Robotic LV Epicardial Lead Placement: Indications and Technique

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Cardiac Resynchronization Therapy

CRT improves functional status and cardiac performance in patients with CHF and intraventricular conduction delay:
- Ventricular function
- Exercise capacity
- Quality of life
- Mortality

Response rate ranges from 69-72%
Percutaneous Coronary Sinus Cannulation

Advantages

- Local anesthesia
- Same access as right-sided lead
Percutaneous Coronary Sinus Cannulation

Disadvantages

- 10-15% procedural failure rate
- Limited by coronary venous anatomy
- 5-10% late failure rate
- Site on LV is limited
- Long fluoroscopy time
Surgical LV leads: Is there a need?

- 2 million patients with NYHA class III-IV CHF
- 30-50% have widened QRS (600,000-1,000,000)
- CS failure rate of 15% (90,000-150,000)
- Lead dislodgement rate of 7% (42,000-70,000)
Alternative Approaches to Percutaneous LV Pacing

- Sternotomy
- Thoracotomy
- Mini-thoracotomy
- Thoracoscopy
- Robotic
Thoracotomy

- Most common incision used for CS lead failure

Morbidity includes:
- Postoperative pain
- Respiratory complications
- Atelectasis/pneumonia
- Several days of recovery
Limited Thoracotomies/Sternotomy

- Minimally invasive method
- Difficult to access posterolateral wall
- Ability to use screw in leads with minimal cardiac displacement
Thoracoscopy

- Eliminates chest wall retraction, thereby decreasing postoperative pain and splinting
- Shortens postoperative recovery
- Technology support with screw in tools
- Good visualization
- Difficult to access entire heart, especially in the presence of cardiomegaly or adhesions
DaVinci™ Robot
Robotic LV Epicardial Leads

Advantages

- Direct placement on any portion of the LV
- Minimally invasive
- Site-directed approach
Robotic LV Epicardial Leads

Disadvantages

- General anesthesia
- Single lung ventilation
Indications For Robotic LV Lead Placement

- Inability to cannulate CS
- Small CS venous tributaries
- Prior perforation
- Lead fracture or dislodgement
- High pacing threshold
- Primary implant
Technical Aspects of Robotic Lead Placement

- Requires general anesthesia
- Selective single lung ventilation
- Preop pulmonary function tests
- Posterior approach
- Hold anticoagulation (coumadin)
- Lead surveillance similar to CS leads
- Back-up lead kept in device pocket
Operative Technique: The Posterior Approach
Operative Time for Robotic LV Lead Implantation

Operative Time (minutes):

First 5 cases: 108 minutes
Second 5 cases: 50 minutes

(p<0.05)
Types of Epicardial LV Leads

- Steroid-eluting, sew-in leads
- Screw in leads
Can Robotic Pacing Improve Clinical Outcomes of CRT?
Determine Site of Latest Activation

- EKG
- Use of Pressure Volume Loops
- Tissue Doppler Imaging
- Tissue Strain Imaging
- Intraoperative Epicardial Site Testing
- Three-dimensional Mapping
Echocardiographic Mapping: Tissue Doppler Imaging

Asynchrony  CRT
Importance of Intraoperative Mapping

- The anatomic landmark can vary from the site of latest activation in up to 37% of patients.
- Anatomy alone can result in non-response in up to 33% of patients.

Optimal Pacing Site

- 54 patients,
  Thoracoscopy/lateral thoracotomy
  TSI to identify area of latest peak systolic velocity

- Significant Improvement in reverse remodeling and systolic function

- BEST CLINICAL AND HEMODYNAMIC BENEFIT CAME FROM THOSE PATIENTS WHO HAD TSI TO IDENTIFY THE AREA OF LATEST PEAK SYSTOLIC VELOCITY

- GRADED RESPONSE: Those patients whose LV lead was placed one segment away from the recommended area (site of maximal LV delay) had less remodeling and those >1 segment away showed no significant reverse remodeling

Murphy RT, Sigurdsson G, Mulamalla S, Agler D, Popovic ZB, Starling RC, Wilkoff BL, Thomas JD, Grimm RA. Tissue synchronization imaging and optimal left ventricular pacing site in cardiac resynchronization therapy. *Am J Cardiol*. 2006 Jun 1;97(11):1615-21
Importance of LV mapping

- Measured distance between the site of latest activation and that determined by flouroscopy was the only independent predictor of improvement of LV volumes.

