# Diffrentiation Conduction System pacing vs Myocardial Pacing

Suin Han

Severance Hospital, Republic of Korea

# History of pacing lead

# 1. Adverse Effects of RV pacing

Normal conduction:

- Through His-Purkinje system
- Electrically and mechanically synchronous LV activation
- Narrow QRS(80~120ms)

Conduction during RV pacing :

- Direct pacing the myocardium
- Electrically and mechanically dyssynchronous LV activation
- LBBB pattern, Wide QRS(120ms more)
- The deleterious effects on LV Systolic function termed PiCM

Right Ventricular Pacing, Mechanical Dyssynchrony, and Heart Failure DOI 10.1007/s12265-011-9341-8/J. of Cardiovasc. Trans. Res. (2012) 5:219–231 Alan J. Bank & Ryan M. Gage & Kevin V. Burns

# 1-2. Mechanism of RV pacing's adverse effects

Intraventricular dyssynchrony in LV:

- The uncoordinated wall motion

-> Prolongs isovolumic contraction

-> reduces the rate of rise of LV pressure & needed to open the aortic valve

- Some walls of the LV still contracting after aortic valve closing

-> Prolongs isovolumic relaxation

-> slowing the rate of pressure decreased in LV

- Delays mitral valve opening

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# 1-2. Mechanism of RV pacing's adverse effects

Interventricular dyssynchrony in LV :

- Delayed LV ejection
- During RV ejection, interventricular septum can be pushed toward the LV and This impairs the ability of the LV to adequately fill during diastole
- Delay in Mitral valve opening shorten the LV filling times

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# 1-2. Mechanism of RV pacing's adverse effects

Deterious remodeling of Left ventricle :

- Systolic period : make LV not contract strongly and rapidly
- Diastolic period : make LV not fill enough blood in chamber
- Heart failure in Left venticle

Right Ventricular Pacing, Mechanical Dyssynchrony, and Heart Failure DOI 10.1007/s12265-011-9341-8/J. of Cardiovasc. Trans. Res. (2012) 5:219–231 Alan J. Bank & Ryan M. Gage & Kevin V. Burns

# 2. Biventricular Pacing

Appearance of Biventricular pacing:

- To make LV reverse remodeling in PiCM Patients
- For Congestive Heart failure patients with ventricular conduction delay like LBBB

The purpose of Biventricular pacing :

- To get the RV and LV to pump together
- During pacing, both Ventricles are activated simultaneously
- Allows the LV to complete contraction and begin relaxation earlier
- Increases filling time and can improve the EF

