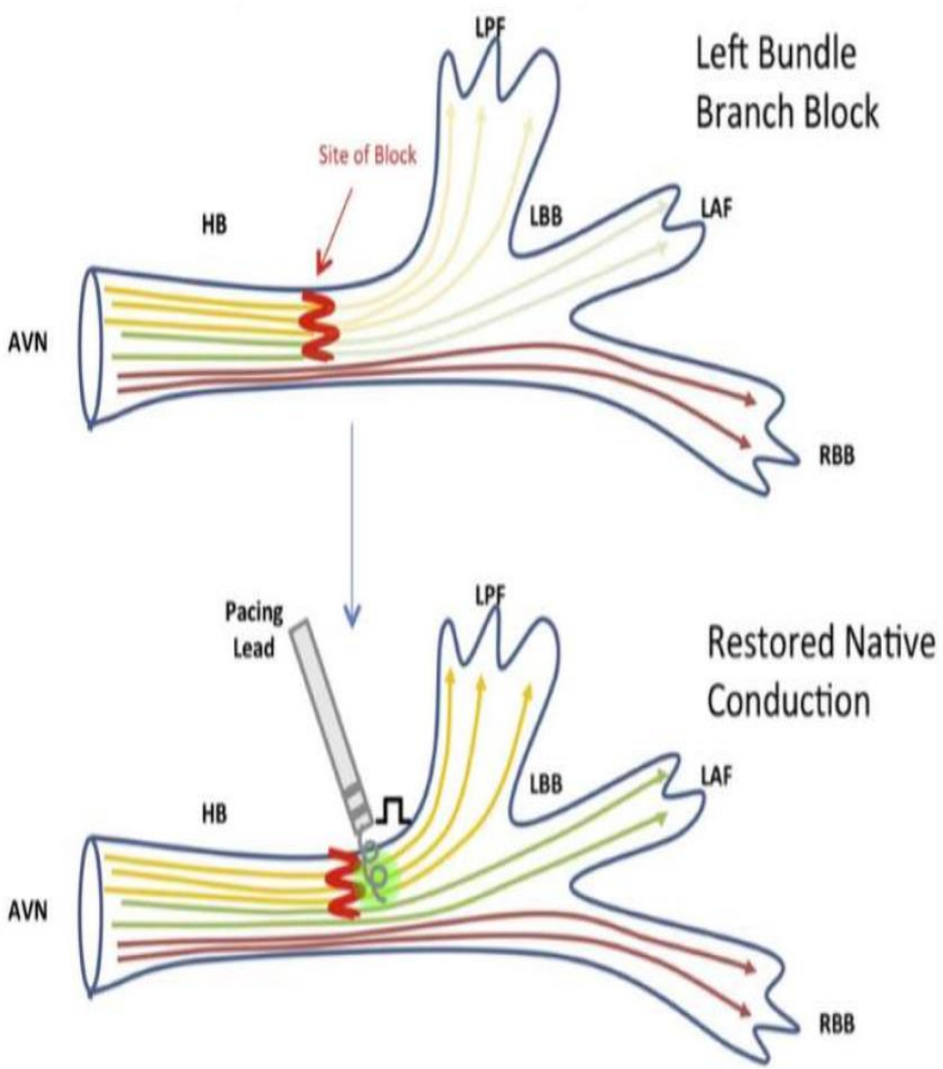
STABLE Threshold





HIS BUNDLE PACING (HBP) IN CRT
BACKGROUND

- BBB
  - Delay or block in fibers for bundle branches from Bundle of HIS
- Recruit HB in pacing distal to the site of block to restore normal conduction
- Multiple studies proved HBP is an alternative option for CRT patients, especially for those who failed to receive LV lead implantation or not response to CRT BiVp.



HIS BUNDLE PACING (HBP) IN CRT
CLINICAL EVIDENCE

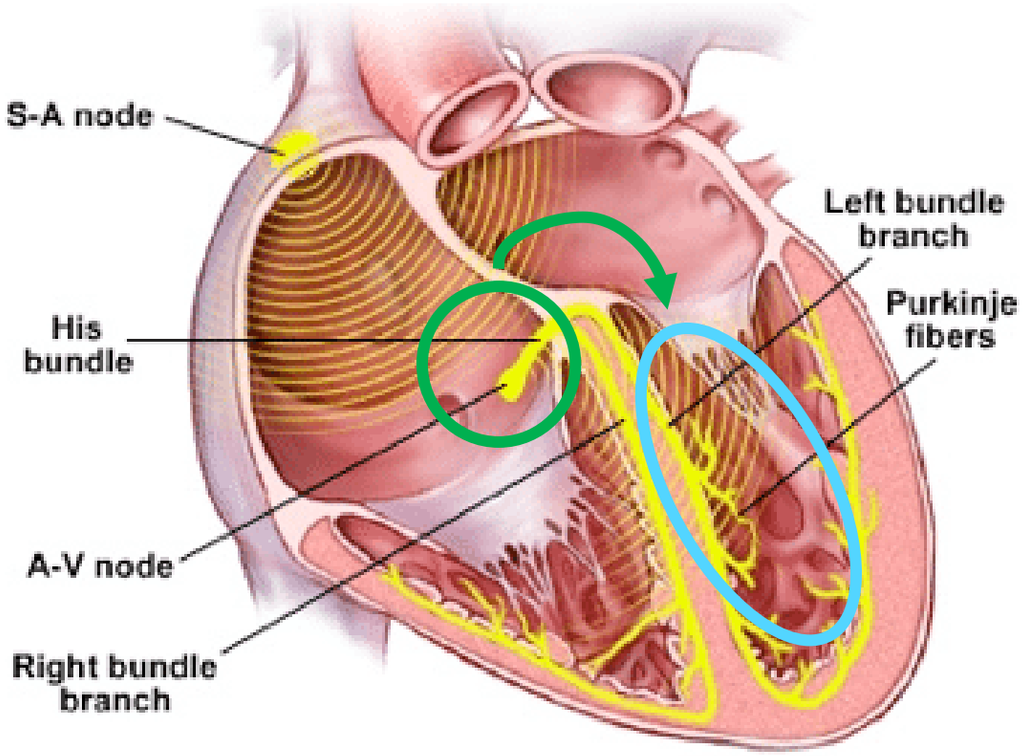
Permanent His-bundle pacing as an alternative to biventricular pacing for cardiac resynchronization therapy: A multicenter experience

Parikshit S. Sharma, MD, MPH, FACC,* Gopi Dandamudi, MD, FHRS,† Bengt Herweg, MD,‡ David Wilson, MD,‡ Rajeev Singh, MD,† Angela Naperkowski, RN, FHRS, CCDS, CEPS,§ Jayanthi N. Koneru, MBBS,¶ Kenneth A. Ellenbogen, MD, FACC, FHRS,¶ Pugazhendhi Vijayaraman, MD, FACC, FHRS§

- Published in Heart Rhythm in Mar 2018
- Objective: to assess the feasibility and outcomes of HBP in CRT eligible or failed patients
- Result:
  - 90% (95 out of 106) cases successfully recruited HB and QRS<120ms/ ≥20% narrowing compared with baseline
  - 75% (6 out of 8) CRT BiVp non-responders had echocardiographic response with HBP; mean LVEF increases from 30%±10% to 38%±13%

LIMITATION OF HBP

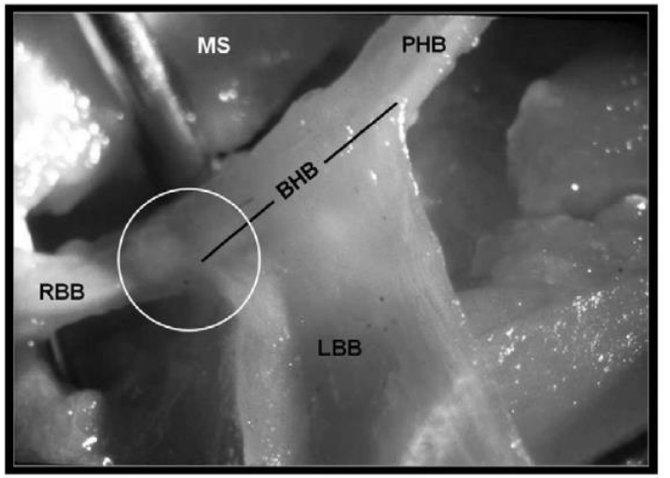
- High threshold for HIS bundle recruitment
  - HIS threshold is 1.35 V – 1.71 V @ varied pulse width [1,2] while RV pacing is <1V @ 0.4ms
- Elevated pacing threshold -> Shorter battery longevity
- Sensing issues due to low R-wave and potential P-wave oversensing
- Failure to correct bundle branch block

