Emerging applications of stress echocardiography:

Right heart haemodynamics

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DECLARATION OF INTEREST

- I have nothing to declare
Ms MF

- 27 year old mother
- Hemodynamic collapse, now recovered
- Past history
  - Addison’s disease
- Non-smoker
- Medications
  - Hydrocortisone
  - Oral contraceptive
Ms MF

- Exercise stress echocardiogram
  - 9:19 minutes to Stage 4
  - Developed severe dyspnoea, fatigue and $O_2$ desaturation
  - Poor blood pressure response
- Dilated right ventricle
- Normal LV
- Right ventricular systolic pressure 28 mmHg
• Right ventricular systolic pressure 72 mmHg
• ? Exercise-induced pulmonary hypertension
3 months later...
Mrs MF

• Right heart catheter
  – Mean pulmonary artery pressure = 34mmHg
  – Cardiac output = 3.3 L/min
  – Pulmonary vascular resistance = 6 WU

Mean pulmonary artery pressure ≥ 25mmHg at rest
Pulmonary capillary wedge pressure ≤15mmHg
Pulmonary vascular resistance >3
What is EIPH?
- normal pulmonary vascular response to exercise
Normal vs. abnormal pulmonary vascular function

mPAP > 3 x cardiac output is abnormal
PQ plots - echo
TR for estimation of PASP

- Trans-tricuspid pressure gradient related to the velocity of regurgitant blood
- \( P = 4 \times TRV^2 \)
- Can use agitated contrast
- \( mPAP = 0.6 \times SPAP + 2 \) (Chemla et al. *Chest* 2004)
PAP increase during ex in healthy subjects

Estimate CO with output

(a) LVOT d 26 mm

CSA = 5.31 cm²

(b) VTI 19.5 cm

SV = CSA * VTI

= 104 ml

(c) LVEDV 115 ml

(d) LVESV 44 ml

LVEF 62 %

LVSV 71 ml
PQ plots - catheter

? gold standard
but no assessment of ventricular function
Accurate exercise pressure / volumes

during intense exercise & free breathing

La Gerche et al. *Circ Imaging* 2013
Normal vs. abnormal pulmonary vascular function

G Lewis et al. *Circ Heart Fail* 2011

G Claessen *YIA AHA Chicago* 2014
Impact of pulmonary vascular disease on RV function
RV dysfunction in CTEPH
RV dysfunction in CTEPH

Claessen et al. Unpublished
RV reserve correlates with exercise capacity – resting measures DO NOT

Claessen et al. *Unpublished*
But I don’t have a bike in my CMR!

Himmelman et al. *Circulation* 1989

Claessen, La Gerche et al. *Unpublished*
But I don’t have a bike in my CMR!

Claessen, La Gerche et al. *Unpublished*
Ex-induced sPAP in mitral valve disease

- Exercise-induced sPAP associated with a 3 fold increased risk of developing symptoms at 3 years
  - More predictive than resting sPAP

- Best cutoff value of PASP during exercise for predicting events was 56 mm Hg

Relationship between PAP, RV function & vascular load

La Gerche et al. *The Right Heart* Springer Press
Failure to increase PAP with exercise is associated with a poor prognosis

Lewis, Semigran et al.  
*Circ Heart Failure* 2011
Exercise TAPSE and sPAP

ExPHT: sPAP during ex > 54 mmHg
ExRVF: TAPSE during exercise <19 mm

Ex-induced RV dysfunction incremental prognostic value in management of asymptomatic MR

Exercise right heart haemodynamics - summary

• What is EIPH? *Excessive increase in PAP for given CO*
• Exercise estimates of PASP and CO are feasible
• Importance of exercise testing in:
  – Breathless patients (diagnosis)
    “To assess exertional breathlessness you must exert the breathless”
  – Patients with heart disease (prognosis)
    *Poor RV reserve = poor exercise capacity and ↑mortality*
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