was significantly increased in TOF patients (P=0.0004-0.006). Peak diastolic WSS was significantly higher than the temporally averaged WSS in TOF patients but not in controls (P=0.011 vs P=0.688). There was no differential spatial distribution of WSS across the MPA segments. Low intraobserver variability (2% mean percentage difference) was present between repeated WSS measurements.

### 4D flow CMR derived WSS values

<table>
<thead>
<tr>
<th></th>
<th>Patients (n=17)</th>
<th>Controls (n=6)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tangential mean WSS (N/m²)</td>
<td>0.368±0.050</td>
<td>0.215±0.016</td>
<td>0.0004</td>
</tr>
<tr>
<td>Tangential peak diastolic WSS (N/m²)</td>
<td>0.450±0.071</td>
<td>0.203±0.034</td>
<td>0.0005</td>
</tr>
<tr>
<td>Axial mean WSS (N/m²)</td>
<td>0.223±0.037</td>
<td>0.134±0.021</td>
<td>0.0004</td>
</tr>
<tr>
<td>Axial peak diastolic WSS (N/m²)</td>
<td>0.269±0.060</td>
<td>0.137±0.014</td>
<td>0.0004</td>
</tr>
</tbody>
</table>

Wall shear stress (WSS) values in patients and controls expressed as mean ± standard deviation. Mann-Whitney test was used for statistical comparison.

### Conclusion:

Wall shear stress (WSS) was significantly higher than the temporally averaged WSS in TOF patients, but the change was not statistically significant with n=26.

### Table 1. 4D Flow MRI Results

<table>
<thead>
<tr>
<th>Age (days)</th>
<th>Weight (g)</th>
<th>Length (cm)</th>
<th>BSA (m²)</th>
<th>Qs (L/min)</th>
<th>Qp (L/min)</th>
<th>Qp/Qs</th>
<th>Qrpa (L/min)</th>
<th>Qlpa (L/min)</th>
<th>SV (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>20.7</td>
<td>4100</td>
<td>53.4</td>
<td>0.25</td>
<td>0.85</td>
<td>0.98</td>
<td>1.17</td>
<td>0.42</td>
<td>0.42</td>
</tr>
<tr>
<td>SD</td>
<td>6.7</td>
<td>530</td>
<td>0.15</td>
<td>0.17</td>
<td>0.17</td>
<td>0.16</td>
<td>0.08</td>
<td>0.08</td>
<td>0.92</td>
</tr>
</tbody>
</table>

Results of 26 neonates. Qs = systemic blood flow, Qp = pulmonary blood flow, Qrpa = right pulmonary artery blood flow, Qlpa = left pulmonary artery blood flow, SV = stroke volume.

### Figure 1: Cardiac index (CI) in the first 33 days of life

The plotted lines are linear regression and confidence intervals.

#### Conclusion:

Normal values for CI and pulmonary blood flow is reported. CI was seen to rise 60% during the first 33 days of life, this is due to a gradual increase in stroke volume. Neonates has a 17% higher Qp compared to Qs, probably due to shunting through the foramen ovale.

4D flow using ViosWorks and Artery’s software is feasible (80% success rate) and quick, the CMR scan takes 10 min and flow analysis less than 10 min.

### Funding Acknowledgements:

Danish Heart Association, Candies Foundation.

### P874

#### Mitral and aortic flow adaptation to 58 days head-down bed-rest assessed by PC-MRI, and effectiveness of high-intensity jump training countermeasure

1 Politecnico di Milano, Electronics, Information and Biomedical Engineering, Milan, Italy; 2Città Di Lecce Hospital, SVM Care & Research, Lecce, Italy; 3Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institute of Aerospace Medicine, Space Physiology, Cologne, Germany; 4University of Bordeaux, Bordeaux, France; 5Université libre de Bruxelles (ULB), Brussels, Belgium

#### Aims:

Prolonged immobilization generates cardiac deconditioning, a cardiovascular disease risk factor, and efficient countermeasures (CM) are needed to prevent it. We aimed to assess by Phase-Contrast (PC) MRI the effects of long-term strict head-down (-6 degrees) bed-rest (BR) deconditioning and the effectiveness of high-intensity jump training CM on aortic and mitral flow.

