RVOTO – adult and post-op

- Morphology - level of obstruction
  - subinfundibular (double chambered RV)
  - infundibular
  - valvular
  - supravalvular / peripheral
  - combinations
  - conduit
- Hemodynamics
  - RVOTO (gradient)
  - PR grading
  - TR grading / TR velocity / RVP
- RV size, RVH, RVF
- RA / IVC / PA
- Associated lesions (VSD, ASD.....)
RVOTO – adult and post-op
Echocardiographic evaluation
The DIFFICULTIES

• Limited evaluation of RVOT/PA morphology due to poor image quality

CMR (CT)

• Limitations of RVOT gradient estimation
  - Doppler angle (underestimation)
  - Pressure recovery (overestimation)
RVOTO – adult and post-op
Echocardiographic evaluation

The DIFFICULTIES

- Limited evaluation of RVOT/PA morphology due to poor image quality
  - CMR (CT)
- Limitations of RVOT gradient estimation
  - Doppler angle (underestimation)
  - Pressure recovery (overestimation)
  - RVP (TR-velocity)
- Assessment of RV volumes and function by echocardiography still limited
RVOTO – adult and post-op
Echocardiographic evaluation

The DIFFICULTIES

- Limited evaluation of RVOT/PA morphology due to poor image quality
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- Assessment of RV volumes and function by echocardiography still limited
  - CMR

Valvular Pulmonic Stenosis
Valvular Pulmonic Stenosis

<table>
<thead>
<tr>
<th>Grading</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak vel (m/s)</td>
<td>&lt;3</td>
<td>3-4</td>
<td>&gt;4</td>
</tr>
<tr>
<td>Peak grad (mmHg)</td>
<td>&lt;36</td>
<td>36-64</td>
<td>&gt;60</td>
</tr>
</tbody>
</table>

RVOT Obstruction

**INDICATIONS FOR INTERVENTION**

ESC Guidelines 2010

**Symptoms:**
- PG / MG >50/>30 mmHg
- Less than moderate PR

**No Symptoms:**
- PG / MG >60/>40 mmHg
- and less than moderate PR

Baumgartner H et al Eur Heart J 2010

Intervention in patients with **pulmonic stenosis** should be considered if severe right ventricular hypertension is present or if there is a decrease in right ventricular function or if there is a decrease in right ventricular output. The intervention should be performed in a patient with severe pulmonary hypertension and LV dysfunction or severe RV dysfunction.

Baumgartner H et al Eur Heart J 2010

Intervention in the presence of ASD, VSD, and/or arrhythmias may be indicated.

Class / Level?

??
Male, 62 years Restrictive VSD

Double chambered right ventricle
Invasive RVP inflow 105/0-8mmHg, Gradient 68mmHg

RVOTO - Stenoses in series

Gradient Calculation by CW-Doppler

BERNOULLI EQUATION

\[ p_1 - p_2 = \frac{1}{2} \rho (v_2^2 - v_1^2) + \rho \int_{V_1}^{V_2} \frac{dv}{dt} \, ds + R \left( \mu \gamma \right) \]

Convective acceleration
Flow acceleration
Viscous friction

\[ \Delta p = \frac{1}{2} \rho \left( v_2^2 - v_1^2 \right) \]

\[ \Delta p = 4 \left( \frac{v_2^2}{\Delta t} \right) \]

\[ \Delta p = 4v_1^2 \]

V_1: subv. velocity (LVOT) = 1m/s
Pressure Recovery

Pressure recovery in RVOTO:
- Stenoses in series
- Long, tubular stenoses
- Hypoplastic PA

RVOTO – adult and post-op

Pulmonary Artery Stenoses
RVOTO – adult and post-op
Complex CHD with RVOT repair
• Residual / recurrent stenosis
• Pulmonary regurgitation
• Conduit
  - non-valved
  - homograft
  - xenograft (Contegra®)

Tetralogy of Fallot

Severe PR after ToF repair

assessment of
  pulmonary regurgitation (grading)
  RVOT morphology
  RV volumes
  RV function (EF)
  TR (velocity, grading)
  additional lesions (VSD, peri.PS, AR, Ao)
  LV
Grading of PR after ToF repair

Measurement of regurgitant volume and regurgitant fraction

Severe PR after ToF repair
Severe PR after ToF repair: RV volume/function

Tetralogy of Fallot After Repair
Severe PR – Timing of Intervention

Prior to PVR
After PVR

Pulmonary Regurgitation after TOF Repair
Response of the RV to valve replacement

Oosterhof Th et al Circulation. 2007;116:545-551
Indications for Intervention After Repair of Tetralogy of Fallot

Aortic valve replacement should be performed in patients with severe AR with symptoms or signs of LV dysfunction.

PVRep should be performed in symptomatic patients with severe PR and/or stenosis (RV systolic pressure > 60 mmHg, TR velocity > 3.5 m/sec).

PVRep should be considered in asymptomatic patients with severe PR and/or PS when at least one of the following criteria is present:

- Decrease in objective exercise capacity (CPET)
- Progressive RV dilation
- Progressive RV systolic dysfunction
- Progressive TR (at least moderate)
- RVOTO with RV systolic pressure > 60 mmHg (TR velocity > 4.3 m/sec)
- Sustained atrial/ventricular arrhythmias

VSD closure should be considered in patients with residual VSD and significant LV volume overload or if the patient is undergoing pulmonary valve surgery.

Baumgartner H et al Eur Heart J 2010

Male, 65 yrs  ToF, repair 1982
re-op for VSD 1983+1987

Female, 22 yrs  ToF, repair+Contegra 2002
<table>
<thead>
<tr>
<th>Male, 16 yrs</th>
<th>ToF, repair 1995, re-op 1998</th>
<th>homograft 21mm 2000</th>
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- ToF, repair 1995, re-op 1998
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homograft 21mm 2000
Thank you for your attention!