Βηματοδότηση από το δεμάτιο His

Σκεύος Σιδερής
Διευθυντής
Καρδιολογικό Τμήμα
Ιπποκράτειο Νοσοκομείο Αθηνών
Δεν έχω να αναφέρω οποιαδήποτε σύγκρουση συμφερόντων σχετική με την παρούσα ομιλία.
The incidence and prevalence of cardiac conduction disease continues to increase worldwide with the aging of the population. The number of patients receiving permanent pacemakers and their mean age have increased over the last several decades.

The only effective treatment for bradyarrhythmias is cardiac pacing.
Central Illustration: Alternative Pacing Sites to Mimic Physiological Pacing

**FIGURE 1** Anatomic Variations of the His Bundle

(A) Type 1: The His bundle (AVB) runs under the membranous part of the interventricular septum (MS). 
(B) The type II His bundle runs within the muscular part of the interventricular muscle apart from the lower border of the membranous part of the interventricular septum. 
(C) The type III His bundle (arrow) is naked running beneath the endocardium with no surrounding myocardial fibers. 

AT = attachment of septal tricuspid leaflet; AVB = atrioventricular bundle; AVN = atrioventricular node; CS = coronary sinus. Reprinted from Kawashima and Sasaki (9).
Introducing HBP in humans in 2000. Between 2006 and 2011, a handful of case reports and case series were published which applied HBP in more general clinical practice. These initial studies and observations have led to further exploration of the utility of permanent HBP in patients requiring pacing and device-paced HF therapy.

Circulation 2000;101:869-877
Europace 2013;15:546-553
A His bundle injury current can often be recorded following lead fixation in 40% of patients. The presence of a His bundle injury current has been shown to predict excellent acute and long-term capture thresholds. In most patients, a His bundle capture threshold of $\leq 2.0\,V$ at 1 ms is acceptable.
His Pacing

Permanent HBP can be challenging due to the limited availability of delivery tools, particularly in patients with an enlarged right atrium and a displaced tricuspid annular region or right pectoral implants. Modifications to implant techniques have recently been described to achieve higher success in these patients.

Heart Rhythm 2018;Mar 8
His Pacing

The implant success rate was $>90\%$. While early studies reported significantly longer procedural times, recent studies suggest similar fluoroscopy and procedural times compared with right ventricular pacing.

Heart Rhythm 2015;12:305-312
His Pacing

In a study of 100 consecutive patients with advanced AV block, acute His capture threshold at implant was 1.3±0.9 V at 0.5ms and slightly increased to 1.7±1.0V at 0.5ms during a mean follow-up of 19 months.

JACC EP 2015;1:571-581
There are two forms of His bundle capture:

Selective capture, in which the His bundle is the only tissue captured by the pacing stimulus and

Nonselective capture, in which there is fusion capture of the His bundle and adjacent ventricular tissues.
His Pacing

Selective or nonselective capture of His bundle is often dependent on the location of the pacing electrode in relation to the His bundle, surrounding atrial or ventricular tissue, and the amplitude of the pacing output.

Heart Rhythm 2014;11:529-530
His Pacing

Published data indicate that there is little hemodynamic and clinical difference between the two forms of capture, possibly due to rapid conduction of the His-Purkinje system relative to ventricular myocardial conduction. The most important aspect of HBP is to clearly document RV and His capture thresholds along with BBB correction thresholds for the purpose of follow-up and programming final output settings.

Europace 2018;20:1010-1017
AV Node ablation and His Pacing

The QRS duration during HBP remained unchanged compared with baseline (107.1±25.8ms vs 105.3±23.9ms). Successful HBP was achieved in 40 of 42 (95%) patients with improvement in LVEF from 43±13% to 50±11% (P=0.01) along with improvement in functional class.

Europace 2017;19::iv10-6
AV Block and His Pacing

Permanent HBP was successful in 85% of patients with high-grade AVB and narrow QRS complex.

They achieved S-HBP in 11% and NS-HBP in 74% of patients.

In this randomized study, patients were initially paced in either RV apex or HBP, and crossed over to the opposite strategy after 12 months.
AV Block and His Pacing

They noted a significant improvement in LVEF with HBP than with RVA pacing 55% vs 50%

Europace 2014;16:1189-96
CRT or His Pacing

Rates of nonresponse to CRT remain high-between 30-40%. Rates of implant failure for CRT range between 5-9%. Rates of CS lead dislodgement 3-7%.

In light of this, alternative strategies to achieve resynchronization have gained momentum, including endocardial LV pacing, wireless LV stimulation, and permanent HBP.

Among these, HBP may have a theoretic advantage to conventional CRT, because it restores the intrinsic electromechanical activation sequence of the heart.

Heart Rhythm 2012;9:1524-1576
CRT or His Pacing

In the largely short-term and midterm results reported from studies

Improved functional status
Reduced mitral regurgitation
Reduced dyssynchrony and
Improved LVEF after HBP on par with what has been shown in CRT responders

JACC 2018;72:927-947
Open Questions and His Pacing

The use of HBP in patients with intraventricular conduction delay and/or extensive LV scar remains uncertain.