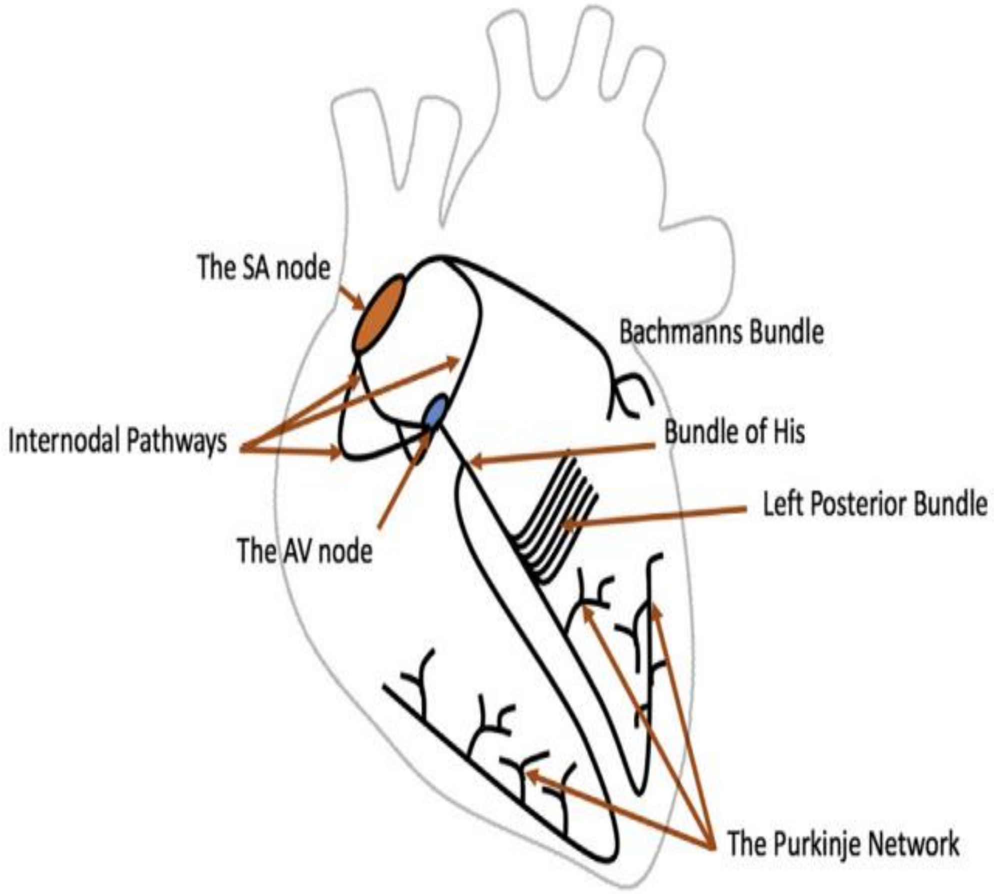
# 2. Biventricular Pacing

Limitation of Biventricular pacing :

- A significant proportion of patients are classified as nonresponders
- Nonphysiological pacing, activating ventricular myocardium
- Unfavorable anatomy of the coronary venous system

Left Bundle Branch Pacing JACC Review Topic of the Week JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY JACC VOL. 74, NO. 24, 2019 DECEMBER 17, 2019:3039 – 4 9 Shu Zhang, MD

# 3. His Bundle pacing




What is the bundle of his :

- The Specialized muscle bundle connecting the atrial and ventricular chambers of heart
- The bundle of His quickly transmits the impulse to the left and right bundle branches and into the ventricle, resulting in a synchronized contraction of the ventricles


The Cardiac Conduction System Generation and Conduction of the Cardiac Impulse, Critical care nursing clinics of north america, 28 (2016) 269–279
http://dx.doi.org/10.1016/j.cnc.2016.04.001, Alan Kennedy, BSca, Dewar D. Finlay, PhDa

# 3. His Bundle pacing

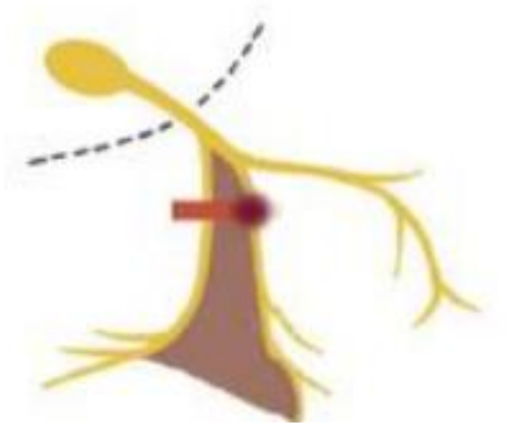
His bundle pacing :

- Physiological pacing
- The activation of the ventricles via the native conduction system

Limitation of His bundle pacing :

- Difficulty in identifying the precise location of the his bundle
- A high and unstable pacing threshold
- Low R-wave amplitude or Large atrial signals
- Damage to the His bundle during implantation

# 4. Left Bundle Branch Pacing



Left bundle branch pacing :

- Builds on experience from RV septal pacing
- Implant technique is simpler to learn and implement than HBP
- The Pacing lead reach the left bundle area at the subendocardium of the left intervetricular septum.