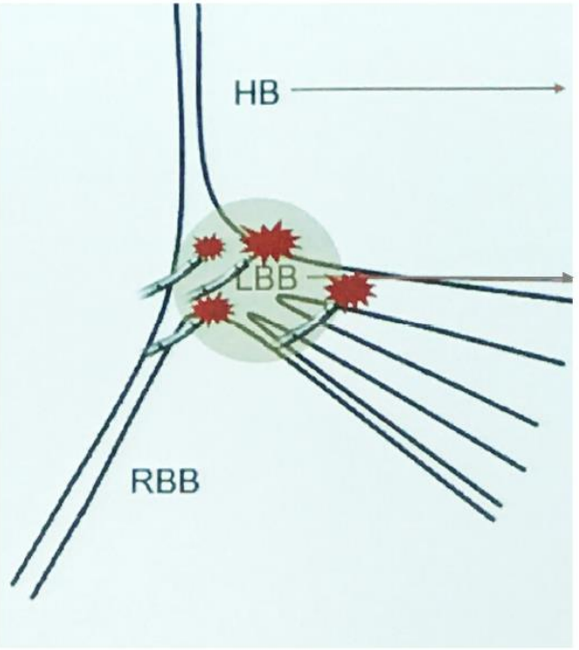


New pacing option - LBBP

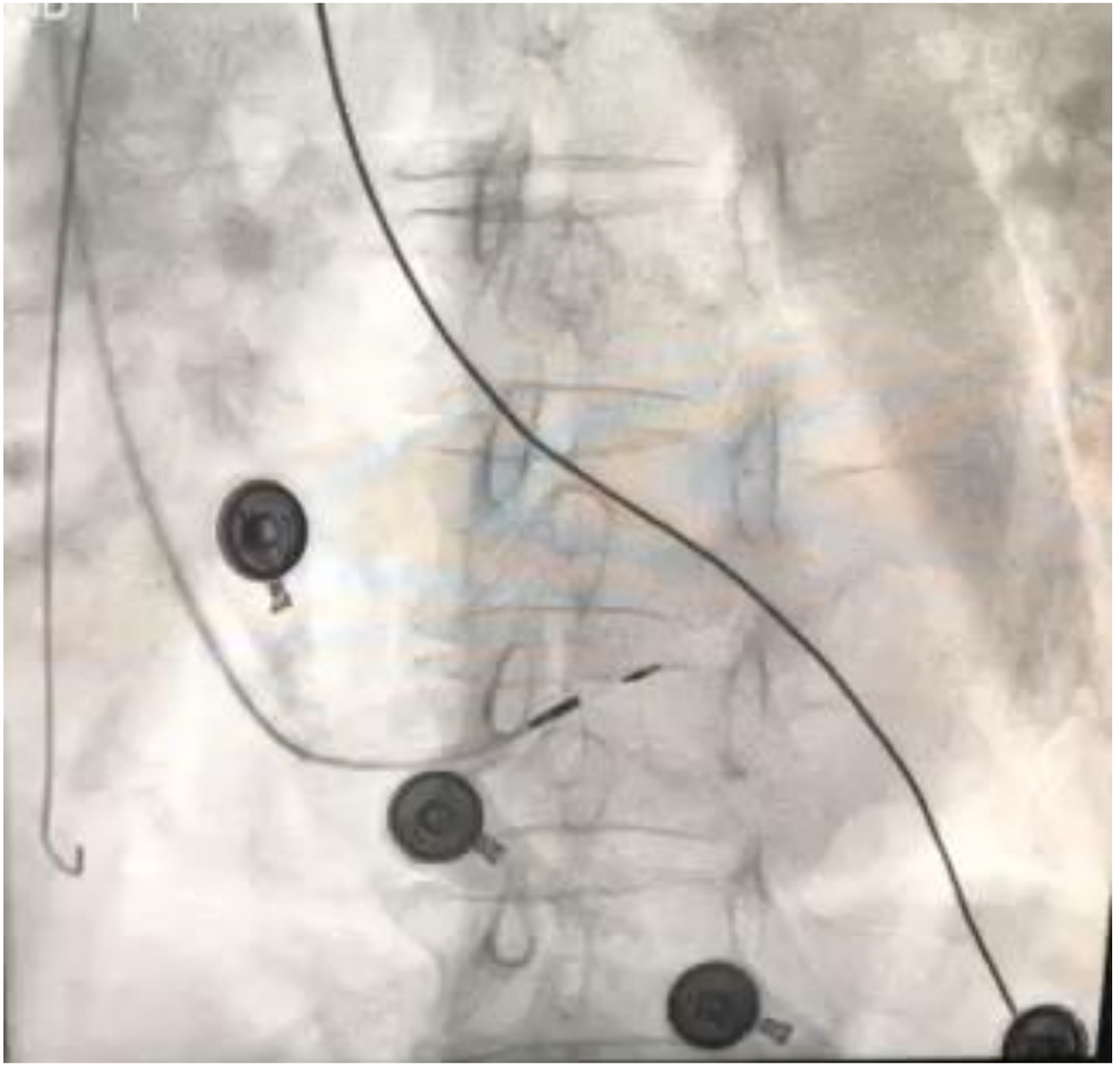
LEFT BUNDLE BRANCH PACING (LBBP)
ADVANTAGES

- Easier to cross learning curve comparing to HBP
  - LBB: wide conduction net
- Pacing beyond the site of block
  - Intra and infra-Hisian block
  - LBBB
- Low and stable threshold (0.68V-0.76V @ 0.5ms[3,4])
- Good sensing
- High stability





ADVANTAGES OF LBBP
High stability



LIMITATION OF LBBP

- Lack of long term data on LBBP (1st LBBP case report: published in 2017)
- Lack of prospective, randomized, controlled trials

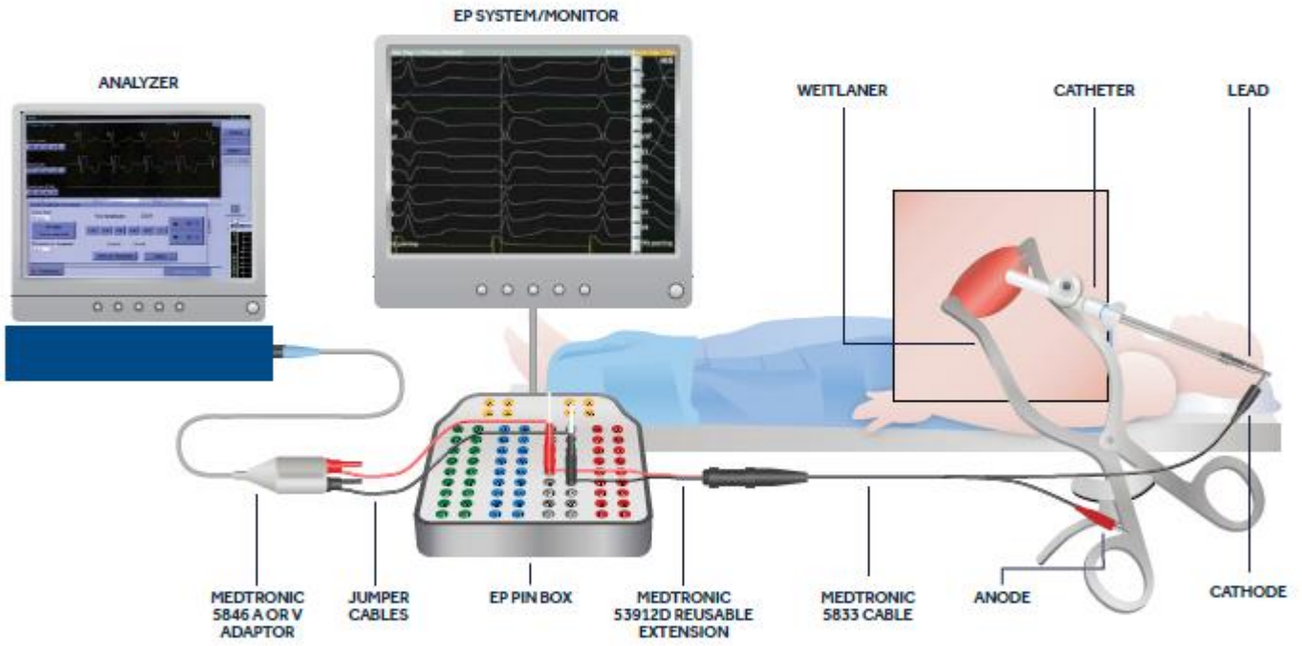
PRE-IMPLANT PREPARATION

SET UP
ANALYZER

- **12 lead ECG is prepared? A clear 12 lead ECG is important!**
- **Connect analyzer with EP system?**

HIS-BUNDLE MAPPING
CONNECT TO THE EP RECORDING SYSTEM

The illustration below shows the different cables/ connectors needed to connect the SelectSecure™ MRI SureScan™ Model 3830 pacing lead to the Medtronic Analyzer AND the EP recording system. This setup is used in the lab for mapping the location of the His bundle, measuring R-waves, and testing pacing thresholds.