In about 10-30% of patients, LBBB may not be correctly by permanent HBP.
The major clinical advantage of HBP is that it can maintain electromechanical synchrony both intraventricular and interventricular.

The LV total activation time did not differ significantly during NS-HBP compared with S-HBP or intrinsic activation.

Hemodynamic improvements appear to be comparable with both S-HBP and NS-HBP.
HBP in CRT

Recently two observational studies showed that HBP can improve echocardiographic and clinical outcomes in patients who failed traditional LV lead implantation and CRT nonresponders.

Heart Rhythm 2017;14:1353-1361
Heart Rhythm 2018;15:413-420
Combined End-point of Death or Heart Failure Hospitalization

On Treatment

P=0.04
HR 1.7

P=0.02
HR 2.1
<table>
<thead>
<tr>
<th>A</th>
<th>Initial cardiac activation (Narrow or broad QRS)</th>
<th>B</th>
<th>Current pacing solutions (Never narrow QRS)</th>
<th>C</th>
<th>His bundle pacing solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow QRS</td>
<td><img src="image1.png" alt="ECG Graph" /></td>
<td>Activation prolonged</td>
<td>RVP</td>
<td><img src="image2.png" alt="ECG Graph" /></td>
<td>BVP</td>
</tr>
<tr>
<td>LBBB</td>
<td><img src="image3.png" alt="ECG Graph" /></td>
<td>Activation moderately improved</td>
<td><img src="image4.png" alt="ECG Graph" /></td>
<td>BVP</td>
<td>Ventricular activation restored</td>
</tr>
<tr>
<td>Narrow QRS long PR interval</td>
<td><img src="image5.png" alt="ECG Graph" /></td>
<td>Activation prolonged</td>
<td><img src="image6.png" alt="ECG Graph" /></td>
<td>BVP</td>
<td>Ventricular activation preserved and AVD optimised</td>
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HBP – Capture Threshold

The His capture thresholds can be significantly higher than traditional RV capture thresholds.

In some patients, the His bundle may be located deeper and the helix may not be long enough to achieve acceptable His thresholds.

His bundle capture threshold may progressively increase during follow-up.
Recent reports show that HBP leads are relatively stable, and routine placement of a back-up RV pacing lead is not necessary in most patients.

In a long-term study of 75 patients with HBP, lead revisions were required in 5 (6.7%), 4 of whom underwent successful lead replacement at the His bundle region even as late as 5 years after the initial implant.

Micro-dislodgement of the lead can lead to significant increase in His bundle capture threshold compared to RV myocardium.

Pacing Clin Electrophysiol 2017;40:883-891
Heart Rhythm 2018;15:696-702
Recent studies have demonstrated that the majority of patients undergoing HBP do well without need for early generator changes.
<table>
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<tr>
<th><strong>TABLE 3</strong> Current Candidates for Consideration of Permanent HBP</th>
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<tbody>
<tr>
<td>AV nodal block: second- and third-degree block</td>
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<tr>
<td>Infranodal, intra-Hisian AV block</td>
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<tr>
<td>Atrial fibrillation and slow ventricular response</td>
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<tr>
<td>Sinus node dysfunction and marked first-degree AV block</td>
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<td>(PR interval &gt;240 ms)</td>
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<td>AV nodal ablation (especially if EF &lt;40%)</td>
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<td>Any patient with anticipated need for high burden of RV pacing, especially if EF &lt;40%-50%</td>
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<tr>
<td>ICD-eligible patients with previously-listed indications and high RV pacing burden (&gt;40%)</td>
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<tr>
<td>CRT-eligible patients with LBBB who failed LV lead placement</td>
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<td>CRT nonresponder: especially RBBB</td>
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Rationale and design of the randomized multicentre His Optimized Pacing Evaluated for Heart Failure (HOPE-HF) trial

**AIMS:** In patients with heart failure and pathological prolonged PR interval, LV filing can be improved by shortening AV delay using His-bundle pacing. HBP delivers physiological ventricular activation and has been shown to improve acute haemodynamic function in his group of patients. In the HOPE trial, we are investigating whether these acute haemodynamic improvements translate into improvements in exercise capacity and heart failure symptoms.

His Bundle Pacing Versus Coronary Sinus Pacing for Cardiac Resynchronization Therapy (His-SYNC)

**Brief Summary:** The goal of this study is to compare the effectiveness of pacing from a physiologic His bundle lead position versus with standard coronary sinus lead position in subjects with heart failure undergoing cardiac resynchronization therapy. While placement of left ventricular leads via coronary sinus has anatomic limitations, we hypothesis that the achievement of QRS narrowing with HBP will be superior for improving systolic function by echocardiographic indices and quality of life and decreased rehospitalization and mortality.

Clinicaltrials.gov/ct2/NCT02700425
Conclusion

HBP is an attractive mode of physiological pacing with significant promise for future applications in patients who are traditional candidates for RV pacing as well as CRT.

Widespread adaptation of this technique is dependent on the improvement of tools and further validation of its efficacy in large randomized clinical trials.
Σας ευχαριστώ για την προσοχή σας