

## HIT MODERATED POSTER SESSION: IMAGING IN EVERYDAY PRACTICE

### P143

#### Relationship of FDG-PET and pressure-strain loops as novel measures of regional myocardial workload in LBBB-like dyssynchrony

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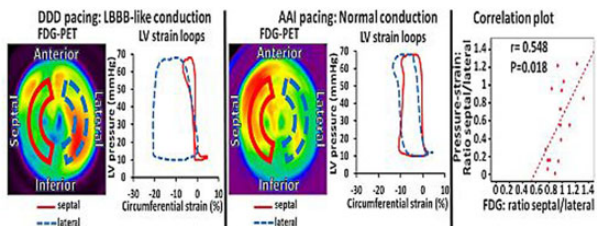
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**Purpose:** To investigate the relationship between two measures of regional myocardial workload (RMW): regional myocardial glucose metabolism, assessed by 18F-fluorodeoxyglucose (FDG) positron emission tomography (PET) and regional LV pressure-strain loop area. Both were evaluated in a chronic rapid pacing animal model of dilated cardiomyopathy (DCM) and LBBB-like mechanical dyssynchrony.

**Methods:** Nine sheep were subjected to rapid RV pacing (180 bpm), developing LV dilatation and asymmetric remodelling, with LBBB-like ventricular activation. After 8 weeks all animals underwent two FDG-PET scans: one under normal LV conduction (AAI pacing), another under LBBB-like activation (DDD pacing). Potential inhomogeneities in RMW represented by FDG-uptake, were then evaluated. Before the last PET scan, all animals were subjected to invasive pressure-volume and simultaneous echocardiographic circumferential strain (CS) analysis of the mid-ventricular segments. Segmental pressure-CS-loop area was then recorded as alternative measure of RMW and compared to PET results.

**Results:** DDD and AAI pacing led to different, but reproducible patterns of inhomogeneous RMW distribution (Figure) with a significant decreased septal-to-lateral wall ratio of RMW in DDD mode compared to AAI, both in the FDG-uptake ( $0.87 \pm 0.09$  vs  $1.05 \pm 0.15$ , resp.,  $p=0.005$ ) and pressure-strain loops area ( $0.22 \pm 0.18$  vs  $0.94 \pm 0.23$ , resp.,  $p=0.0001$ ). A significant correlation was found between both measures ( $r=0.584$ ,  $p=0.018$ ).

**Conclusions:** Our study indicates that RMW can be measured with both regional FDG-uptake and the area of regional pressure-strain loops. The influence of motion and partial volume on the reconstructed FDG-uptake in the asymmetrically remodelled hearts is currently being investigated.



Abstract P143 Figure.

### P144

#### Cardiotoxicity of anti-vascular endothelial growth factor therapies: results of a pilot study

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**Background:** Agents targeting the vascular endothelial growth factor (VEGF) are broadly used in oncology, improving survival in cancers that were previously untreatable. Studies reported cardiac toxicity associated with these agents (thromboembolic events, QT prolongation, arterial hypertension (HTN) and heart failure), but without a detailed assessment. We aimed to characterize the complex cardiovascular response to antiVEGF agents.

**Methods:** We conducted a prospective study with complete cardiac surveillance of oncologic patients with digestive and renal malignancies receiving antiVEGF therapy (bevacizumab, sunitinib, sorafenib). Patients were evaluated before the start of the anti-VEGF agents and one month after, by performing the electrocardiogram at rest, complete transthoracic echocardiography (2D, speckle tracking and 3D methods), ambulatory 24 hours blood pressure (BP) monitoring and evaluation of cardiac biomarkers (BNP and troponin I).

