Methods: Four hundred and thirty patients with HF underwent echocardiography, laboratory measurements, and CPX. They were divided into two groups according to estimated glomerular filtration rate (eGFR) < 60 [mL/min/1.73m²] (n=141) or eGFR > 60 (n=288). Each patient performed a progressively increasing work rate CPX to maximum tolerance on a cycle ergometer, and respiratory gas exchange variables were acquired continuously throughout exercise, breath by breath. VO2(peak)-VO2(AT)/VO2(peak) and (VO2(RC)-VO2(AT))/VO2(RC) were calculated as exercise capacity after anaerobic thresholds (AT) [RC: respiratory compensation point].

Results: One hundred and eight nine ischemic cardiomyopathy, 132 dilated cardiomyopathy and 59 hypertrophic cardiomyopathy patients were included in this study. The average of left ventricular ejection fraction (LVEF), eGFR, hemoglobin level, and peak VO2 were 50.1 [%], 68.6 [mL/min/1.73m²], 13.6 [g/dL], and 19.4 [mL/kg/min]. In the eGFR < 60 group, peak VO2 was lower than in the eGFR ≥ 60 group (17.5 vs 20.3, p < 0.001). (VO2(peak)-VO2(AT))/VO2(peak) was significantly lower in the eGFR < 60 group (0.30 vs 0.35, p < 0.001). Furthermore, (VO2(RC)-VO2(AT))/VO2(RC) was significantly lower in the eGFR < 60 group (0.22 vs 0.25, p = 0.002). Multivariate analysis revealed that eGFR (p < 0.04), hemoglobin level (p = 0.04), LVEF (p = 0.004), and age (p = 0.001) were significant determinants of (VO2(peak)-VO2(AT))/VO2(peak). As to (VO2(RC)-VO2(AT))/VO2(RC), hemoglobin level was a significant determinant (p = 0.048), but eGFR was not (p = 0.09).

Conclusions: Renal dysfunction might be associated with reduced exercise capacity in HF patients. The exercise intolerance after AT may contribute to impaired overall exercise capacity and hemoglobin level may be an important factor for respiratory compensation after AT in HF patients with renal insufficiency.

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Changes in biventricular volumes during respiration: assessment of the respiratory pump using real-time cardiac magnetic resonance imaging during exercise
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Background: Real-time cardiac magnetic resonance (CMR) imaging has emerged as an accurate and reproducible tool for biventricular volume assessment during free-breathing and whilst exercising. The aim of this study was to examine the degree to which the respiratory pump influenced cardiac filling and performance at rest and during exercise.

Methods: Nine healthy subjects (8 male, 1 female) underwent CMR during free-breathing using an ungated real-time CMR sequence. ECG and respiratory movements were retrospectively synchronized enabling compensation for cardiac cycle and respiratory phase. Cardiac volumes oscillations were determined for the left and right ventricles (LV and RV) from stacks of bi-plane cine images using customized software. End-diastolic and end-systolic volumes (EDV and ESV) as well as diastolic and systolic eccentricity indexes were measured for the LV and RV during peak inspiration and peak expiration, both at rest (heart rate 58 ± 10 bpm) and whilst cycling at low (110 ± 17 bpm), moderate (138 ± 18 bpm) and strenuous (153 ± 20 bpm) workload intensities.

Results: As compared with expiration, there was an increase in RV volumes during inspiration (RVEDV +11%, RVEF +12%, RSV +10%, p < 0.05). In contrast, LV EDV, ESV and LV SV reduced during inspiration (-6%, -6%, -6%, p < 0.05). LVEF and RVEF did not change with respiration, at rest or during exercise. During inspiration, RV SV tended to be larger than LV SV (p = 0.064), whilst LV SV was significantly larger than RV SV during expiration (p < 0.0001). Mean SV, defined as the average of peak-inspiratory and peak expiratory SV, was slightly greater (5%, p = 0.047) for the LV than for the RV, possibly reflecting the expected physiologic advantage due to the bronchial and thebesian circulation. The interventricular septum pushed toward the LV during inspiration as evidenced by a greater eccentricity index during inspiration than during expiration, which was greatest in diastole (+16%, p < 0.0001) but also evident during systole (+ 6%, p = 0.019).

Conclusions: Biventricular volumes oscillate with respiratory phase such that RV volumes and LV volumes are maximal during inspiration and expiration, respectively. Thus, instantaneous measures of stroke volume should not be expected to be equal. Real-time CMR provides a novel means of quantifying the degree to which pulmonary disorders may impact on cardiac performance.

P3380 | BENCH
Cardiopulmonary performance testing using a robotics-assisted tilt table technology with integrated leg drives for balance
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Purpose: Robotics-assisted tilt table technology with integrated leg drives for balance stepping functionality is clinically available for patients with neurological impairments. Initially introduced for early rehabilitation, it provides cyclical stepping movement and physiological loading in immobilized patients. This technology provides stability and support in patients with neurological disorders for whom weakness, balance and coordination problems would preclude cardiopulmonary performance testing using a treadmill or cycle ergometer. This type of device may facilitate the estimation of peak oxygen uptake and other important cardiopulmonary performance parameters in patients who have neurological deficits.

The aim of the present study was to assess the feasibility and safety of this device for peak cardiopulmonary performance testing in able-bodied subjects.

Methods: A robotics-assisted tilt table (Erigo, Hocoma AG, Switzerland) was augmented with force sensors in the thigh cuffs and a work rate estimation algorithm. A custom visual feedback system was employed to guide the subjects' work rate and to provide real time feedback of actual work rate. Each subject carried out an incremental exercise test to the limit of functional capacity with a work rate increment of 5 W/min in female subjects and 8 W/min in males. Outcome measures were peak oxygen uptake (VO2peak), peak heart rate (HRpeak), respiratory exchange ratio (RER), peak work rate (WRpeak) and the Borg CR10 scale to measure exertion and leg fatigue.

Results: 11 able-bodied subjects were included (9 male, 2 female; age 29.6 ± 7.1 years; mean ± SD). Resting VO2 was 4.6 ± 0.7 ml/kg/min and VO2peak was 32.4 ± 5.1 ml/kg/min. All participants reached at least 85% of their predicted HRmax value. RER at peak VO2 was 1.02 ± 0.07. Eight participants (72.7%) reached their peak VO2 in 8-12 minutes, which is considered the optimal duration. The average WRpeak was 65.7 W for males and 41.5 W for females. All participants reported a Borg CR10 value for exertion and leg fatigue of 7 or more. There were no serious adverse events.

Conclusions: The robotics-assisted tilt table augmented with work rate estimation and a visual feedback system is a feasible and safe method for peak cardiopulmonary performance testing in able-bodied subjects. Future work will evaluate test-retest reliability and compare peak cardiosrespiratory performance values with those obtained from a treadmill and a cycle ergometer. The approach will then be piloted in subjects with neurological impairments.