Advances in Cardiac Pacing #1

State of the Art - 2017

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Disclosures

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- Medtronic, Inc.

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- Medtronic, Inc.
2017 Advances

Evolution of standard pacing approaches

Strategies to reduce CIED complications

Future directions in CIED
Sinus function/Cardiac Conduction – Pacing indications
Progress in CIED Technology

<table>
<thead>
<tr>
<th>Paradigm Shifts in Cardiac Pacemakers</th>
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<tr>
<td><strong>1950s</strong></td>
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<td>AC-powered pacemakers tethered to an extension cord (Furman)</td>
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Pre-procedure assessment of pacing needs essential . . .

Sick sinus syndrome—Ventricular pacing need LOW — Will pace the atria primarily
Pre-procedure assessment of pacing needs essential . . .

AF with slow response – Ventricular pacing need HIGH
Pre-procedure assessment of pacing needs essential . . .

Options for Ventricular Pacing

- RV apical pacing
- RV septal pacing
- Biventricular pacing
- His-bundle pacing
However . . . In many cases, particularly patients with baseline LV dysfunction RV apical pacing may worsen ventricular function . . .

“Pacemaker syndrome” or “Pacing-induced cardiomyopathy”
MADIT-II
Long-term follow-up
Pacing from the RV septum may alleviate this issue, but data not confirmatory . . .
Pacing Site Study - - Hemodynamic response by RV site
(Septum, RV outflow tract, RV apex)

Optimal RV site varied by patient – No ideal site identified

Patterns of Electrical Activation

- Normal conduction or His pacing
- RV pacing or Left Bundle Branch Block conduction
- Biventricular pacing
Four chamber pacing is technically feasible. In patients with evidence of interventricular dyssynchrony, the original pacing mode probably provides a mechanical activation sequence closer to the natural one.
Biventricular Pacing (CRT) Prevents/Reverses LBBB or RV pacing hazards
Ventricular Dyssynchrony

**LBBB and RV pacing**
- Activate right and left ventricles sequentially
- Prolongs QRS duration
- Asynchronous activation
- Cardiac output and blood pressure reduced
- Mitral regurgitation increased

**CRT pacing**
- Activates right and left ventricles simultaneously
- Narrows QRS duration
- Synchronous activation
- Cardiac output and blood pressure increased
- Mitral regurgitation decreased
Cardiac Resynchronization Therapy (CRT)

- Interventional techniques useful
- Favorable results in all classes of heart failure
- Patients with true LBBB with best outcomes
- Superresponders may normalize LV function
MADIT-CRT – 1820 Class I and II HF patients with EF < 0.30 and BBB
11 of 83 patients with normal EF post-CRT

Patterns of Response to CRT

LVEF AFTER CRT

QRS > 150 msec
No CAD
Typical LBBB
• In patients with AV block and mild LV systolic dysfunction (LVEF < 50%) . . . .

• BiV pacing compared to RV pacing resulted in a significant 26% reduction in the combined endpoint of mortality, heart-failure related urgent care, and increase in LVESVI.

• Furthermore, there is a 27% relative risk reduction in the composite endpoint of heart-failure urgent care and all-cause mortality
Evolution of LV lead technology

“Multipoint pacing” may enhance CRT response
Potential Benefits of Multipoint pacing

- Super-responders: > 30% reduction
- Responders: 15-30% reduction
- Non-responders: 0-15% reduction
- Negative responders: ESV increase

12 Month CRT Response Rate

- Conventional Group (N = 21)
  - Super-responders: 14%
  - Responders: 43%
  - Non-responders: 19%
  - Negative responders: 24%

- MultiPoint™ Pacing Group (N = 21)
  - Super-responders: 34%
  - Responders: 43%
  - Non-responders: 14%
  - Negative responders: 9%
Triventricular Pacing

Multisite with 3 ventricular electrodes in different locations
RV-LV Synchrony (Reflected in QRS) Impacts Hemodynamics

- Normal QRS duration: 80 msec (0.08 sec)
- LBBB conduction: 150 msec (0.15 sec)
- Standard RV Pacing: 180 msec (0.18 sec)
- RV septal/outflow Pacing: 150 msec (0.15 sec)
- Biventricular Pacing: 140 msec (0.14 sec)
Patterns of Electrical Activation

RV pacing or left bundle branch conduction

Biventricular pacing

Normal conduction or His pacing
RV-LV Synchrony (Reflected in QRS) Impacts Hemodynamics

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Heart failure hospitalizations reduced with HB pacing when % paced >40%

No difference in mortality observed

His-bundle pacing - Anatomy

His bundle electrode does not traverse the tricuspid valve!

RAO view

LAO view
RV-LV Synchrony (Reflected in QRS Impacts Hemodynamics)

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His-bundle pacing replicates the normal QRS complex
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Pacing electrode
His catheter – Proximal, distal
His-bundle pacing

Favorable outcomes compared with BiV pacing in 29 patients with CRT indication

Until recently . . .

All Pacemakers and ICDs required placement of transvenous electrodes to directly monitor and stimulate the cardiac electrical system.
Until recently...

- All Pacemakers and ICDs required placement of transvenous electrodes to directly monitor and stimulate the cardiac electrical system.

- Infection prevention methods

- **Leadless**
  - Pacemakers and Defibrillators offer alternative solution to electrode issues

![Diagram showing the problem with leads and pockets](image)
Tyrx
antibiotic-eluding envelope

- Bioabsorbable mesh polymer with full resorption achieved by 9 weeks.
- Elution of minocycline and rifampin over minimum of 7 days
- Use of Tyrx envelope results in marked reduction in device infections
CITADEL/CENTURION studies – Interim results - Marked benefit vs Historical controls

Cardiostim - 2014

- CITADEL, CENTURION studies reported
- 1000 patients
- ICD replacement procedures (Highest risk of infection)
Leadless Pacemakers

Nanostim

Micra
RV-LV Synchrony (Reflected in QRS)

Impacts

Hemodynamics

Normal QRS duration
80 msec (.08 sec)

LBBB conduction
150 msec (.15 sec)

Standard RV Pacing
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Micra deployment
Micra performance versus historical controls

In this Micra TPS (Medtronic, Minneapolis, Minnesota) study post hoc analysis, the 725 study patients were compared with 2,667 patients who received transvenous pacemakers in previous studies as a historical control cohort. Leadless study patients were older and had more comorbidities than control subjects. At 6-month follow-up, patients with leadless pacemakers had significantly fewer major complications than control patients (HR: 0.49, p < 0.001), with study patients experiencing fewer hospitalizations, system revisions, and dislodgments. Reprinted with permission from Reynolds et al. (63). Abbreviations as in Figure 4.
Subcutaneous ICD (extravascular)

❖ Generator and Electrode implanted in subcutaneous tissue w/o fluoroscopy

❖ Potential for reduced infections including endocarditis and lead and vascular complications.
Cardiac Implantable Electronic Devices (CIED)

State of the Art 2017

2017 Advances

Chronic RV pacing or LBBB may harm LV function

CRT beneficial and His-bundle pacing compares favorably

Preventive measures, leadless devices promote improved long-term outcomes
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