**Results:** We present the preliminary results on 13 patients (mean age 61.9 years, M/F 2.25), all with preserved 2D LVEF ( $\geq 53\%$ ) at the beginning of therapy. Six patients had preexisting HTN and were receiving ACE inhibitors and beta-blockers. At one month after the start of the antiVEGF agents, there was no statistically significant change in the ambulatory 24 hours BP values (average systolic BP from  $121.4 \pm 11.7$  mmHg to  $121.5 \pm 10.2$  mmHg,  $p=0.96$ ). There was no change in 2D LVEF (from  $64 \pm 5\%$  to  $63 \pm 7\%$ ,  $p=0.62$ ) or 3D LVEF (from  $60 \pm 6\%$  to  $58 \pm 9\%$ ,  $p=0.93$ ) and cardiac biomarkers values were stable (BNP from  $51.3 \pm 34.4$  pg/ml to  $68.0 \pm 57.4$  pg/ml,  $p=0.20$ ; troponin I was negative in all patients). At one month after the start of the antiVEGF therapy, we observed however that the global longitudinal strain (GLS) of the left ventricle measured by the speckle tracking method, was significantly reduced from  $-19.0 \pm 2.3\%$  to  $-17.5 \pm 2.6\%$  ( $p=0.03$ ). Also, we report a statistically significant reduction in the right ventricular systolic function parameters: the tricuspid annular plane systolic excursion (TAPSE) was significantly reduced from an average of  $23.8 \pm 4.1$  mm to an average of  $21.0 \pm 2.9$  mm ( $p=0.02$ ), and the GLS of the right ventricle, by the speckle tracking 6 segments method, decreased from  $-24.6 \pm 4\%$  to  $-20.6 \pm 6\%$  ( $p=0.04$ ).

**Conclusions:** AntiVEGF agents have the potential to induce early subclinical cardiac dysfunction, irrespective of BP response. It appears that both ventricles are affected concomitantly. GLS emerged as a more sensitive tool to detect early changes when compared to conventional systolic function parameters or biomarkers.

### P145

#### A new animal model of rapid pacing-induced dilated cardiomyopathy and LBBB

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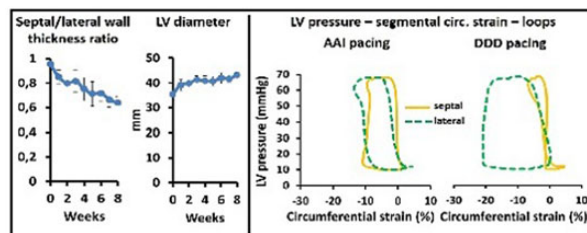
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**Background:** Inhomogeneous regional loading and function due to e.g. left bundle branch block (LBBB) induces cardiac remodelling. We propose an animal model of rapid pacing-induced dilated cardiomyopathy (DCM) and LBBB-like morphology, featuring acute controllable inhomogeneous regional myocardial workload (RMW).

**Methods:** Nine sheep were subjected to 8 weeks of rapid pacing (180 bpm) on the RA and RV mid free wall. LV regional wall thickness and diameter changes were evaluated by weekly echocardiograms. LV volumes were also assessed by MRI at baseline and after 8 weeks. At week 8, the animals underwent invasive hemodynamic pressure-volume and simultaneous echo circumferential strain (CS) analysis. Mid-ventricular segmental pressure-CS-loops, representing RMW, were recorded with normal LV conduction (AAI pacing; RA) versus LBBB-like conduction (DDD pacing; RA + RV).

**Results:** Within 8 weeks of rapid DDD pacing, the LV septal/lateral wall thickness ratio sign. decreased ( $0.97 \pm 0.15$  to  $0.64 \pm 0.1$ ,  $p=0.001$ ), while LV diameter sign. increased ( $36 \pm 2$  to  $43 \pm 1$  mm,  $p=0.001$ ). LV end-diastolic and LV end-systolic volume sign. increased from  $69 \pm 9$  to  $101 \pm 24$  ml ( $p=0.0001$ ) and  $44 \pm 6$  to  $71 \pm 19$  ml ( $p=0.0001$ ) respectively. Acute switching from DDD to AAI resulted in a sign. increase in LV stroke work ( $1503 \pm 690$  to  $2060 \pm 933$  mmHg\*ml,  $p=0.034$ ) and sign. increase in dP/dt max ( $918 \pm 327$  to  $1197 \pm 440$  mmHg/s,  $p=0.025$ ). At the same time, the RMW showed a sign. increase in the septal wall from  $176 \pm 142$  to  $597 \pm 149$  mmHg\*% ( $p=0.0001$ ), and a decrease in the lateral wall ( $959 \pm 396$  to  $640 \pm 284$  mmHg\*%,  $p=0.085$ ).

**Conclusions:** Our animal model of rapid DDD pacing on the RA and RV provides all hallmarks of DCM with LBBB-like asymmetric LV remodelling. Significant immediate changes in RMW can be achieved by switching pacing modes.



Abstract P145 Figure.