- Site of latest strain activation demonstrates marked improvement in ejection fraction and a marked decrease in left ventricular end-systolic and end-diastolic volumes.

Site-Directed LV leads

Target zone for LV lead placement should correspond to the latest point of both electrical and mechanical activation.

Rovner A, de Las Fuentes L, Faddis MN, Gleva MJ, Davila-Roman VG, Waggoner AD. Relation of left ventricular lead placement in cardiac resynchronization therapy to left ventricular reverse remodeling and to diastolic dyssynchrony. Am J Cardiol. 2007 Jan 15;99(2):239-41. Epub 2006 Nov 21
Epicardial vs. Percutaneous Leads

No prospective randomized trials as yet

Mair et al report a retrospective comparison of
– 79 patients with CS lead insertion
– 16 patients with epicardial lead placement through limited thoracotomy

Results:
– 100% patient with epicardial leads had posterolateral placement vs 70% in transvenous group
– No statistically different length of stay
– Percutaneous leads had higher thresholds over 16 month follow up.

Transvenous lead placement vs Lateral Thoracotomy

81 patients

Results:
Lower incidence of re-intervention for surgical leads
Less clinical benefit and reverse remodeling for the 25 patients who had lateral thoracotomy
Note: 44% of the LV leads in the surgical group were positioned ANTERIORLY as compared to the transvenous group (4.5%)

Posteriorly-positioned epicardial leads are a key component in improved clinical and physiologic outcomes.

St. Luke’s-Roosevelt Hospital: Robotic-Assisted CRT Program

- 84 patients with CHF and widened QRS > 140 ms
- All patients underwent intraoperative electrophysiologic mapping to determine the area of the LV with latest electrical activation
- TDI used pre- and intra-operatively to assess resynchronization
Patient Characteristics

N=84

- **Age**: 73 ± 9 yrs (43-87)
- **Inpatient**: 42%
- **Ischemic CM**: 68%
- **Idiopathic CM**: 32%
- **Prior CABG**: 56%
- **Multiple Re-op**: 17%
Results

- 100% epicardial lead placement success
- All patients extubated in the operating room
- 2% conversion to mini-thoracotomy
- Mortality 0%
- Morbidity 6%
- Length of stay 2.1 ± 1.6 days
Complications

- Pneumonia
- Ischemic Colitis
- Intercostal Neuropathy
- Renal Insufficiency (transient)
- LV lead failure (6 mos)
## Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline</th>
<th>6 mos post-op</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVEF</td>
<td>11 ± 6%</td>
<td>23.4 ± 13.6%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LVEDD</td>
<td>7.2 ± 1.2 cm</td>
<td>7.1 ± 1.0 cm</td>
<td>NS</td>
</tr>
<tr>
<td>NYHA class</td>
<td>3.5 ± 0.5</td>
<td>1.8 ± 0.8</td>
<td>&lt;0.001</td>
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<tr>
<td>QRS duration</td>
<td>184 ± 29 msec</td>
<td>151 ± 20 msec</td>
<td>&lt;0.01</td>
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**Response Rate:** 85%
# Results - Lead Stability

F/U = 25 ± 8 months

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<thead>
<tr>
<th></th>
<th>Threshold</th>
<th>Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-op</td>
<td>1.0 ± 0.5 V</td>
<td>1160 ± 248 Ω</td>
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<tr>
<td>Post-op</td>
<td>1.8 ± 1.1 V</td>
<td>310 ± 158 Ω</td>
</tr>
<tr>
<td>P value</td>
<td>NS</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
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Summary

- Robotic LV lead implantation is safe and effective
- Excellent minimally invasive option for failed CS cannulation
- Optimal portion of myocardium can be targeted
- Posterior approach particularly useful for re-ops
- Epicardial leads are stable over time
- Role in primary implants awaits randomized trials