Evaluation of Right Heart Function: Exercise Test

Philippe Hervé
Centre de référence national de l’HTP,
Hopital Bicetre, Paris Sud University
Hemodynamic Exercise Testing

- Antebrachial or jugular approach
- 15 minutes cycling in supine position
- Ergometer attached to the table
- The workload being increased stepwise by 10, 20 or 30 W every 3 to 5 min to a maximum depending on the functional tolerance
- Ideally, more than 5 measurements (PAP, PAOP, CO) to establish P/F curves (slope and intercept by linear regression) PAP = RQ + intercept
1) Role of heart rate in the RV response to exercise in PH.

2) Effect of treatment of PH on RV-PA coupling

Denis Chemla, Marc Humbert, Olivier Sitbon, Gerald Simonneau
Post doc: Frédéric Lador, Vincent Castelain, Steve Provencher,
Edmund Lau, Laurent Godinas……
Right ventricular during exercise in PAH

Cardiac output = Heart Rate X Stroke Volume

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Stroke volume (ml) vs. $O_2$ uptake (L/min) for Normals and PH.
Percentage increase at peak exercise

<table>
<thead>
<tr>
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<th>Controls (n=12)</th>
<th>PAH (n=44)</th>
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<tbody>
<tr>
<td>Cardiac output %</td>
<td>105</td>
<td>42</td>
</tr>
<tr>
<td>Stroke volume %</td>
<td>38</td>
<td>5</td>
</tr>
<tr>
<td>HR %</td>
<td>40</td>
<td>41</td>
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Variance of mPAP was explained for 98.5% by heart rate, versus for 80% by CO


Correlates of 6MWD in 50 PAHi

Rest CI \( r=0.4 \) \( P<0.006 \)

Ex CI \( r=0.35 \) \( P<0.02 \)

Rest SV \( r=0.4 \) \( P<0.008 \)

Ex SV \( r=0.35 \) \( P<0.02 \)

P/F slope \( r=0.31 \) \( P<0.04 \)

\( \Delta \) HR \( r=0.47 \) \( P<0.001 \)

The best correlate is the chronotropic reserve
Kinetics of cardiac output at the onset of exercise in pulmonary hypertension
S Bengueddache, A Bringard, G Ferreti, M Beghetti, PM Soccal, F Lador

CO was recorded non invasively from the arterial pulse pressure profiles by a Portapres system positioned on the index
1) RV in PH during exercise.

2) Effect of treatment of PH on RV-PA coupling.
### Hemodynamic at baseline and after 6 weeks prostacyclin

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<tr>
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<th>Baseline N = 7</th>
<th>Prostacyclin N = 7</th>
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<tbody>
<tr>
<td>RAP (mmHg)</td>
<td>12.6 ± 6.5</td>
<td>12.5 ± 4.2</td>
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<tr>
<td>MAP (mmHg)</td>
<td>94.6 ± 8.2</td>
<td>91.7 ± 11.8</td>
</tr>
<tr>
<td>Mean PAP (mmHg)</td>
<td>56.3 ± 5.1</td>
<td>52.3 ± 8.2</td>
</tr>
<tr>
<td>PAOP (mmHg)</td>
<td>12.2 ± 3.4</td>
<td>11.3 ± 3</td>
</tr>
<tr>
<td>CI (L/min/m²)</td>
<td>2.45 ± 0.47</td>
<td>2.62 ± 0.57</td>
</tr>
<tr>
<td>PVR (mmHg/L/min/m²)</td>
<td>23.5 ± 3.6</td>
<td>20.9 ± 5.7</td>
</tr>
<tr>
<td>SvO₂ (%)</td>
<td>60 ± 5</td>
<td>64 ± 6</td>
</tr>
<tr>
<td>Six-minute Walk test (m)</td>
<td>398 ± 59</td>
<td>478 ± 72*</td>
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</table>

The baseline resting values of mPAP and PVR were similar

But the slope of the pressure flow relation was decreased
What pattern of response to treatment in term of RV PA coupling is beneficial on exercise tolerance?

n= 42 PAHi before and after six months vasodilator treatment

Spontaneous variability:

\[ \tilde{P}_{pa} - CI \text{ slope changes } > 20\% \text{ and resting PVRi changes } > 20\% \]

Correlation with change in 6 min walking test

Changes in exercise haemodynamics during treatment in pulmonary arterial hypertension.
Pattern IA (n = 9)

Pattern IB (n = 9)

Pattern IIA (n = 3)

Pattern IIB (n = 11)

Pattern IIIA (n = 5)

Pattern IIIB (n = 5)
The reference isoflow CI value was first defined as the lowest of the two peak exercise CI values recorded before and after treatment. The corresponding isoflow mPAP was extrapolated from the two mPAP/CI regression lines. Treatment-induced changes in extrapolated isoflow mPAP were then calculated.
No difference in baseline hemodynamics or pre treatment 6MWD

Therefore, when during exercise a given CO is achieved at a lower mean PAP, the treatment is beneficial in term of right ventricular energetic and the exercise tolerance is improved.
Mean PAP and CO at rest and at Peak exercise before and 6 months after PTE in 9 patients

Only 3 patients had a beneficial effect with a decrease in right ventricular work during exercise
CONCLUSIONS

1) Right ventricular response

The exercise tolerance is critically dependent of the chronotropic response that may be the only mechanism available to increase cardiac output.

2) Response to treatment

A vasodilator treatment improves the exercise tolerance when it decreases the mean part of ventricular load providing an economic effect on the RV-PA coupling.