Ischemic Ventricular Septal Rupture
Optimal Management Strategies

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FCI – Institute of Cardiology
Disclosures

• Abbott Mitraclip – Royalties
• Johnson & Johnson – Proctor
• Edwards - Consultant
VSD in the Era of Thrombolysis

- 2% incidence pre-thrombolytics
- Incidence declining:
  - 0.2% with early reperfusion therapies (GUSTO)
  - Aggressive control of BP post-MI
VSD - Predictors

- Advanced age
- Female gender
- NO smoking history
- Anterior location of MI
- Thrombolysis after 12 hours of MI
VSD Timing - Bimodal

Medical vs. Surgical Treatment

Surgical repair is required urgently, but optimal timing is unclear
VSD – Timing of Surgery

➢ Early Surgery:
  ✓ High mortality rate
  ✓ High risk of recurrent ventricular rupture

➢ Delayed Surgery:
  ✓ Easier repair on scarred tissue
  ✓ Risk of complications/death while-u-wait

➢ Mortality high “across the board”
## Surgical Mortality

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>No. pts</th>
<th>Mean delay VSD-surgery in days</th>
<th>Location of the VSD</th>
<th>Hospital mortality (%)</th>
<th>Recurrence of VSD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ant (%)</td>
<td>Post (%)</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>Cox [4]</td>
<td>109</td>
<td>5-6</td>
<td>50</td>
<td>50</td>
<td>27.5</td>
</tr>
<tr>
<td>1998</td>
<td>Dalrymple-hay [5]</td>
<td>150</td>
<td>2</td>
<td>59</td>
<td>41</td>
<td>32</td>
</tr>
<tr>
<td>1998</td>
<td>David [9]</td>
<td>52</td>
<td>3</td>
<td>50</td>
<td>50</td>
<td>19</td>
</tr>
<tr>
<td>1999</td>
<td>Prete [3]</td>
<td>54</td>
<td>2</td>
<td>44.5</td>
<td>55.5</td>
<td>26</td>
</tr>
<tr>
<td>2000</td>
<td>Crenshaw [1]</td>
<td>84</td>
<td>3.5</td>
<td>71.5</td>
<td>28.5</td>
<td>47</td>
</tr>
<tr>
<td>2003</td>
<td>Barker [8]</td>
<td>65</td>
<td>11.5</td>
<td>46</td>
<td>54</td>
<td>23.1</td>
</tr>
<tr>
<td>2004</td>
<td>Deville one patch</td>
<td>56</td>
<td>3.4</td>
<td>55.5</td>
<td>44.5</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>two patches</td>
<td>37</td>
<td>3.1</td>
<td>59.5</td>
<td>40.5</td>
<td>27</td>
</tr>
</tbody>
</table>
Delay Surgery?

![Survival curve showing early surgery vs. late surgery](image)

- Early surgery (<2 days)
- Late surgery (>2 days)

<table>
<thead>
<tr>
<th>Time (days)</th>
<th>Early surgery</th>
<th>Later surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>14</td>
<td>31</td>
</tr>
<tr>
<td>90</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>180</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>270</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>360</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>

Outcomes from the STS Database

Operative Mortality (Reflects Confusion)

Non-linear trend in mortality
Overall mortality 42.9% (highest of STS database)

Outcomes from the STS Database

Operative Mortality

<7 days 54.1%

>7 days 18.4%

p<0.001

Immediate vs. Delayed Surgery

- Patients with multiple risk factors may benefit from delaying surgery for several weeks (Arnaoutakis et al.)

- **Beware!** Mortality in stable patients that decompensate while waiting for surgery is 100% (Poulsen et al.)
IABP in All Patients?

- Placement of IABP leads to immediate reduction in left-to-right shunt
- Improves systemic cardiac output
- Hemodynamic stabilization may allow delayed operation

Percutaneous Closure?

- Based on congenital muscular VSD
- Poor tissue quality = poor success rate
- May be offered to patients at excessive risk for surgery:
  - Shock
  - VSD location
  - MOF
  - Profound biventricular dysfunction
Percutaneous Closure

Overall Mortality

Kaplan-Meier cumulative mortality for all patients

Follow up from procedure (years)

Calvert et al. Circulation 2014;129:2395
Percutaneous Closure

Overall Mortality

Multiple defects are frequent

Calvert et al. Circulation 2014;129:2395
Percutaneous Closure

Post-Discharge Mortality

Kaplan-Meier cumulative mortality for patients discharged from hospital

Number at risk: 31 16 11 9 9 5 4 4 2 2 2

Follow up from discharge (years): 0 1 2 3 4 5 6 7 8 9 10

Cumulative death (fraction): 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

Calvert et al. Circulation 2014;129:2395
So...Percutaneous Closure?

