Non-Sternotomy Surgical Approaches for Implantation of CF-LVADs

VANDERBILT HEART

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Disclosures

• Will discuss off-label use of the Heartware LVAS

• Research Funding and Clinical Trial Educator (SM)
  • American Heart Association
  • HeartWare
One Size Fits All?
Right Operation for the Right Patient

- Avoid extensive dissection with reoperations, decrease risks of cardiac injury
- Shorten implant, facilitate inflow positioning, reduce CPB time
- Avoid sternotomy or multiple reentries for patients undergoing heart transplantation
- Decrease blood product requirements and sensitization
- Preserve RV dysfunction through preservation of pericardial function?
Growing Experience with Alternative Strategies

- Hetzer, Ann Thorac Surg, 2004
- Selzman, J Card Surg, 2007
- Schmitto, J Am Coll Cardiol, 2010
- Borovic, JHLT, 2011
- Popov, Ann Thorac Surg, 2012
- Schmitto, J Thorac Cardiovasc Surg, 2012
- Sabashnikov, Expert Review Medical Devices, 2013
- Duese, ASAIO Journal, 2014
- Maltais, ACS, 2014
- Maltais, JHLT 2015
Surgical Approaches

- **ON**-pump or **OFF**-pump when suitable

- **Inflow**
  - Median sternotomy
  - Minimally invasive left thoracotomy
  - Subcostal diaphragmatic approach
Surgical Approaches

• **Ouflow**
  
  – **Ascending aorta**
    
    • Full or partial upper hemi-sternotomy
  
  – **Descending aorta**
    
    • Single incision left thoracotomy
  
  – **Left subclavian artery**
    
    • Left axillary approach
Left Thoracotomy Implants

Maltais, Operative Techniques in Thorac and CV Surgery, 2015
Contraindications for LT

- Concomitant valve interventions
  - AV, TV, MV, PFO?
  - Mechanical AV
- Severe RV dysfunction?
- Left atrial thrombus

Maltais, ACS, 2015
Thoracotomy Level

Maltais, Operative Techniques in Thorac and CV Surgery, 2015
OFF-Pump?

- Reduce Inflammation and coagulopathy associated with cardiopulmonary bypass
- Reduced blood product transfusions
- Avoid aortic and venous cannulation with their potential complications
- Right heart protection?
- Reduce cost?
OFF-Pump Strategy?

- ACT always above 350
- Adenosine (30mg X 2) to induce short bradycardia asystole, allows LV coring and pump placement
  - Decreases arterial pressure
  - Lowers heart rate
  - Pulmonary vasodilatation

## Early Perioperative Outcomes

<table>
<thead>
<tr>
<th></th>
<th>All (n=81)</th>
<th>LT (n=27)</th>
<th>CS (n=54)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU LOS (days)</td>
<td>8 ±10</td>
<td>10 ±12</td>
<td>9 ±9</td>
<td>0.62</td>
</tr>
<tr>
<td>Total LOS (days)</td>
<td>15 ±9</td>
<td>15 ±11</td>
<td>15 ±9</td>
<td>0.85</td>
</tr>
<tr>
<td>RVAD (%)</td>
<td>4</td>
<td>0</td>
<td>6</td>
<td>0.22</td>
</tr>
<tr>
<td>Dialysis (%)</td>
<td>12</td>
<td>19</td>
<td>9</td>
<td>0.23</td>
</tr>
<tr>
<td>OR Blood Products (U)</td>
<td>6 ±10</td>
<td>6 ±5</td>
<td>8 ±112</td>
<td>0.04</td>
</tr>
<tr>
<td>Total Blood Products (U)</td>
<td>12 ±18</td>
<td>9 ±16</td>
<td>14 ±18</td>
<td>0.11</td>
</tr>
<tr>
<td>Time on MV (days)</td>
<td>4 ±9</td>
<td>4 ±8</td>
<td>4 ±9</td>
<td>0.04</td>
</tr>
<tr>
<td>Inotrope duration (days)</td>
<td>7 ±8</td>
<td>6 ±7</td>
<td>7 ±8</td>
<td>0.22</td>
</tr>
<tr>
<td>30-day mortality (%)</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0.98</td>
</tr>
<tr>
<td>Follow-up Time (years)</td>
<td>0.6 ±0.4</td>
<td>0.5 ±0.3</td>
<td>0.6 ±0.5</td>
<td>0.96</td>
</tr>
</tbody>
</table>
## Clinical Outcomes