**P146**  
**Three-dimensional echocardiography assessment of the systolic variation of effective regurgitant orifice area in patients with functional tricuspid regurgitation: implications for quantification**

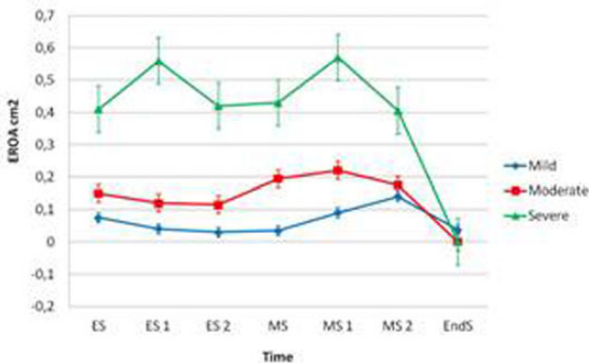
P.Aruta<sup>1</sup>; D. Muraru<sup>2</sup>; C. Janei<sup>3</sup>; M. Haertel Miglioranza<sup>4</sup>; G. Cavalli<sup>2</sup>; G. Romeo<sup>2</sup>; D. Peluso<sup>2</sup>; U. Cucchini<sup>2</sup>; S. Iliceto<sup>2</sup>; L. Badano<sup>2</sup>  
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**Purpose:** Current guidelines recommend to measure 2D PISA radius at mid systolic frame but actually few data support this indication. To address this issue, we explored the changes of the effective regurgitant orifice area (EROA) during systole in patients with functional tricuspid regurgitation (FTR).

**Methods:** Thirty-four patients (70 ± 15 years, 65% women) in sinus rhythm with FTR underwent complete 2D/Doppler and 3D echocardiography. Severity of FTR was assessed using the multiparametric approach suggested by current guidelines. EROA was obtained from the full-volume data set of the FTR regurgitant jet using 3D eSiePISA (Siemens Medical Solution, San Francisco, CA) and measured at each systolic frame afterwards normalized in 7 phases (early-systole, ES; early-systole 1, ES1; early-systole2, ES2; mid-systole, MS; mid-systole, MS1; mid-systole2, MS2; end end-systole, EndS).

**Results:** FTR was graded severe in 11 pts (32%), moderate in 12 (35%) and mild in 11 (32%) mild. All the groups showed the typical biphasic trend of functional regurgitation. However, in severe FTR this pattern was more pronounced and less predictable than mild and moderate FTR. MS EROA could differentiate mild from moderate FTR (0.1 ± 0.13vs0.2 (0.1-0.5) cm<sup>2</sup>; p=0.005) but not moderate from severe (0.2 (0.1-0.5)vs0.6 ± 0.2 cm<sup>2</sup>; p=0.076). Conversely, the average value of the EROAs during systole discriminated between both mild and moderate FTR (0.10 (0.06-0.16)vs0.26 ± 0.2; p=0.042) and moderate and severe (0.26 ± 0.2vs0.5 ± 0.2; p=0.001).

**Conclusions:** In pts with FTR, EROA showed high variability during systole, with different behavior according to its severity. Quantitative assessment of EROA at a single time point (particularly at MS) is not sufficient to discriminate among the different degrees of FTR severity.



Abstract P146 Figure. Systolic variation of 3D EROA

**P147**  
**Clinical prognostic value of myocardial mechanics using speckle-tracking echocardiography in patients post primary coronary intervention for acute ST-segment elevation myocardial infarction**

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**Purpose:** Echocardiography is frequently used post myocardial infarction (MI) to assess the left ventricular ejection fraction (LVEF) and help guide further management and follow up. However, it is subjected to many confounders. Novel quantitative assessment of left ventricular (LV) myocardial indices using speckle-tracking echocardiography holds promise of overcoming these constraints. Our study aims to evaluate the clinical prognostic value of measuring global longitudinal strain (GLS) in patients who received reperfusion therapy post ST-segment elevation myocardial infarction (STEMI).

**Methods:** A 4-year retrospective cohort study which included patients post primary percutaneous coronary intervention (PCI) for acute STEMI in 2010 at Changi General Hospital (Singapore) was done. All images and measurements were obtained using standard protocols with GE medical systems. The primary outcome was admission for decompensated heart failure (HF). Secondary outcomes include recurrent MI, cardiovascular-related deaths, all-cause mortality and localization of infarct.

**Results:** 133 (70%) of 190 patients were reviewed. As expected, patients with LVEF <40% were 9 times (95% CI 2.6 - 31.3) more likely to be admitted for HF than those with LVEF >40% (p=0.001). LVEF threshold of 40% had a high negative predictive value (NPV) of 96%. GLS and torsion were not predictors of HF. However, in a subgroup analysis of 100 patients with LVEF >40%, GLS was a predictor of the primary outcome: mean GLS in patients admitted with HF -7.2 compared to -12.3 in those not admitted (95% CI -8.3 to -1.9; p<0.02). GLS threshold of -11 had a NPV of 98.5%. Torsion was not a predictor.