Advantage of Left bundle branch pacing :

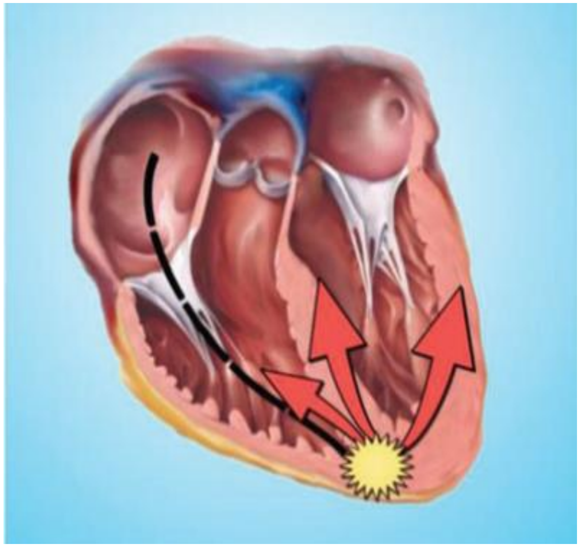
- Generates a narrow QRS complex, and fast LV activation time
- Low and stable pacing capture threshold

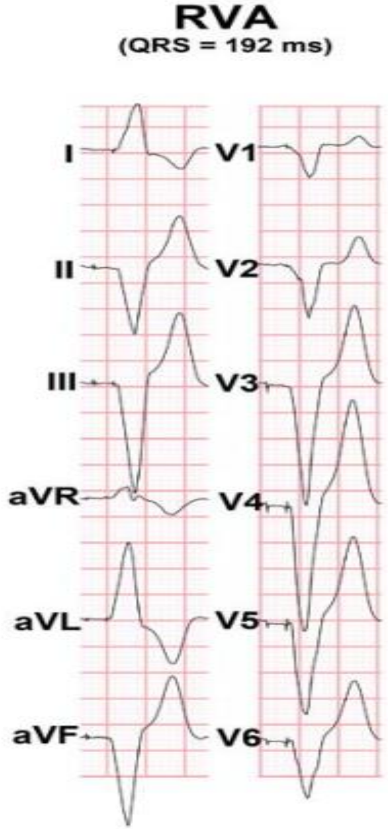
Left Bundle Branch Area Pacing: Implant Technique, Definitions, Outcomes, and Complications
Current Cardiology Reports (2021) 23: 155
Óscar Cano1,2 · Pugazhendhi Vijayaraman

Left Bundle Branch Pacing JACC Review Topic of the Week
JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY VOL. 74, NO. 24, 2019
Shu Zhang, MD, PHD,a Xiaohong Zhou, MD,b Michael R. Gold, MD, PHD

# Electrical activation of Ventricle and QRS morphology

# 1. RV pacing



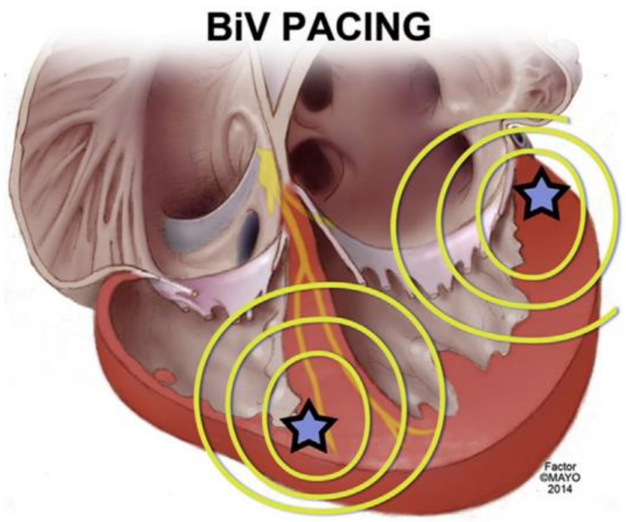


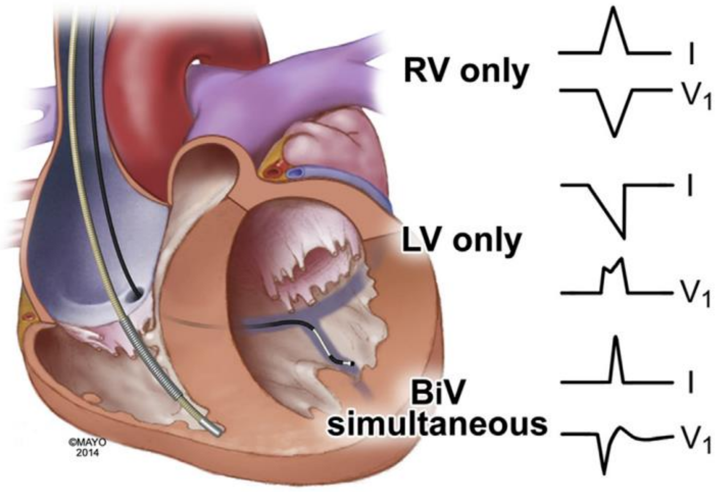

- The earliest depolarization at the RV apex
- Followed by slow cell-to-cell spread of the activation wavefront
- The Latest depolarization at the inferoposterior base of the LV
- Wide QRS and a left superior axis on ECG
- Iatrogenic form of left bundle branch block