#### Methods:

23 males (29±6 years, 181±6 cm, 77±7 kg) were enrolled. The experiment was conducted at Ervibiab research facility as part of the European Space Agency BR studies. Participants were randomly allocated to the jump training group (JUMP, n=12) or to the control group (CTRL, n=11). A typical training session consisted of 4x10 countermovement jumps and 2x10 hops in a horizontal sledge jump system, with 5–6 sessions/week. PC-MRI images (7.5T Biograph mMR) with interleaved 3-directional velocity encoding (VENC; x and y: 80 cm/s; z: 150 cm/s) were obtained (spatial resolution 1.4x1.4 mm²) at the level of the aortic root, and of the mitral plane, before (PRE) and after 58-days (HDT58) of BR. The resulting planar magnitude data and 3-directional velocity images were semi-automatically analysed with previously validated custom software to compute the following parameters: cardiac output (CO), stroke volume (SV), flow rate (Qpeak), systolic duration (Syst) and heart beat duration (RR), rapid filling (Efi) and inflow rate (Epeak).

#### Results:

In CTRL, compared to baseline values, at HDT58 a significant (p<.05, paired t-test) RR (14%) and systolic (10%) shortening, with a decrease in CO (7.5%), Efi (11%), Epeak (15%) were observed. In CM, only RR was shortened (8%), together with a decrease in SV (12%), Qpeak (7.5%), Efi (11%), Epeak (15%).

#### Conclusions:

This is the first study addressing aortic and mitral flow using PC-MRI during BR. Cardiac adaptation to deconditioning due to prolonged immobilization resulted in a reduction of aortic outflow and mitral inflow. The applied CM appeared only partially effective in opposing this phenomenon. This information could be useful to better understand physiologic changes in patients undergoing long periods of immobilization, and to improve countermeasures to reduce cardiac deconditioning.
performed accidentally a Valsalva-like maneuver during breath-holding, a cine real-time acquisition of a modified LV short-axis view (single-oblique coronal orientation) was also acquired during breath-holding in these patients and the difference between the LV end-diastolic cavity at the beginning and the end of the breath-hold was measured.

Results: Aortic flow measured by Flow-BHhighres was higher than by Flow-BHstandard (84±15ml vs 73±20ml, p=0.0002, see Figure) and by Flow-BHhighres (72±21ml, p=0.0003). In comparison with the LVSV of 84±23ml, Flow-BFhighres was not different (p=0.764), while Flow-BHstandard and Flow-BHhighres tended to underestimate flow (p=0.001 and p=0.011, respectively). The acquisition duration for Flow-BHstandard, Flow-BHhighres, and Flow-BHhighres were 234±42s, 15±3s, and 23±4s, respectively. The underestimation of aortic flow by Flow-BHstandard vs Flow-BFhighres (expressed as percentage of Flow-BFhighres) correlated positively with a reduction in LV cavity size during breath-holding (change expressed as percentage of cavity size at the beginning of breath-holding) with p=0.006 and r=0.49, and by Flow-BHhighres vs Flow-BFhighres with p=0.006 and r=0.59.

Figure 1. Flow-BHstandard vs Flow-BFhighres.

Conclusions: Aortic flow may be underestimated when measured with a standard breath-hold PC sequence and this underestimation may partly be explained by a Valsalva-like maneuver provoked by breath-holding. A high temporal resolution free-breathing PC acquisition may avoid this source of error. Further studies are needed to confirm these findings.

P877

Left atrial phasic function by cardiac magnetic resonance feature-tracking is a strong predictor of incident cardiovascular events

M. Sardana1, A. Bensari2, V. Satija3, D. Kuriakose4, I. Edelstein5, G. Oldall2, R. Miller2, S. Gadam2, J. Lee6, A. Suri7, S. Aker8, J. Chiaroni9, University of Massachusetts, Medicine, Worcester, United States of America; 2University of Pennsylvania, Philadelphia, United States of America; 3Corporal Michael J. Crescenz VA Medical Center, Philadelphia, United States of America

Background: The prognostic importance of left atrial (LA) dysfunctions is increasingly recognized. Magnetic Resonance Imaging (MRI) can provide excellent visualization of the left atrial wall.