<table>
<thead>
<tr>
<th></th>
<th>All n=81</th>
<th>LT n=27</th>
<th>CS n=54</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ischemic CVA (%)</strong></td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0.28</td>
</tr>
<tr>
<td><strong>Hemorrhagic CVA (%)</strong></td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.49</td>
</tr>
<tr>
<td><strong>TIA (%)</strong></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0.97</td>
</tr>
<tr>
<td><strong>GI Bleeding (%)</strong></td>
<td>9</td>
<td>8</td>
<td>6</td>
<td>0.57</td>
</tr>
<tr>
<td><strong>Driveline infection (%)</strong></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0.61</td>
</tr>
<tr>
<td><strong>Other infections (%)</strong></td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>0.57</td>
</tr>
<tr>
<td><strong>RV failure, RVAD (%)</strong></td>
<td>4</td>
<td>0</td>
<td>6</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Thrombus/hemolysis (%)</strong></td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0.49</td>
</tr>
<tr>
<td><strong>Readmission (#)</strong></td>
<td>1.0 ±1.3</td>
<td>0.9 ±1.3</td>
<td>1.0 ±1.3</td>
<td>0.41</td>
</tr>
<tr>
<td><strong>Cardiac Readmit (#)</strong></td>
<td>0.3 ±0.6</td>
<td>0.2 ±0.5</td>
<td>0.3 ±0.7</td>
<td>0.72</td>
</tr>
<tr>
<td><strong>N-Cardiac Readmit (#)</strong></td>
<td>0.7 ±1.2</td>
<td>0.7 ±1.1</td>
<td>0.7 ±1.1</td>
<td>0.62</td>
</tr>
<tr>
<td><strong>Follow-up Time (years)</strong></td>
<td>0.6 ±0.4</td>
<td>0.5 ±0.3</td>
<td>0.6 ±0.5</td>
<td>0.96</td>
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</tbody>
</table>
Survival Analysis

% Survival

<table>
<thead>
<tr>
<th>Days Post implant</th>
<th>MILT</th>
<th>Sternotomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>93%</td>
<td>91%</td>
</tr>
<tr>
<td>60</td>
<td>81%</td>
<td>87%</td>
</tr>
<tr>
<td>180</td>
<td>81%</td>
<td>79%</td>
</tr>
<tr>
<td>360</td>
<td>52%</td>
<td>79%</td>
</tr>
</tbody>
</table>

p = 0.52

Event: Death (censored at transplant or recovery)

<table>
<thead>
<tr>
<th>Days Post Implant</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>120</td>
</tr>
<tr>
<td>180</td>
</tr>
<tr>
<td>240</td>
</tr>
<tr>
<td>300</td>
</tr>
<tr>
<td>360</td>
</tr>
</tbody>
</table>

Sternotomy n=54, deaths=10
MILT n=27, deaths=7
Descending Anastomosis

- Surface echo: identify LV apex and perform 6cm left thoracotomy
- Femoral access for CPB if needed
- OFF-pump outflow graft anastomosis to descending aorta using 4-5cm piece of outflow graft – pulmonary ligament detached for better exposure, anastomosis performed near diaphragmatic junction
- OFF-pump attachment of sewing ring to LV apex and tunneling of driveline through subxiphoid counter incision
- ON-pump or OFF-pump LV coring and pump implant
- End-to-end anastomosis with hemashield graft and deairing
Outflow graft anastomosed to descending aorta distally in posterior mediastinum
Left Subclavian Anastomosis

- LVAD flow to left upper extremity and cerebral vasculature with backflow to systemic circulation
  - Increases forward flow and native ejection

- Implications
  - Left upper extremity hyperemia and edema
    - Technical considerations for anastomosis
    - Arterial flow to LUE restricted (banded)
    - TED hose on LUE x 10 days postop
    - Elevate LUE to improve venous return
  - Blood pressure always assessed on right side
Left Subclavian Anastomosis

Maltais, Operative Techniques in Thorac and CV Surgery, 2015
Left Subclavian Anastomosis

Driveline exiting subcutaneous tunnel

10mm ringed gortex

8mm graft

Maltais, Operative Techniques in Thorac and CV Surgery, 2015
Left Subclavian Anastomosis

Maltais, Operative Techniques in Thorac and CV Surgery, 2015
Conclusions:

- Partial support, sternal-sparing approach to HVAD placement is feasible and safe for BTT
- Application for prior sternotomy patients
- Similar early mortality and adverse events as complete support
The Times They Are-a-Changin’
(Bob Dylan, 1964)

• Learn the basics first...

• Alternative LVAD implant techniques may have advantages in specific patient populations

• Medication and device management should be personalized and tailored to pump implant strategy to maximize pump performance and minimize complications

• Indications for alternative approaches and implications for long-term management require further investigation