Ventricular pacing e Electromechanical consequences and valvular function, indian pacing and electrophysiology journal 16 (2016) 19 -30,
Elisa Ebrille, Christopher V. DeSimone

Heart failure due to right ventricular apical pacing: the importance of flow patterns
Article in Europace · May 2016 DOI: 10.1093/europace/euw024
Francesco Radico
Sabina Gallina

# 2. Biventricular pacing

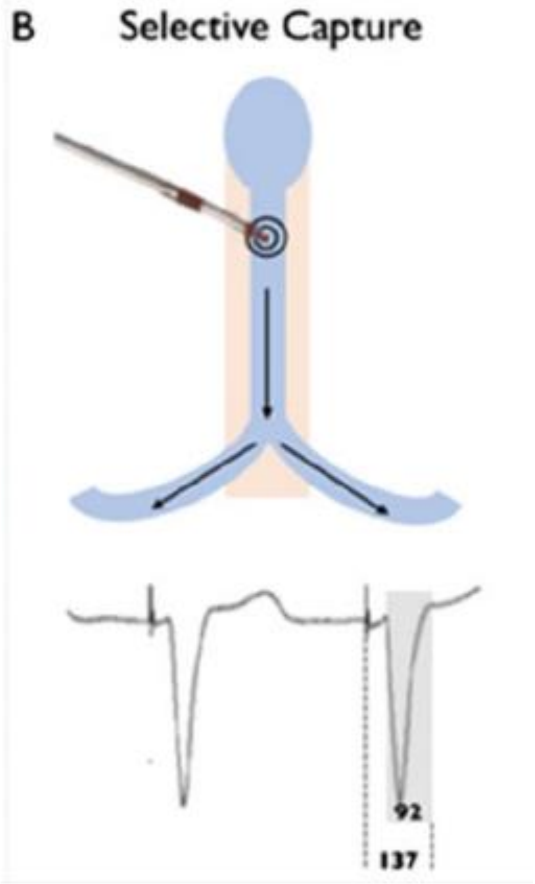



- The electrical activation of the myocardium again
- but the simultaneous pacing decreases in the electrical delay increases coordinated contraction.
- Results in a narrow QRS

Ventricular pacing e Electromechanical consequences and valvular function, indian pacing and electrophy siology journal 16 (2016) 19 -30, Elisa Ebrille, Christopher V. DeSimone

# 3. His bundle pacing

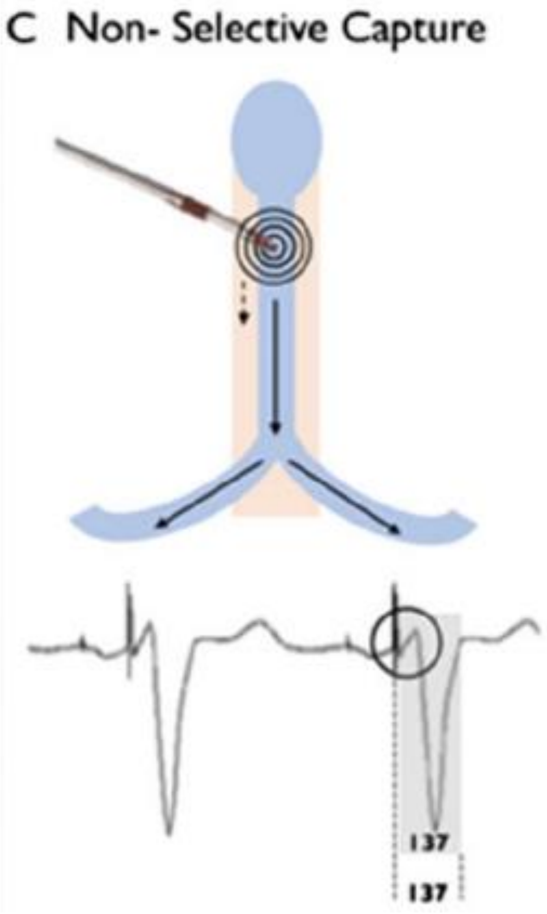



Selective Capture :