Purpose: We aimed to study the association of LA dysfunction measured using feature-tracking with incident adverse cardiovascular events among subjects with or without HF at baseline.

Methods: We prospectively studied 640 adults without HF (n=419), HF with preserved ejection fraction (HFpEF, n=101), or HF with reduced ejection fraction (HFrEF, n=120). We measured phasic LA function by volumetric and feature-tracking methods to derive longitudinal strain. Incident heart failure hospitalization and death were adjudicated over a median follow-up of 37.1 months.

Figure: Standardized Hazard Ratios for various measures of left atrial function, as predictors of Incident Death or Hospitalized Heart Failure

*Adjusted for left ventricular ejection fraction, left ventricular mass, left atrial volume index, heart failure status, age, sex, African-American ethnicity, body mass index, systolic and diastolic blood pressure, hypertension, diabetes and coronary artery disease.

Table 1

<table>
<thead>
<tr>
<th>RR (95% CI)</th>
<th>Sys (mmHg)</th>
<th>Di (mmHg)</th>
<th>pul (mmHg)</th>
<th>ERO (%)</th>
<th>MACE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTRL PRE</td>
<td>98±7</td>
<td>50±6</td>
<td>36±9</td>
<td>12±3</td>
<td>3±1</td>
</tr>
<tr>
<td>HDT58</td>
<td>11±1</td>
<td>61±7</td>
<td>42±8</td>
<td>17±3</td>
<td>4±1</td>
</tr>
<tr>
<td>JUMP PRE</td>
<td>112±9</td>
<td>66±9</td>
<td>46±10</td>
<td>20±3</td>
<td>5±1</td>
</tr>
<tr>
<td>HDT58</td>
<td>12±1</td>
<td>61±6</td>
<td>42±8</td>
<td>17±3</td>
<td>4±1</td>
</tr>
</tbody>
</table>

*p<0.05 paired t-test PRE vs HDT58.

Funding Acknowledgements: This research was supported by the Italian Space Agency (contract 2013-064-R.D. recipient EG Caiani)

P876

Relationship between breathing pattern and aortic flow measurement: head-to-head comparison between high temporal resolution free-breathing phase contrast contrast and standard breath-hold sequence

G. Vincen1, A.G. Pavoni1, P.G. Masc1, P. Monney1, T. Rutzi1, S.Z. Pagoulou2, G. Berchier1, J. Schwitteker1. 1Division of Cardiology and Cardiac MR Center, University Hospital of Lausanne (CHUV), Lausanne, Switzerland; 2Swiss Federal Institute of Technology, Laboratory of Hemodynamics and Cardiovascular Technology, Lausanne, Switzerland; 3Department of Radiology, University Hospital of Lausanne (CHUV), Lausanne, Switzerland

Background: Punctuated aortic and mitral valve interventions are increasingly performed in routine cardiac catheterization. Accordingly, there is a need for precise quantification of mitral valve function. Total systolic aortic flow was measured by phase contrast (PC) MRI and left ventricular stroke volume (LVSV) allow quantification of mitral insufficiency. To this goal, various aortic flow measurements were evaluated.

Purpose: To evaluate the influence of breathing during flow measurements by comparing a high temporal resolution free-breathing (Flow-BFhighres) PC sequence with a standard (Flow-BHstandard) and high-resolution (Flow-BHhighres) breath-hold sequence.

Materials and methods: In 30 patients without relevant valvular disease (4 women, 26 men, 56±12y), a conventional PC sequence was applied in the proximal ascending aorta during breath-holding (Flow-BHstandard; spatial/temporal resolution 1.9±1.9mm/240.8ms, slice thickness 10mm, segments 4; cardiac phases 20; acquisition duration 17 beats); in addition, a high temporal resolution PC sequence was applied at the same aortic position during free-breathing (Flow-FBhighres; spatial/temporal resolution 1.2±1.2mm/28.9ms; segments 1; cardiac phases 60; acquisition duration 262 beats) and also during breath-holding (Flow-BHhighres; spatial/temporal resolution 3.75x3.75mm/9.4ms; segments 1; cardiac phases 60; acquisition duration 26 beats). In order to verify whether patients...