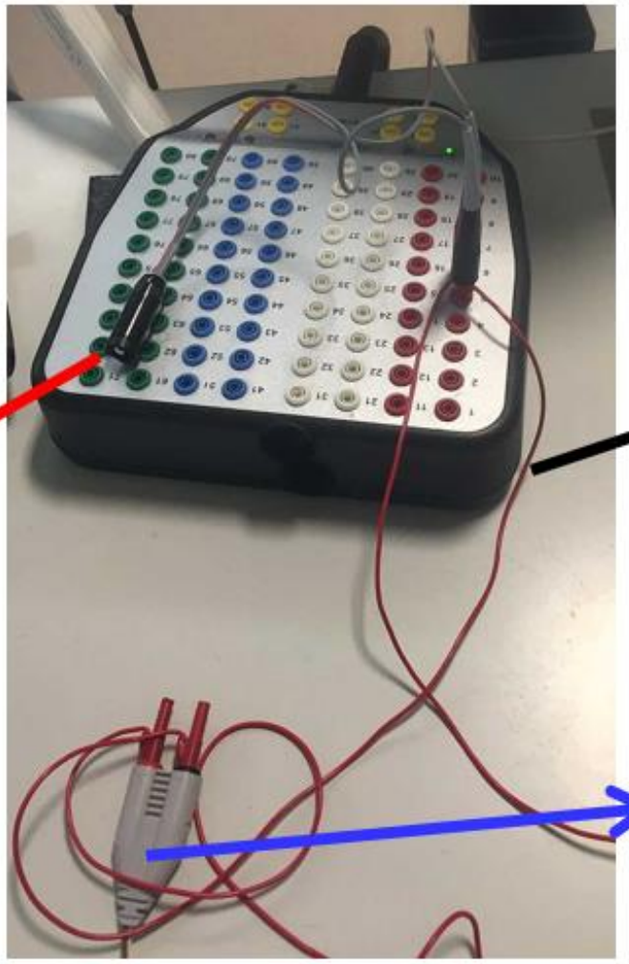
Label	Type	Inputs		Gain	Filter Settings	
		+	-		High Pass	Low Pass
HIS d	Bipolar	6	5	10,000	30.00 Hz	500 Hz
HIS m	Bipolar	6	5	5,000	0.50 Hz	500 Hz

For optimal viewing:
Adjust the gain to the highest setting without observing artifact.
See example on the left of filter settings for His d and His m.

Medtronic

USE THIS "SHARING" SETUP SO YOU CAN SEE THE MAPPING ON EP EQUIPMENT AS WELL AS THE ANALYZER

- Use 12 lead ECG monitoring during implant
  - Use the His DISTAL channel on EP recording equipment (only one EGM)
  - Follow diagram below to display on both Analyzer & EP system



SHIELDED JUMPER CABLES, PLUGGED INTO PIN BOX 5-6 FOR HIS DISTAL RECORDING (MAY DIFFER PER LAB)

CARDIOTRONIC XI.MDT REUSABLE EXTENSION CABLE, connect to 5833SL pacing cable, to patient

REMINGTON MEDICAL ADAP-2000-12 DISPOSABLE ADAPTER, to Analyzer Atrial channel

EGM signal from the lead

IMPLANT PROCEDURE

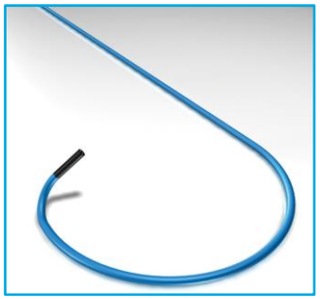
HIS BUNDLE PACING

LEADS & CATHETERS

- **SelectSecure™ MRI SureScan™ Model 3830 Lead[1]:**
  - is intended for pacing and sensing in the atrium, right ventricle, or at the bundle of His as an alternative to right ventricular pacing
  - is MR Conditional (specified lengths including 59, 69 and 74 cm)
- **C315 Catheter[2]**
  - indicated for the introduction of various types of pacing or defibrillator leads and catheters*
- **C304 Deflectable Catheter[3]**
  - indicated for the introduction of various types of pacing or defibrillator leads and catheters*

3830 MRI Lead

C315HIS Catheter



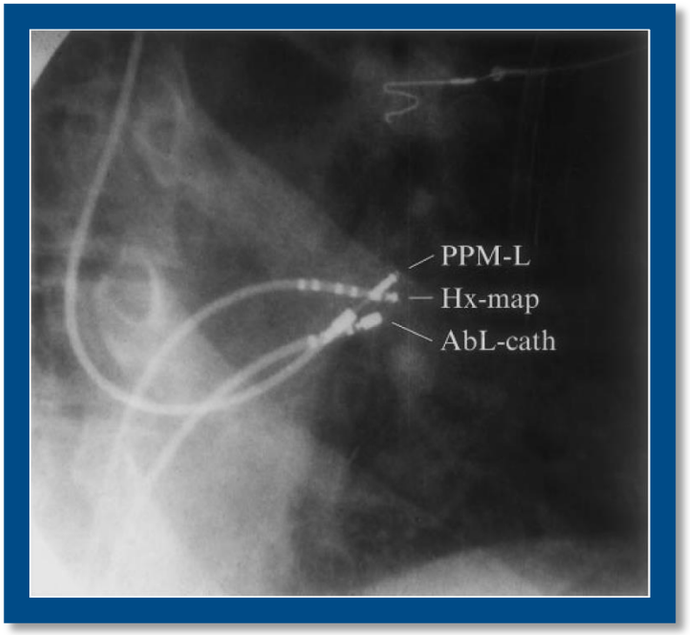
C304 Deflectable Catheter

* C315/C304 catheters are not used for His-bundle pacing with defibrillator leads.

[1] Medtronic SelectSecure™ MRI SureScan™ 3830. Technical Manual. 2018.
[2] Medtronic C315H20, C315H40, C315HIS, C315J, C315S4, C315S5, C315S10 Delivery Catheter. Instructions for Use, 2016.
[3] Medtronic SelectSite™ C304-S59, C304-L69, C304-XL74. Instructions for Use. 2010.

LEADS & CATHETERS
USING EP MAPPING CATHETER

- May be beneficial for unusual anatomy
- Has been superseded by direct mapping using 3830 lead and pre-formed catheter
- May use femoral or subclavian venous approach



Mapping with EP catheter

Image: Courtesy of Gopi Dandamudi MD, FHRS and Pugazhendhi Vijayaraman MD, FHRS.

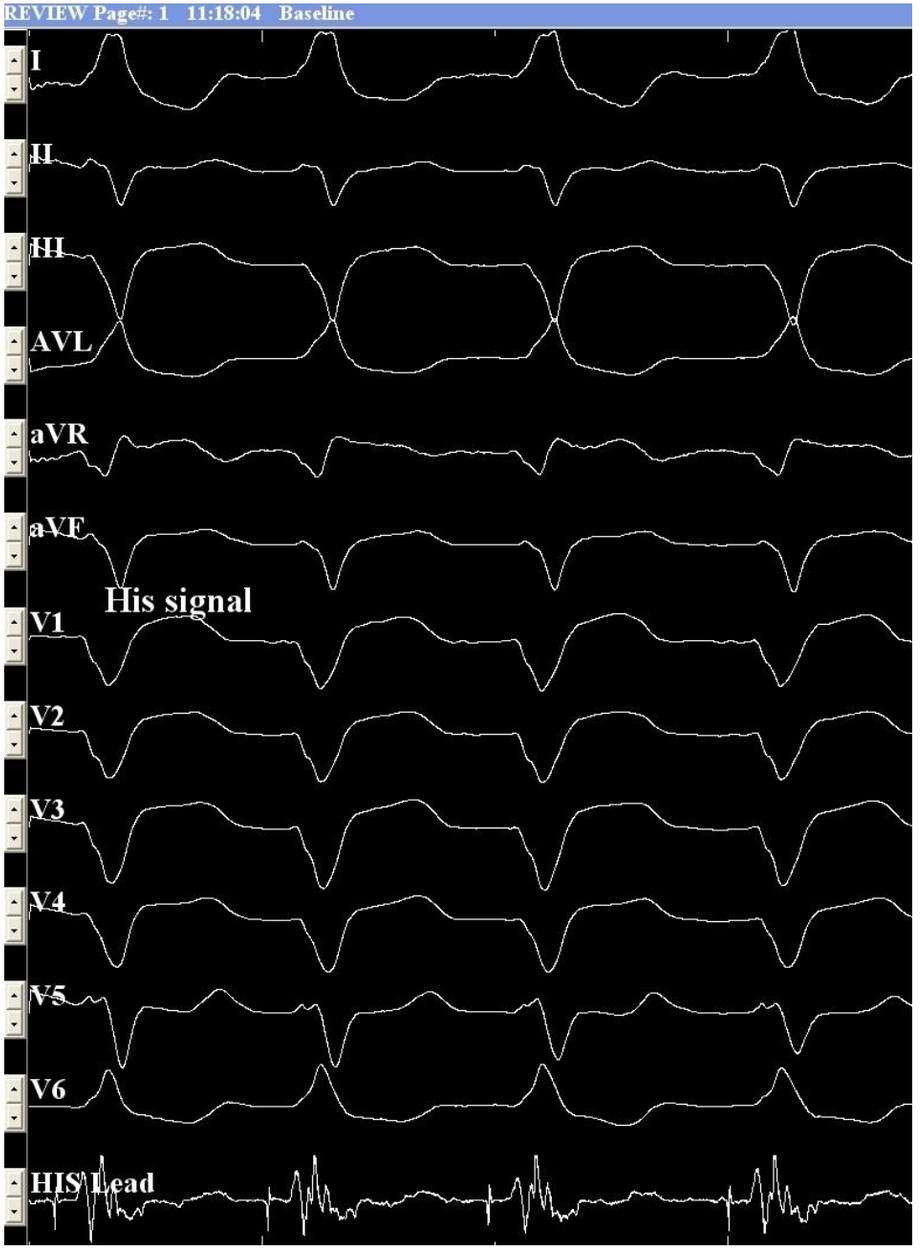
OVERVIEW OF HIS-BUNDLE PACING
HIS-BUNDLE PACING IMPLANT STEPS[1-4]

Step 1: Obtaining Access

Step 2: Mapping the His Bundle

- Set sweep speed to 50 mm/sec and Atrial pulse width to 1.0ms.
- Manipulate the C315HIS catheter until a clear His potential is observable.

