Long-Term Follow-Up after Pulmonary Valve Replacement in Adults with Tetralogy of Fallot: Association between QRS duration and Outcome

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Pulmonary regurgitation is a common long-term complication in tetralogy of Fallot

- PVR improves:
  - RV function and functional class
  - RV de- and repolarization characteristics

- Key determinants of long-term outcome after pulmonary valve replacement are largely unknown
QRS duration

- QRS duration is strongly associated with RV function and prognosis
- QRS duration > 180ms → increased risk for sudden cardiac death
- PVR → reduction of QRS duration

Gatzoulis et al. Circulation 1995
How are pre- and post-operative QRS duration and post-operative changes in QRS duration related to outcome during long-term follow-up after late PVR in tetralogy of Fallot patients?
Protocol

Patients:
• Adult, Tetralogy of Fallot
• Pulmonary valve replacement late after total correction

Operation:
• Pulmonary homograft, concomitant procedures

Measurement QRS duration:
• pre-PVR, 6 months post-PVR, changes pre-to-post

Follow-up:
• Death, re-operation for recurrent PR, symptomatic heart failure, ventricular arrhythmias
# Patient characteristics

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Male/Female</strong></td>
<td>53 / 37</td>
</tr>
<tr>
<td><strong>Age at total correction (yrs)</strong></td>
<td>5.8 ± 5.5</td>
</tr>
<tr>
<td><strong>Age at PVR (yrs)</strong></td>
<td>31.4 ± 10.3</td>
</tr>
<tr>
<td><strong>Pre-operative NYHA</strong></td>
<td>2.4 ± 0.7</td>
</tr>
<tr>
<td><strong>Patients with concomitant procedures</strong></td>
<td>42 (47)</td>
</tr>
<tr>
<td>RVOT reconstruction (%)</td>
<td>27 (30)</td>
</tr>
<tr>
<td>Tricuspid valvuloplasty (%)</td>
<td>17 (19)</td>
</tr>
<tr>
<td>Ventricular septal defect closure (%)</td>
<td>2 (2)</td>
</tr>
<tr>
<td><strong>Pre-operative QRS duration (ms)</strong></td>
<td>158 ± 29</td>
</tr>
<tr>
<td><strong>Changes from pre-post-operative (ms)</strong></td>
<td>-4 ± 17*</td>
</tr>
<tr>
<td><strong>Post-operative (ms)</strong></td>
<td>154 ± 32</td>
</tr>
<tr>
<td><strong>Mean follow-up duration (yrs)</strong></td>
<td>4.9 ± 3.4</td>
</tr>
</tbody>
</table>

![Diagram showing Pulmonary valve replacement outcomes](chart.png)

- Events (n=13)
  - Death (n=2)
  - Re-PVR (n=5)
  - VT (n=4)
  - HF (n=2)

- Event-free (n=77)

*p=0.027*
## QRS duration and outcome

<table>
<thead>
<tr>
<th></th>
<th>Univariate</th>
<th></th>
<th>Multivariate (age, sex, conc. proc.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR</td>
<td>95% CI</td>
<td>HR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Pre-operative &gt; 180ms</td>
<td>2.990</td>
<td>0.948-9.433</td>
<td>2.882</td>
<td>0.855-9.710</td>
</tr>
<tr>
<td>Change in QRS duration</td>
<td>0.979*</td>
<td>0.959-0.999</td>
<td>0.975*</td>
<td>0.954-0.996</td>
</tr>
<tr>
<td>No reduction in QRS duration</td>
<td>5.097*</td>
<td>1.375-18.903</td>
<td>8.080*</td>
<td>1.539-42.406</td>
</tr>
</tbody>
</table>

*p<0.05
# QRS duration and outcome

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Patient years</th>
<th>Events</th>
<th>Events/ 100 patient years</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>90</td>
<td>437.2</td>
<td>13</td>
<td>3.0</td>
<td>1.6-5.1</td>
</tr>
</tbody>
</table>

## Pre-operative QRS duration

- **≤ 180 ms + PO QRS reduction**
  - n: 44
  - Patient years: 215.1
  - Events: 0
  - Events/ 100 patient years: 0
  - 95% CI: NA

- **≤ 180 ms – PO QRS reduction**
  - n: 27
  - Patient years: 142.6
  - Events: 8
  - Events/ 100 patient years: 5.6
  - 95% CI: 2.4-11.1

- **> 180ms + PO QRS reduction**
  - n: 14
  - Patient years: 69.9
  - Events: 3
  - Events/ 100 patient years: 4.3
  - 95% CI: 0.9-12.5

- **> 180ms – PO QRS reduction**
  - n: 5
  - Patient years: 9.7
  - Events: 2
  - Events/ 100 patient years: 20.6
  - 95% CI: 2.5-74.5*

## Post-operative QRS duration

- **≤ 180 ms + PO QRS reduction**
  - n: 52
  - Patient years: 264.2
  - Events: 2
  - Events/ 100 patient years: 0.8
  - 95% CI: 0.1-2.7

- **≤ 180 ms – PO QRS reduction**
  - n: 21
  - Patient years: 118.3
  - Events: 6
  - Events/ 100 patient years: 5.1
  - 95% CI: 1.9-11.0

- **> 180ms + PO QRS reduction**
  - n: 6
  - Patient years: 20.79
  - Events: 1
  - Events/ 100 patient years: 4.8
  - 95% CI: 0.1-26.8

- **> 180ms – PO QRS reduction**
  - n: 11
  - Patient years: 34.00
  - Events: 4
  - Events/ 100 patient years: 11.8
  - 95% CI: 3.2-30.1*

* *p<0.05
QRS duration and outcome

The association between QRS duration and outcome

<table>
<thead>
<tr>
<th>A. Pre-operative</th>
<th>B. Post-operative change</th>
<th>C. 6 months post-operative</th>
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<tbody>
<tr>
<td>QRS≤180ms</td>
<td>QRS reduction</td>
<td>QRS≤180ms</td>
</tr>
<tr>
<td>QRS&gt;180ms</td>
<td>No QRS reduction</td>
<td>QRS&gt;180ms</td>
</tr>
</tbody>
</table>

Event-free follow-up (%)

- **A. Pre-operative**
  - QRS≤180ms: p=0.049
  - QRS>180ms: Yrs

- **B. Post-operative change**
  - QRS reduction: p<0.001
  - No QRS reduction: Yrs

- **C. 6 months post-operative**
  - QRS≤180ms: p<0.001
  - QRS>180ms: Yrs
Discussion (1)

• QRS duration is strongly associated with outcome

• Previous studies indicated reduction of QRS duration after PVR; relevance in terms of clinical outcome unknown

• This study showed significant differences in QRS duration between patients who were event-free during follow-up and those who had events
Discussion (2)

• Previous studies: relation between prolonged QRS duration and RV dilatation
  • Lack of improvement in QRS duration means poorer RV condition thus more risk for adverse events

• Differences were already present pre-operatively; timing PVR?

• Good cut-offs for the detection of adverse events could be obtained from the post-operative ECG using QRS duration
Conclusion

- Severe QRS prolongation, either pre- or post-PVR, and the absence of a reduction in QRS duration after PVR, are major determinants of adverse outcome during long-term follow-up of patients with Tetralogy of Fallot.

- QRS duration may serve as an easy screening tool to identify patients at high risk for adverse events after PVR.

- Pre-operative QRS duration should be used for optimal timing of PVR.
Thank you for your attention