- Ventricular activation occurs purely via the native conduction system
- QRS is no wider than the native QRS

Rationale and design of the randomized multicentre His Optimized Pacing Evaluated for Heart Failure (HOPE-HF) trial, ESC Heart Failure 2018; 5: 966–977, Daniel Keene, Ahran Arnold, Matthew J. Shun-Shin

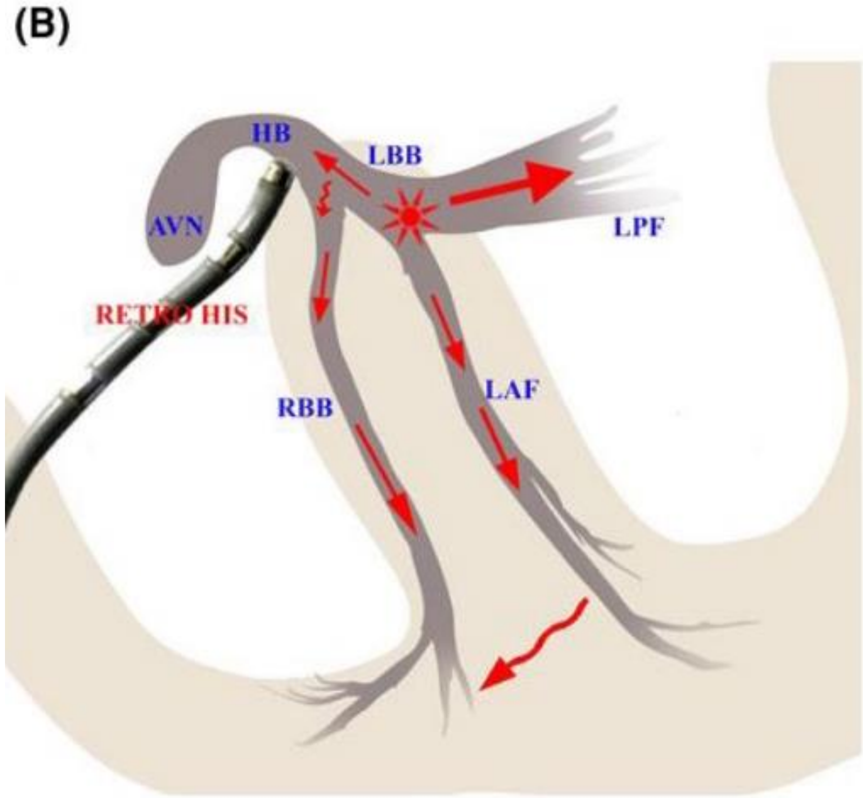
# 3. His bundle pacing




Non Selective Capture :

- Capture both the his bundle and the surrounding local right ventricular myocardium
- Ventricular activation occurs though the his purkinje system prior to myocardial breakout
- Psuedo-delta wave on the surface ECG

# 4. Left Bundle Branch Pacing

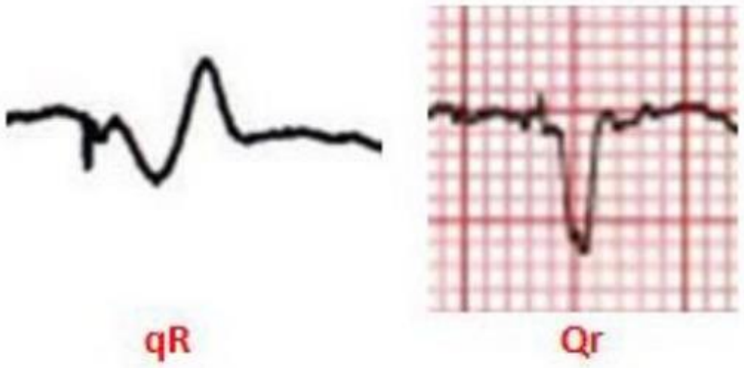



Ventricular activation :