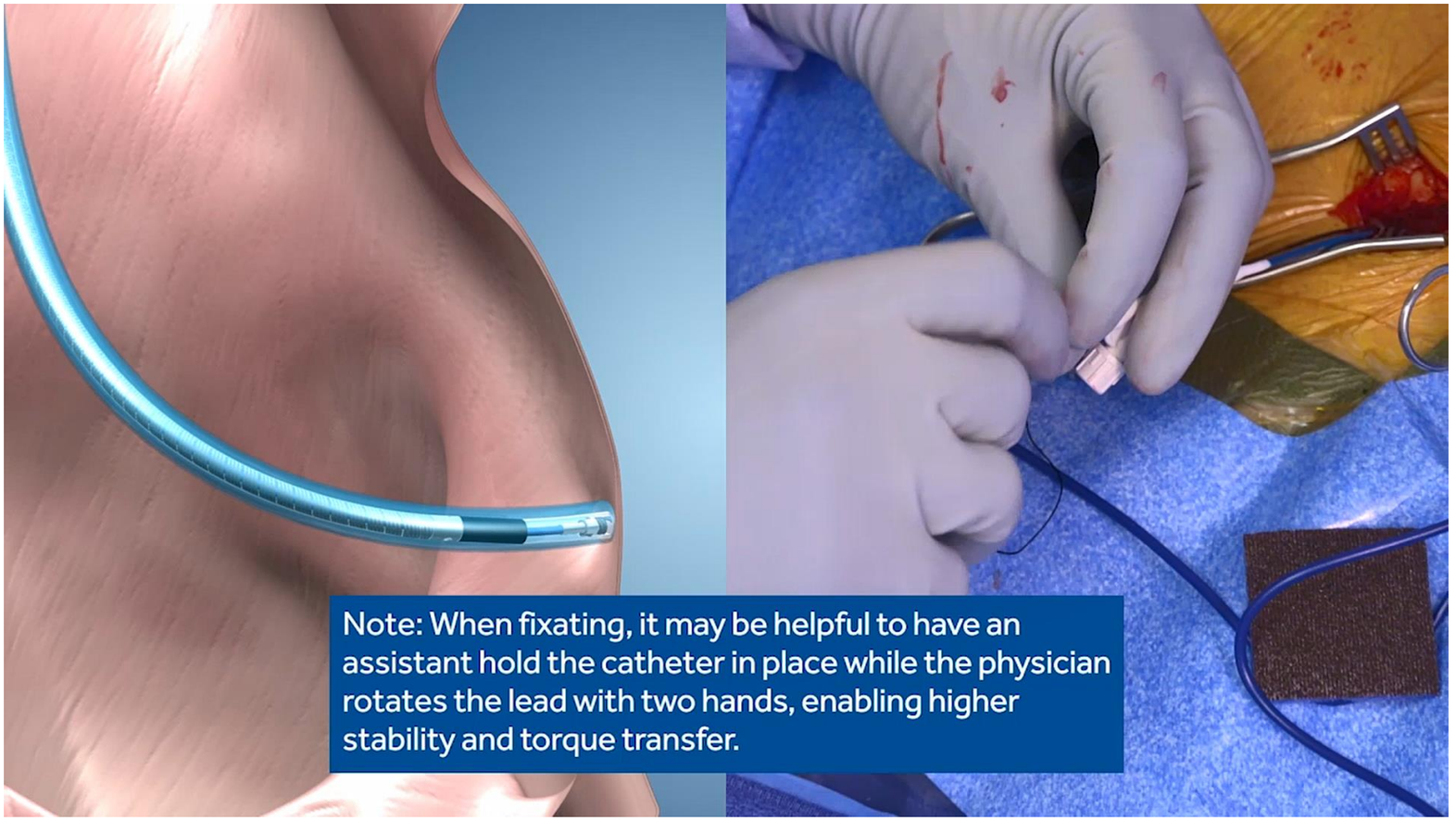
The His bundle region was mapped (His signal was clearly seen)



OVERVIEW OF HIS-BUNDLE PACING
HIS-BUNDLE PACING IMPLANT STEPS[1-4^]

Step 3: Fixating the Lead

- Without letting go of the lead and while applying light forward pressure, rotate the **entire** lead body clockwise 4 complete times.

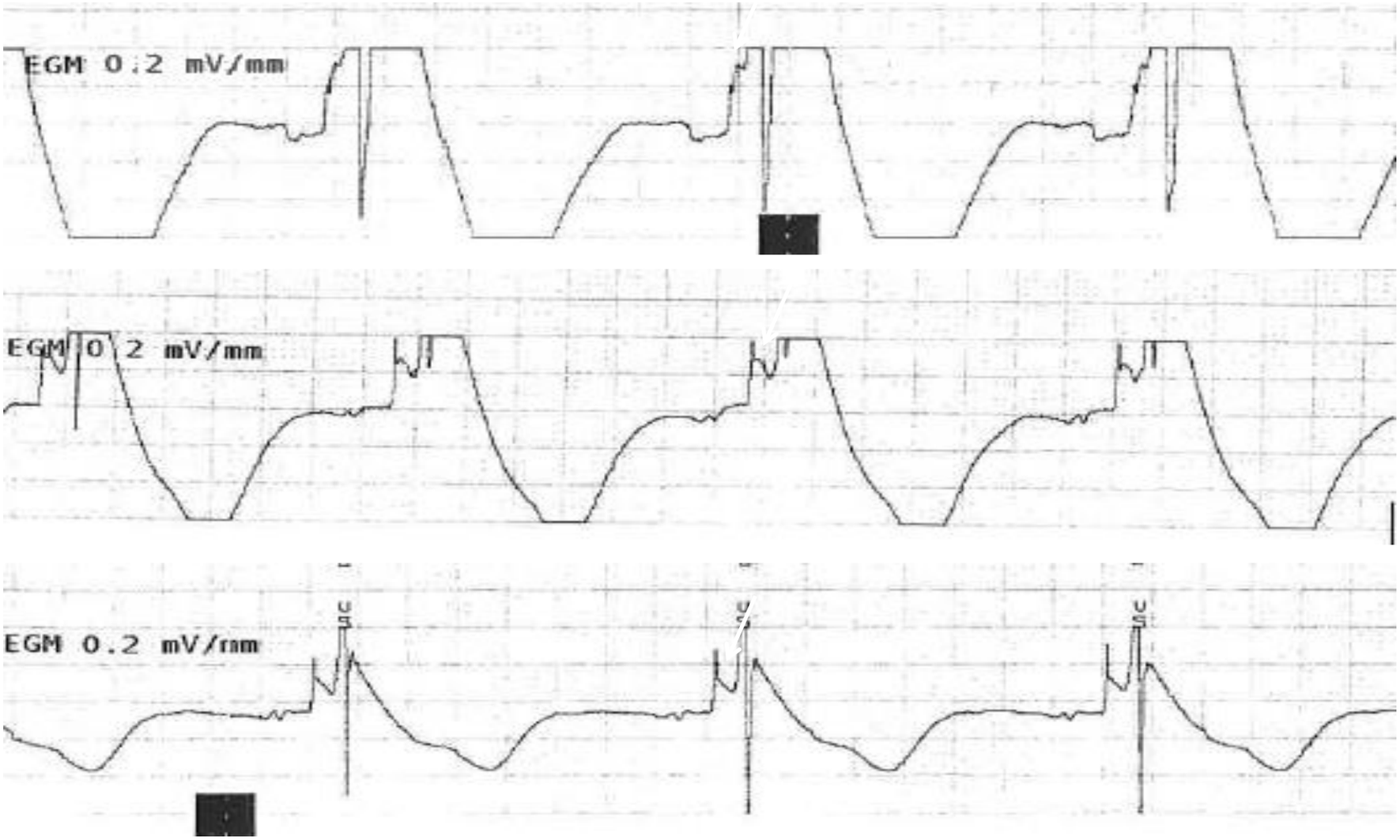


HIS BUNDLE INJURY CURRENT

At implant

5 minutes

20 minutes



OVERVIEW OF HIS-BUNDLE PACING
HIS-BUNDLE PACING IMPLANT STEPS[1-4^]