- Ideal Candidates:
  - VSD diameter < 2,5 cm
  - Adequate septal margins
  - Central rather than apical position
  - No proximity to aortic valve

- Perhaps not quite ready for *Primetime*

Peripheral VAD

Tandem Heart

- 11 patients; 8 preop & 3 postop
- Hemodynamics improved immediately after placement
- pVAD support for 7±3 days prior to VSD repair +/- CABG
- All patients with pVAD preop survived
- Currently *routine* staged approach

Extracorporeal Life Support

**Pros:**
- Easily implantable to allow stabilization and transport from remote facilities
- Widespread use

**Cons:**
- Does not always allow unloading of LV
- Coagulopathy
Methods

- Historical cohort from January of 2004 to October 2018, of patients underwent post-infarction Ventricular septal repair.

- Patients were identified through an institutional cardiac surgery database.

- Prospective harvest from July 2008
# Preoperative Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N=18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex</td>
<td>14 (77.8%)</td>
</tr>
<tr>
<td>Age years, mean ±SD</td>
<td>66 ±8.9</td>
</tr>
<tr>
<td>Diabetes</td>
<td>5 (27.8%)</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>3 (16.7%)</td>
</tr>
<tr>
<td>Dyalisis</td>
<td>1 (5.6%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>8 (44.4%)</td>
</tr>
<tr>
<td>COPD</td>
<td>2 (11.1%)</td>
</tr>
<tr>
<td>creatinina, median IQR</td>
<td>1.06 (0.9-1.3)</td>
</tr>
<tr>
<td>Tobacco use</td>
<td></td>
</tr>
<tr>
<td>current smoker</td>
<td>2 (11.1%)</td>
</tr>
<tr>
<td>Former smoker</td>
<td>4 (22.2%)</td>
</tr>
<tr>
<td>Previous cardiac operation</td>
<td>1 (5.6%)</td>
</tr>
<tr>
<td>NYHA functional class</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>11 (61.1%)</td>
</tr>
<tr>
<td>III</td>
<td>4 (22.2%)</td>
</tr>
<tr>
<td>IV</td>
<td>3 (16.7%)</td>
</tr>
<tr>
<td>Previous arrhythmia</td>
<td>3 (16.7%)</td>
</tr>
<tr>
<td>LVEF, median IQR</td>
<td>39.6 (30-52)</td>
</tr>
</tbody>
</table>

LVEF= left ventricular ejection fraction. Categorical data are expressed as number (%) IQR= Interquartile range SD=Standard deviation
PMI VSD– Patch Exclusion
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PMI VSD– Patch Exclusion
## Operative Characteristics

<table>
<thead>
<tr>
<th></th>
<th>N=18 (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ECMO</td>
<td>3(16,6)</td>
<td></td>
</tr>
<tr>
<td>IABP</td>
<td>5 (27,8)</td>
<td></td>
</tr>
<tr>
<td>CABG</td>
<td>14(77,8)</td>
<td></td>
</tr>
<tr>
<td>Cardiopulmonary bypass</td>
<td></td>
<td>118(99-134)</td>
</tr>
<tr>
<td>time minutes, median IQR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross clamp time</td>
<td></td>
<td>92(57-113)</td>
</tr>
<tr>
<td>minutes, median IQR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Categorical data are expressed as number (%) IQR= Interquartile range SD=Standard deviation
### Postoperative Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N=18(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reoperation for bleeding</td>
<td>6(33.3)</td>
</tr>
<tr>
<td>Renal impairment</td>
<td>1(5.6)</td>
</tr>
<tr>
<td>Hospital stay (IQR)</td>
<td>18.5(12-27)</td>
</tr>
<tr>
<td>Mortality (30 day)</td>
<td>3(17)</td>
</tr>
</tbody>
</table>

Categorical data are expressed as number (%)
30-Day Survival
Long-Term Survival
The 2019 Approach (FCI)

- Unstable
  - IABP
  - Unstable
    - ECMO/pVAD
      - Inoperable
      - PerQ Closure
      - Recurrence
    - Stable
      - PMI - VSD
        - Unstable
          - IABP
          - Unstable
            - ECMO/pVAD
              - Inoperable
              - PerQ Closure
              - Recurrence
            - Stable
              - Watchful Waiting
                - >7 days
                  - Operate
                  - Recurrence
Conclusions

- Despite decreasing incidence, mortality remains exceedingly high.
- Early surgical treatment remains the gold standard, but high mortality.
- Percutaneous closure only in a very selected few.
- IABP in all patients.
- pVAD or ECMO may allow delayed intervention (>7 days) with better overall results.