- Antegrade conduction to purkinje system activated left ventricular myocardium
- Retrograde conduction reached RBB and activated Right ventricular myocardium
- LBB pacing result in not only the rapid LV activation but also RV activation

Left bundle branch area pacing: Electrocardiographic features DOI: 10.1002/joa3.12610 Journal of Arrhythmia. 2021;37:1139–1147 Asit Das MD, DNB, Cardiology

# 4. Left Bundle Branch Pacing




QRS morphology :

- Primary conduction through the LBB makes a Q or q wave in V1
- And Followed rapid conduction through the RBB could lessen the degree of RV delay and contribute to the terminal R’ wave in V1
- Biphasic qR or Qr morphology

Left bundle branch area pacing: Electrocardiographic features DOI: 10.1002/joa3.12610 Journal of Arrhythmia. 2021;37:1139–1147 Asit Das MD, DNB, Cardiology

# Clinical outcome of CSP

compared with RV pacing and Biventricular pacing

# 1. CSP vs RV pacing

updates

## Outcomes of conduction system pacing compared to right ventricular pacing as a primary strategy for treating bradyarrhythmia: systematic review and meta-analysis

Amr Abdin[1] · Suleman Aktaa[2,3] · Davor Vukadinović[1] · Elena Arbelo[4,5,6] · Harran Burri[7] · Michael Glikson[8] · Christian Meyer[9] · Theresa Munyombwe[2] · Jens Cosedis Nielsen[10,11] · Christian Ukena[1] · Kevin Vernooy[12,13] · Chris P. Gale[2,3]

Received: 9 May 2021 / Accepted: 16 August 2021 / Published online: 19 August 2021


**Abstract**
**Background** Right ventricular pacing (RVP) may cause electrical and mechanical desynchrony leading to impaired left ventricular ejection fraction (LVEF). We investigated the outcomes of RVP with His bundle pacing (HBP) and left bundle branch pacing (LBBP) for patients requiring a de novo permanent pacemaker (PPM) for bradyarrhythmia.
**Methods and results** Systematic review of randomized clinical trials and observational studies comparing HBP or LBP with RVP for de novo PPM implantation between 01 January 2013 and 17 November 2020 was performed. Random and fixed effects meta-analyses of the effect of pacing technology on outcomes were performed. Study outcomes included all-cause mortality, heart failure hospitalization (HFH), LVEF, QRS duration, lead revision, atrial fibrillation, procedure parameters, and pacing metrics. Overall, 9 studies were included (6 observational, 3 randomised). HBP compared with RVP was associated with decreased HFH (risk ratio [RR] 0.68, 95% confidence interval [CI] 0.49–0.94), preservation of LVEF (mean difference [MD] 0.81, 95% CI − 1.23 to 2.85 vs. − 5.72, 95% CI − 7.64 to -3.79), increased procedure duration (MD 15.17 min, 95% CI 11.30–19.04), and increased lead revisions (RR 5.83, 95% CI 2.17–15.70, $p = 0.0005$). LBBP compared with RVP was associated with shorter paced QRS durations (MD 5.6 ms, 95% CI − 6.4 to 17.6) vs. (51.0 ms, 95% CI 39.2–62.9) and increased procedure duration (MD 37.78 min, 95% CI 20.04–55.51).
**Conclusion** Of the limited studies published, this meta-analysis found that HBP and LBBP were superior to RVP in maintaining physiological ventricular activation as an initial pacing strategy.

**Keywords** Cardiac pacing · His-bundle pacing · Left bundle branch pacing · Clinical outcomes · Meta-analysis · Systematic review

- Decrease in heart failure hospitalization
- Preservation of LVEF
- Increase procedure duration
- Increase lead revisions
- Shorter paced QRS duration

# 2. CSP vs biventricular pacing

CONTEMPORARY REVIEW

**Improved outcomes of conduction system pacing in heart failure with reduced ejection fraction: A systematic review and meta-analysis**