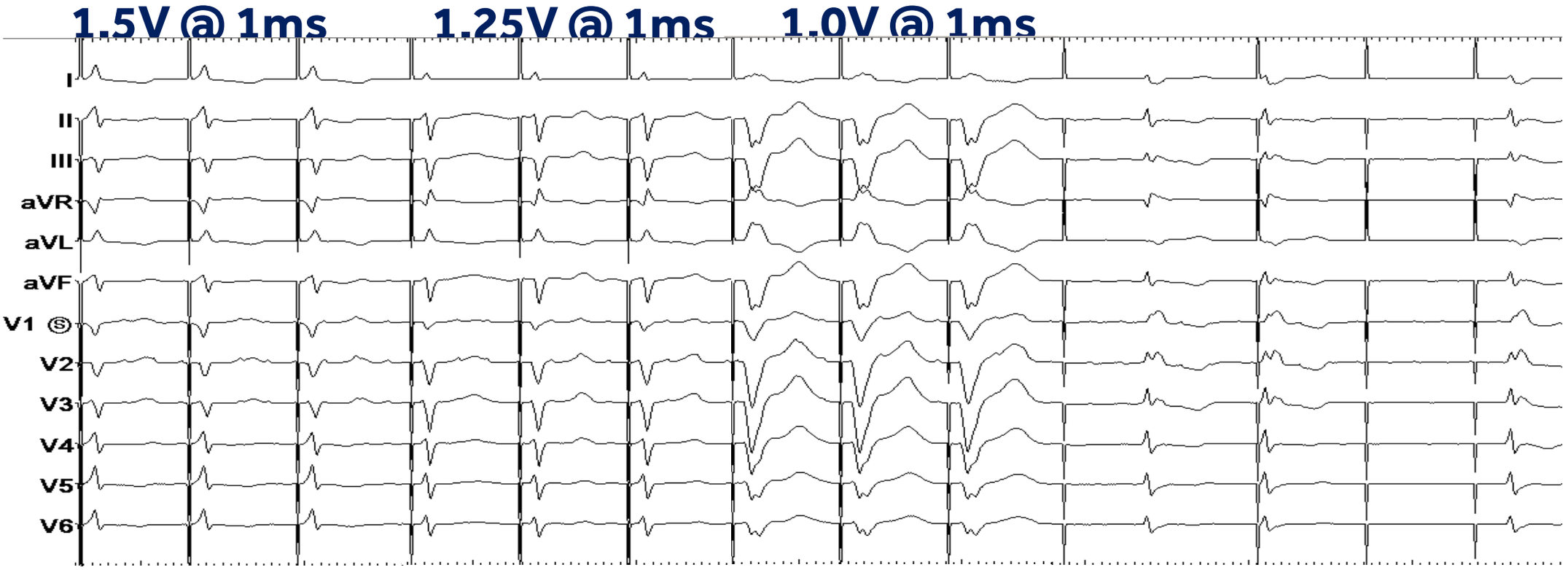
Step 4: Testing the His Bundle Location

- Via 12-lead or other surface ECG, measure the QRS width and V sense time during high output pacing (typically start at 5V @ 1 ms).
- Run a threshold test, decrementing voltage over time. Note here that you will obtain two thresholds, a His threshold and a RV capture threshold.

High Output pacing in a non-selective location may capture surrounding myocardium and widen the QRS. As you decrement the voltage, you may actually see the QRS narrow as you begin to capture the His bundle by itself which is called selective His-bundle pacing.

WHATS MORE
SELECTIVE LBB/ RBB CAPTURE

You may even obtain three thresholds by seeing the ECG morphology change, therefore **a clear ECG is extremely important!**



RV and His capture
NonSelective-HBP

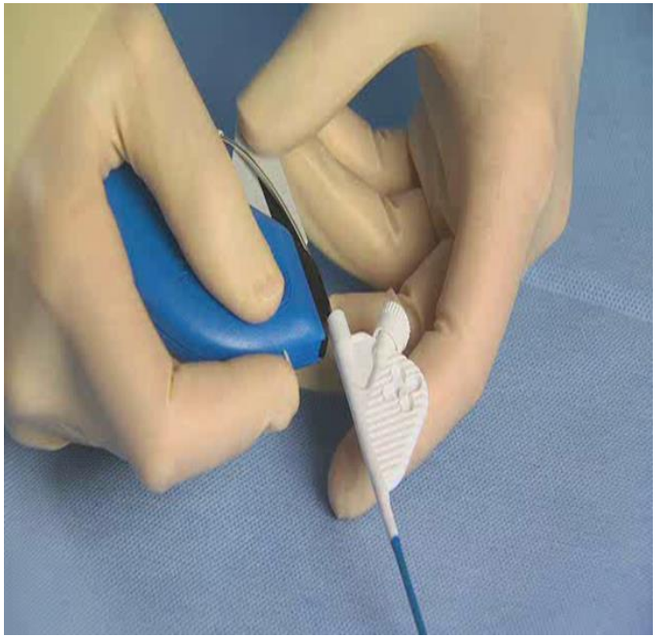
His capture only
Selective HBP

RB capture only
Selective HBP

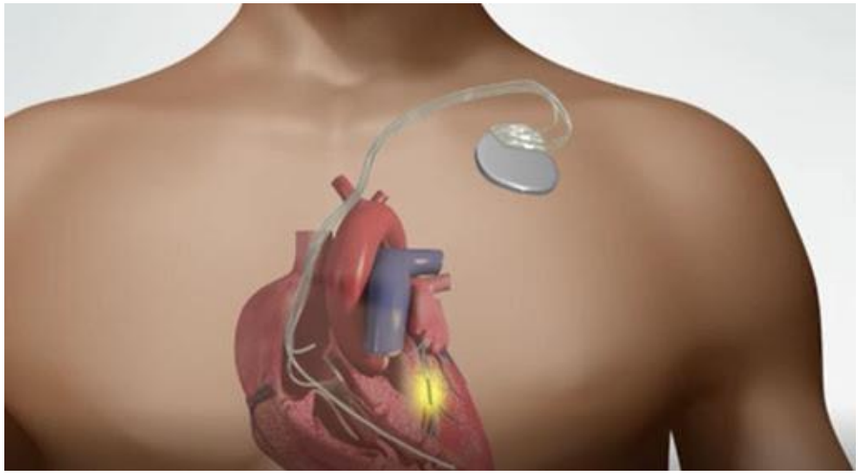
Baseline RBBB

OVERVIEW OF HIS-BUNDLE PACING
HIS-BUNDLE PACING IMPLANT STEPS[1-4^]

Step 5: Slit the C315HIS Catheter



Step 6: Place the Atrial Lead and select Appropriate Device



IF CONTINUOUSLY FAILURE..
WHEN TO GIVE UP?

Cannot Map His signal/ High threshold ?
(5 attempts/ fluoro time <20min as suggested)

Conventional PPM/CRT approach - Accept septal capture for PPM patients

Find His signal below TV or perform LBBP

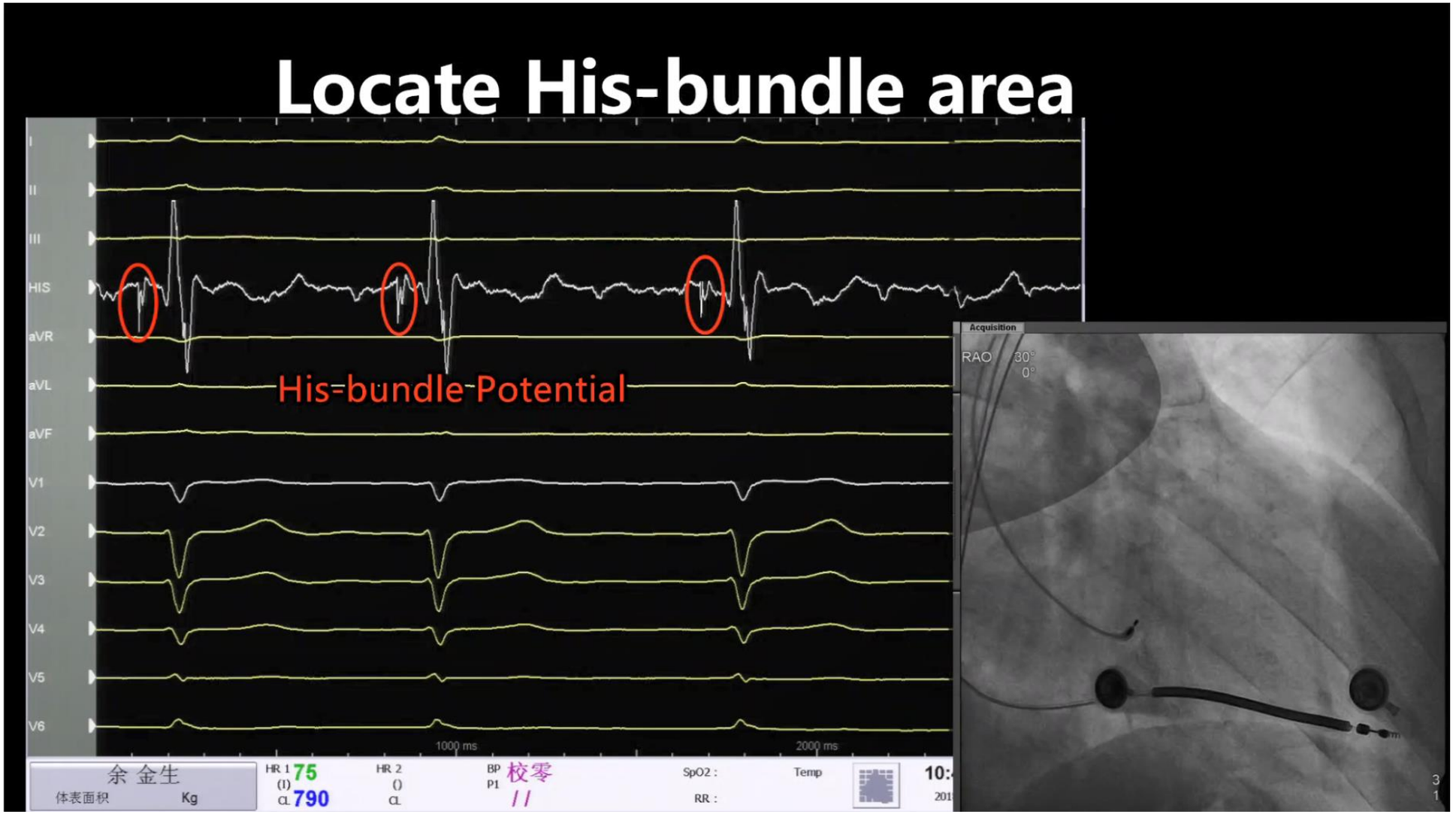
IMPLANT PROCEDURE

LEFT BUNDLE BRANCH PACING

IMPLANTATION OF LBBP

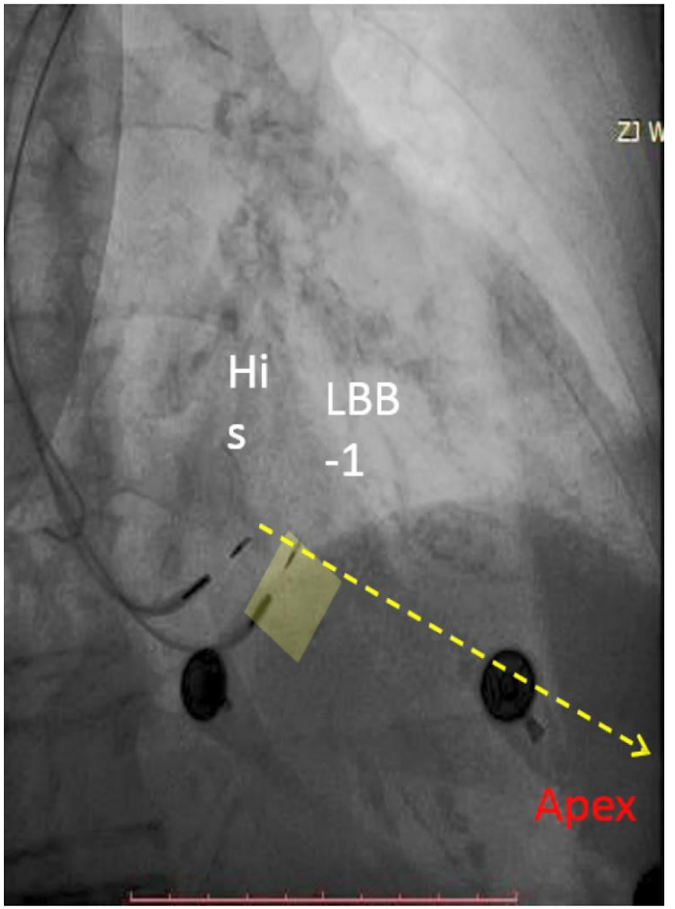
STEP – BY – STEP

1. HIS MAPPING (OPTIONAL BUT RECOMMEND)



IMPLANTATION OF LBBP
STEP – BY – STEP
2. SCREW IN SITE LOCATION

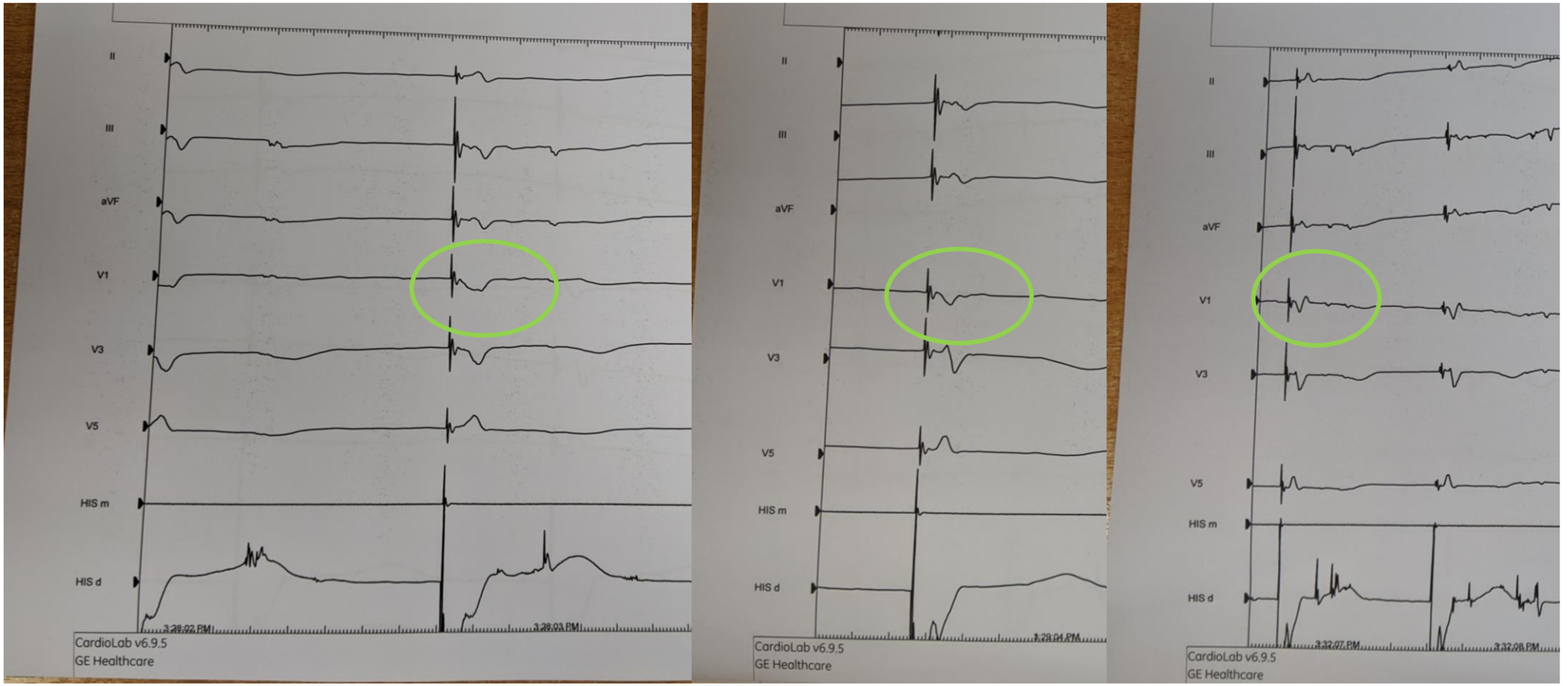
1. Form an imaginary line from HIS – apex (RAO)
2. Advance 3830 lead 1-1.5cm along the imaginary line (RAO) towards Apex
3. Make sure the lead is pointing to septum and the make sure the direction is perpendicular to the septum (LAO)
4. Pace to observe “W” morphology in V1 lead
5. Pace mapping (Pacing at high output to look for QRS narrowing (recruitment of HPSP))
6. Measure impedance (as a baseline reference)



IMPLANTATION OF LBBP
RECOGNITION OF LBBP BY ELECTRICAL PARAMETERS AND ECG

1. Screw in 3830 gradually
2. Observation gradual change of “W” pattern to RBBB pattern in V1 every 4 turns
3. Observe impedance change (should increase gradually when the lead go into myocardium; mindful if the impedance start to drop (*can be perforation)
4. Confirm LBBP by the below:
    1. Changed of “W” pattern to RBBB pattern in V1
    2. Observe LBB potential in EGM (for non LBBB patient)
    3. ECG ~110ms for normal heart; ~20-30% reduction in QRS duration for DCM patient
    4. Stim-QRS peak (stim to LVAT) ~70ms in normal heart; 20-30% LVAT reduction for DCM patient
    5. Stim-LVAT remains constant for direct LBBP. Output dependent if para LBBP