Julian Gin, BSc, MD,[*1] Chee Loong Chow, MBBS,[*†‡1]
Alex Voskoboinik, MBBS (Hons), PhD,[§] Chrishan Nalliah, BSc, LLB, MBBS, PhD,[||]
Chiew Wong, MBBS, PhD,[†‡] William Van Gaal, MBBS, MD, MSc,[†‡]
Omar Farouque, MBBS (Hons), PhD,[*‡] Uwais Mohamed, MBBS, MD,[‡¶]
Han S. Lim, MBBS, PhD,[*†‡] Jonathan M. Kalman, MBBS, PhD,[‡#]
Geoffrey R. Wong, MBBS, PhD[*†‡]

*From the *Department of Cardiology, Austin Health, Melbourne, Victoria, Australia, †Department of Cardiology, Northern Health, Melbourne, Victoria, Australia, ‡Department of Medicine, The University of Melbourne, Melbourne, Victoria, Australia, §Department of Cardiology, Alfred Health, Melbourne, Victoria, Australia, ||Department of Cardiology, Macquarie University Hospital, Sydney, New South Wales, Australia, ¶Department of Cardiology, St. Vincent's Hospital Melbourne, Melbourne, Victoria, Australia, and #Department of Cardiac Electrophysiology, Royal Melbourne Hospital, Melbourne, Victoria, Australia.*

Conduction system pacing (CSP)—His bundle pacing (HBP) and left bundle branch area pacing (LBBAP)—are emerging alternatives to biventricular pacing (BVP) for cardiac resynchronization therapy (CRT) in heart failure. However, evidence is largely limited to small and observational studies. We conducted a meta-analysis including a total of 15 randomized controlled trials (RCTs) and non-RCTs that compare CSP (HBP and LBBAP) with BVP in patients with CRT indications. We assessed the mean differences in QRS duration (QRSd), pacing threshold, left ventricular ejection fraction (LVEF), and New York Heart Association (NYHA) class score. CSP resulted in a pooled mean QRSd improvement of −20.3 ms (95% confidence interval [CI] −26.1 to −14.5 ms; $P < .05$; $I^2 = 87.1\%$) vs BVP. For LVEF, a weighted mean increase of 5.2% (95% CI 3.5%–6.9%; $P < .05$; $I^2 = 55.6$) was observed after CSP vs BVP. The mean NYHA score was reduced by −0.40 (95% CI −0.6 to −0.2; $P < .05$; $I^2 = 61.7$) after CSP vs BVP. A subgroup analysis of outcomes stratified by LBBAP and HBP demonstrated statistically significant weighted mean improvements of QRSd and LVEF with both CSP modalities compared with BVP. LBBAP resulted in NYHA improvement compared with BVP, without differences between CSP subgroups. LBBAP is associated with a significantly lowered mean pacing threshold of −0.51 V (95% CI −0.68 to −0.38 V) while HBP had increased the mean threshold (0.62 V; 95% CI −0.03 to 1.26 V) compared with BVP; however, this was associated with significant heterogeneity. Overall, both CSP techniques are feasible and effective CRT alternatives for heart failure. Further RCTs are needed to establish long-term efficacy and safety.

**KEYWORDS** Heart failure; Cardiac resynchronization therapy; Biventricular pacing; Conduction system pacing; His bundle pacing; Left bundle branch pacing

(Heart Rhythm 2023;■:1–10) 

- Result in a significantly narrower QRS
- Result in better LV function with clinically significant improvements in NYHA Symptoms in patients with HF

# Limitation of CSP

# 1. His Bundle pacing

- The learning curve related to implant is relatively long
- The procedure may be more complicated in the setting of anatomic variants
- HBP had higher threshold than RVP along with a more concerning, unpredictable late rises in threshold over time

Physiologic Pacing Targeting the His Bundle and Left Bundle Branch: a Review of the Literature
Current Cardiology Reports (2022) 24:959–978
Seth D. Scheetz1 · Gaurav A. Upadhyay

# 2. Left Bundle Branch Pacing

- Differentiating left bundle branch capture from left ventricular septal capture is difficult
- Given its depth in the septum, procedural complication can be exist (ventricular septal perforation, myocardial damage..)
- Data regarding longer-term extraction is lacking

Physiologic Pacing Targeting the His Bundle and Left Bundle Branch: a Review of the Literature
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# Thank you for listening