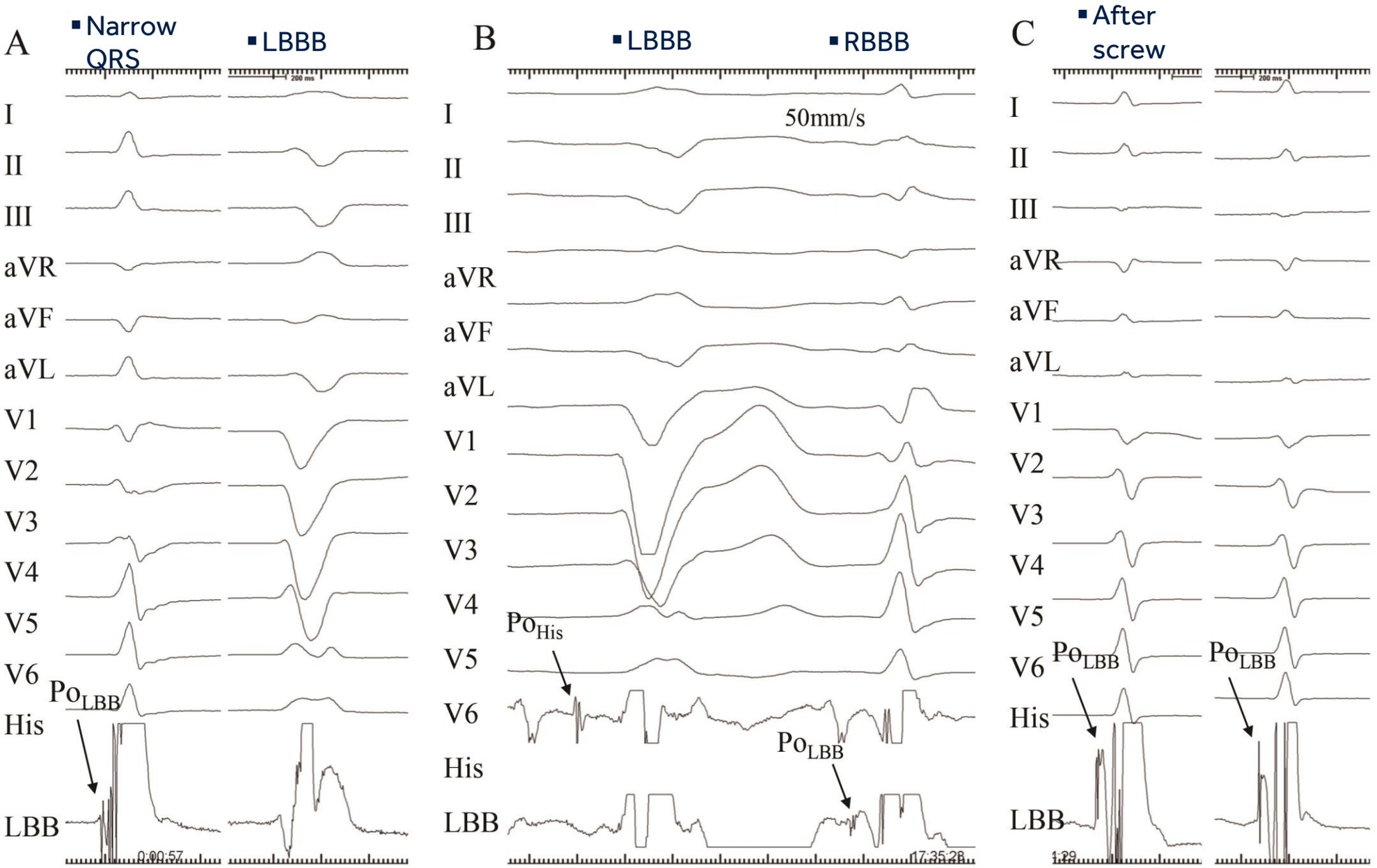
1. CHANGED OF “W” PATTERN TO RBBB PATTERN IN V1



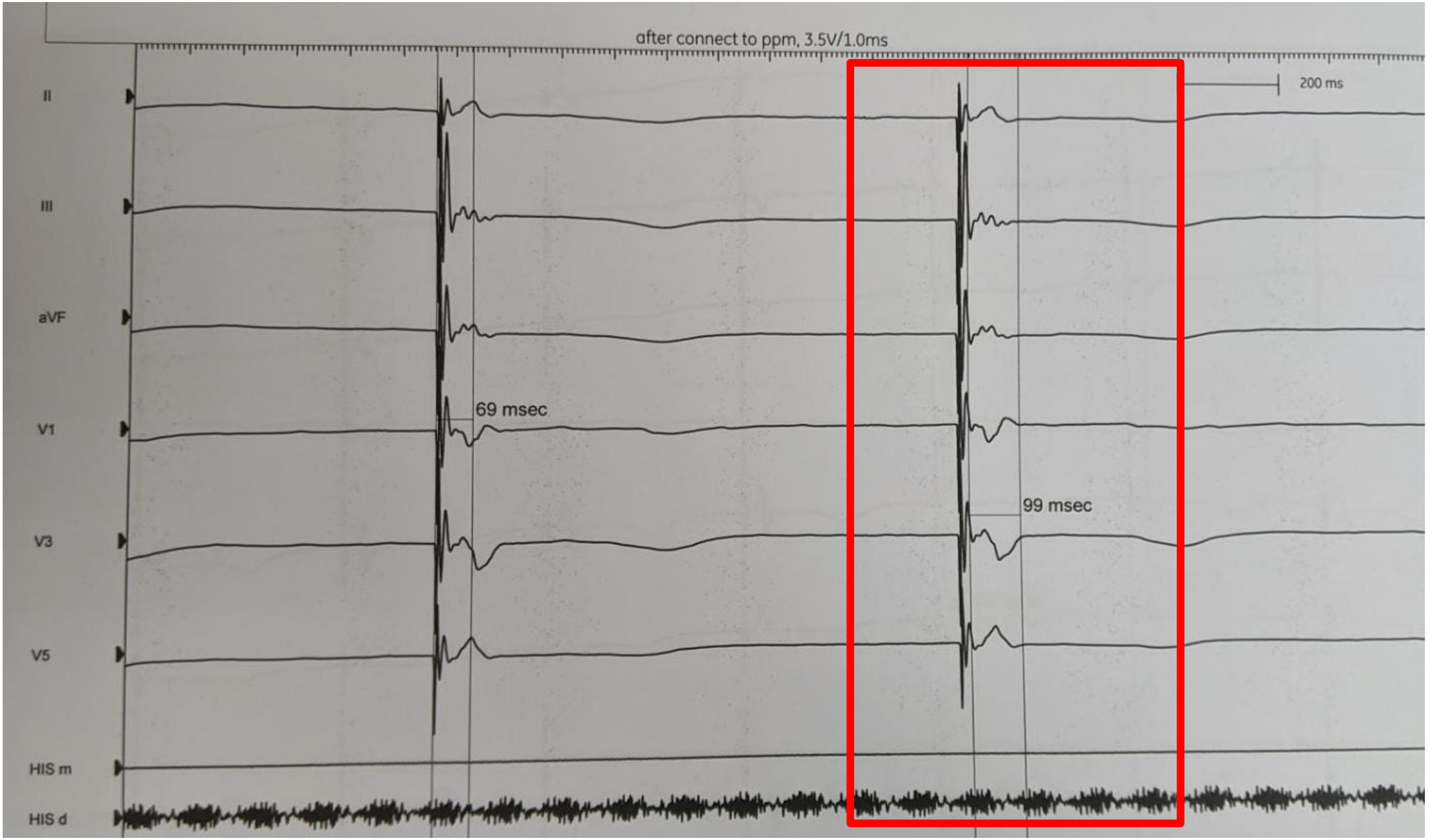
V1 notch move forward during screw


I
II
III
LBB
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
244Ω
346Ω
350Ω
423Ω
563Ω

2. OBSERVE LBB POTENTIAL IN EGM

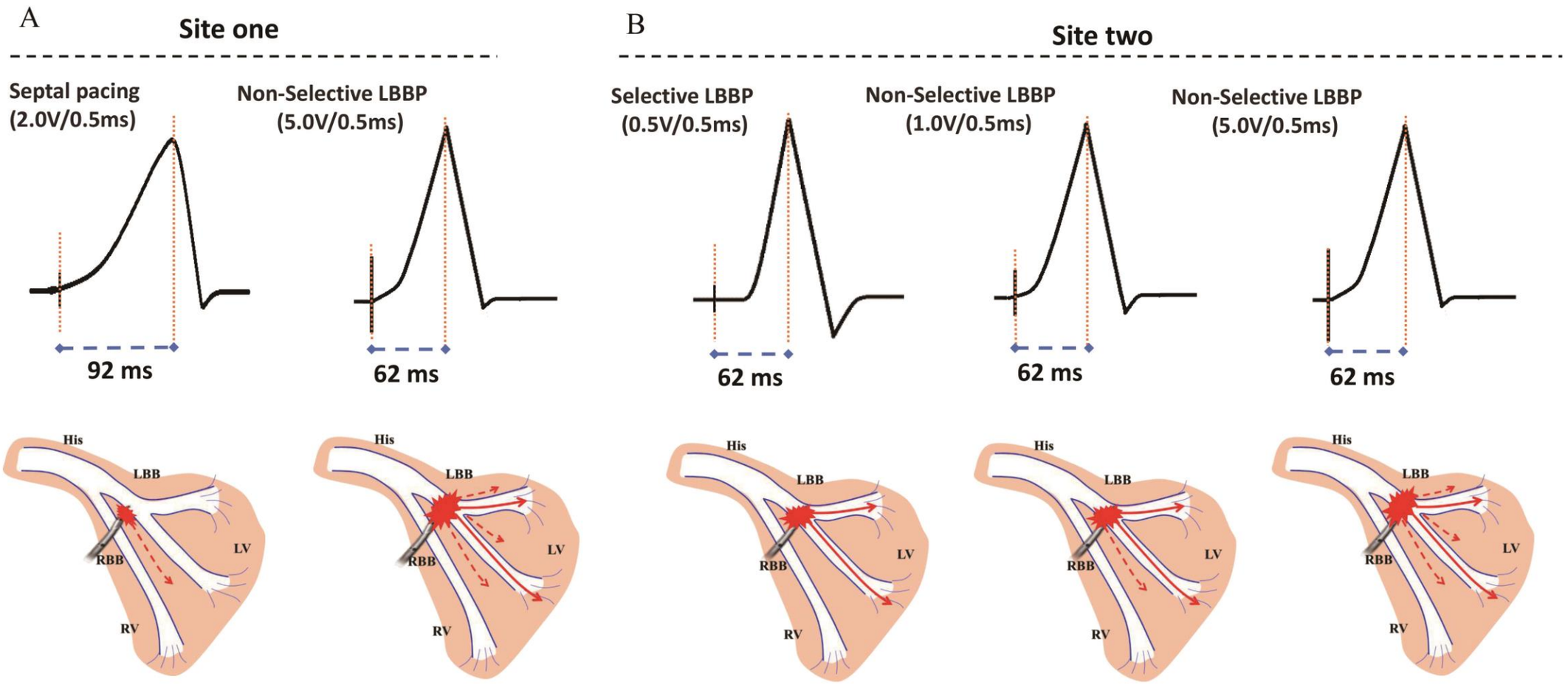


3. ECG ~110MS FOR NORMAL HEART; ~20-30% REDUCTION IN QRS DURATION FOR DCM PATIENT



4. STIM-QRS PEAK (STIM TO LVAT) ~70MS IN NORMAL HEART; 20-30% LVAT REDUCTION FOR DCM PATIENT

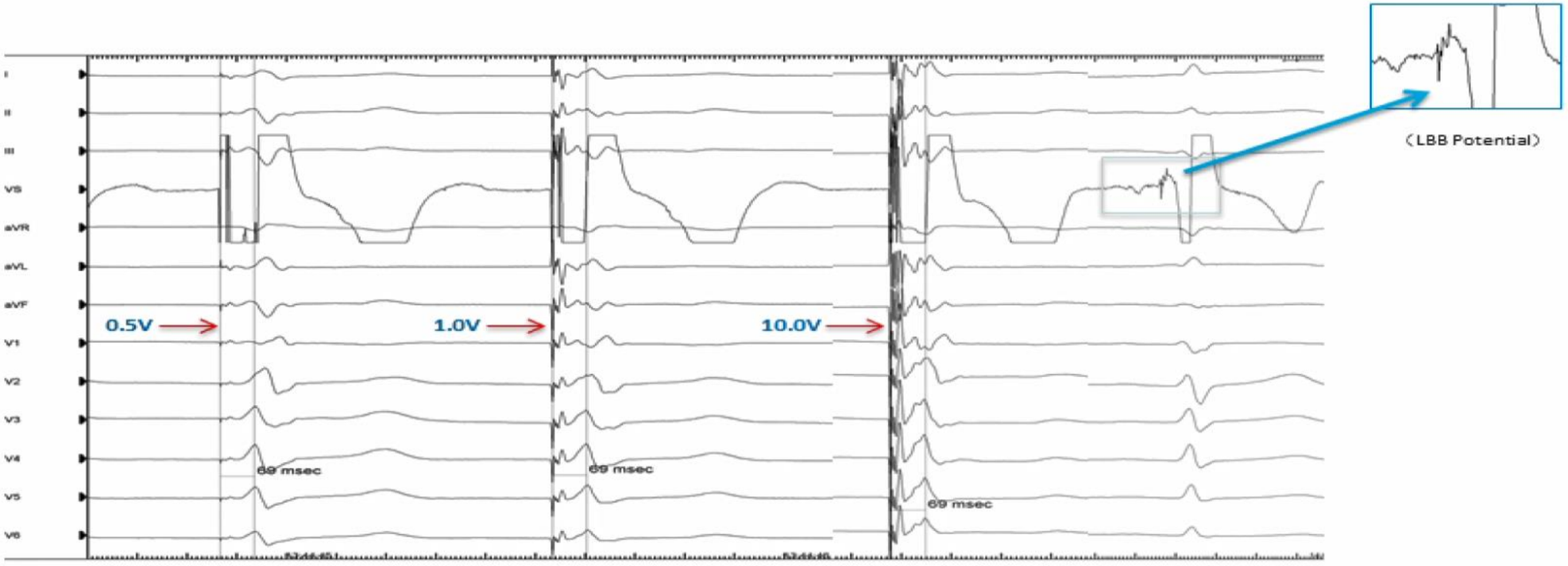
5. STIM-LVAT REMAINS CONSTANT FOR DIRECT LBBP. OUTPUT DEPENDENT IF PARA LBBP



4. STIM-QRS PEAK (STIM TO LVAT) ~70MS IN NORMAL HEART; 20-30% LVAT REDUCTION FOR DCM PATIENT

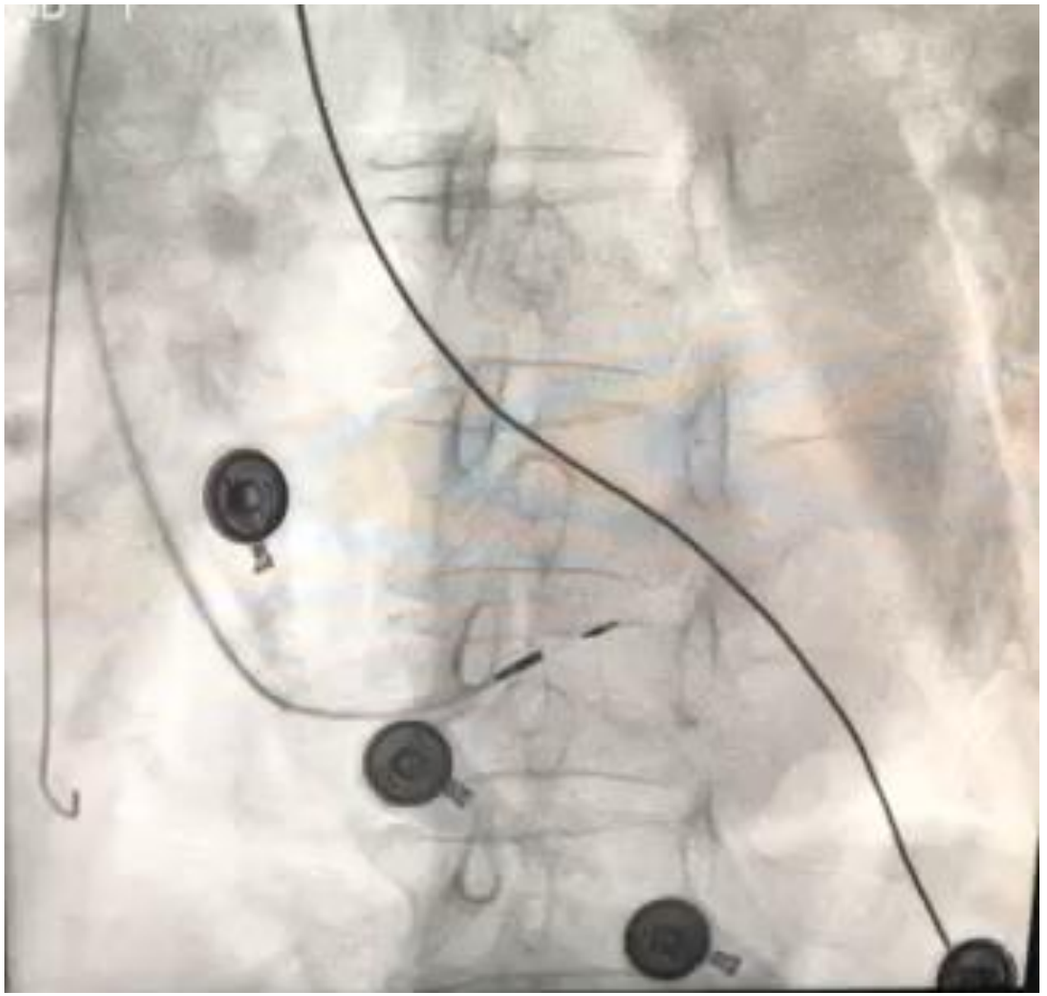
5. STIM-LVAT REMAINS CONSTANT FOR DIRECT LBBP. OUTPUT DEPENDENT IF PARA LBBP

Time to QRS peak on V4-6 lead: same in different output



Measure from pacing spike to peak of V4-6

CONTRAST WOULD BE INJECTED TO CHECK THE DEPTH OF THE LEAD



9 mm Tip-to-ring Spacing

IMPLANTATION OF LBBP
KEY POINTS TO REMEMBER

1. HIS potential can help location of LBBP
2. Pacing RV septum before screwing – a “W” morphology QRS complex in V1
3. Unipolar tip paced QRS with RBBB pattern post fixation - closed to LV endocardium
4. LBB potential can be observed in most patients without LBBB
5. The interval from pacing to the beginning of the paced QRS was shorter than HIS potential to QRS during intrinsic rhythm
6. Stimulus to left ventricular activation peak interval (VAT) remained unchanged while increasing output
7. Monitoring impedance continually, observing depth of helix on LAO, direction of helix perpendicular to septum

Summary

- HBP and LBBP provided significant improvement in ECG, echocardiographic and clinical outcomes for CRT candidates

- HBP is feasible and safe as a primary option for CRT candidates or an alternative for CRT indicated patients who failed LV lead placement or were non-responders of BiVp

- During the procedure, a clear 12-lead ECG is extremely important

Summary

- Endpoint of a successful HBP
  - HIS signal can be mapped
  - sHIS/nsHIS pacing morphology can be obtained. It can be identical or nearly identical to intrinsic morphology for non-BBB patients, or corrected the BBB for BBB patients.
  - Acceptable threshold (<1.5V/1.0ms)

- Endpoint of a successful LBBP
  1. Changed of “W” pattern to RBBB pattern in V1
  2. Observe LBB potential in EGM (for non LBBB patient)
  3. ECG ~110ms for normal heart; ~20-30% reduction in QRS duration for DCM patient
  4. Stim-QRS peak (stim to LVAT) ~70ms in normal heart; 20-30% LVAT reduction for DCM patient
  5. Stim-LVAT remains constant for direct LBBP. Output dependent if para LBBP