The location of infarct demonstrated difference in GLS (p = 0.024) and torsion (p = 0.003), while LVEF (p = 0.086) did not. In anterior MI, there was greater reduction in GLS [mean value of -10.55 (SD -14.24 to -7.83)] and greater torsion [mean value of 14.16 (SD 9.45 to 17.53)] -corresponding to the left anterior descending artery which supplies a larger territory compared to the rest.

GLS and LVEF were not predictive of recurrent MI, cardiovascular-related deaths and all-cause mortality.

**Conclusion:** LVEF is known as a fair predictor of HF admissions after MI. However, direct assessment of LV deformation using GLS and torsion is a more sensitive measure of cardiac dysfunction, allowing early identification of abnormalities. In future, GLS deformation may identify patients at risk of decompensated HF despite having EF > 40% so that they can benefit from closer monitoring and optimization post MI to reduce readmissions for HF.

**P148**  
**Relationship between left atrial volumes and emptying fractions and parameters of infarct size and left ventricular filling pressures in survivors of st elevation myocardial infarction**

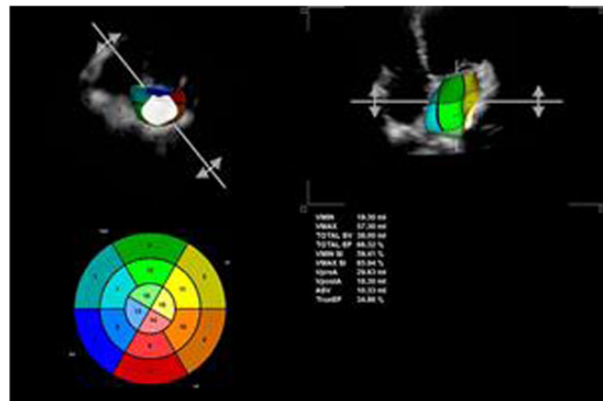
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**Purpose:** Both left atrial (LA) minimal volume (LAVmin) and LA total emptying fraction proved to be better predictors of outcomes compared to LA maximal volume (LAVmax) in patients who survived a ST-elevation myocardial infarction (STEMI). However, the relationships between left atrial (LA) phasic volumes and emptying fractions and indices of infarct size and left ventricular (LV) filling pressures remain to be clarified.

**Methods:** LAVmax, LAVmin, and LA volume before the atrial contraction (LAVpreA), as well as the LA total, passive and active emptying fractions were measured using 3D echocardiography in 60 patients, in the first week following a first STEMI.

**Results:** Among the LA volumes, LAVmin and LAVpreA had the tightest correlations with the peak value of troponin I (r=0.33, p<0.012 and r=0.31, p=0.019 respectively), while LAVmax was not correlated with the troponin levels (r=0.14, p=0.29). In addition, we found significant negative correlations between LA passive, active and total emptying fractions and the troponin levels (r=-0.37, p=0.006; r=-0.28, p=0.036 and r=-0.36, p<0.007, respectively). Significant linear correlations were found between LAVmin, LAVpreA and E/e' (r=0.41, p=0.003 and r=0.33, p=0.019 respectively). Conversely, LAVmax was not correlated with the E/e' (r=0.09, p=0.54). All three LA emptying fractions had significant negative correlations with E/e', with the passive and total emptying fractions having the strongest correlations (r=-0.57, p<0.001 and r=-0.6, p<0.001).

**Conclusions:** LAVmin and LA functional parameters by 3D echocardiography showed tightest correlations with parameters of infarct size and LV filling pressures than LAVmax. Our results may have implications in selecting parameters to predict prognosis in STEMI patients.



Abstract P148 Figure. LA volumes and function by 3D echo

**P149**  
**Left atrial dysfunction assessed by two dimensional speckle tracking echocardiography in patients with impaired left ventricular ejection fraction and sleep-disordered breathing**

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**Aims:** Sleep-disordered breathing (SDB) affects myocardial function and is associated with increased cardiovascular morbidity and mortality. We sought to evaluate the relationship between parameters of left atrial (LA) structure and deformation obtained by two dimensional speckle tracking echocardiography (2D STE): peak longitudinal systolic strain (LAS), peak longitudinal systolic strain rate (LAS-SR), peak longitudinal early diastolic strain rate (LAE-SR), peak longitudinal late diastolic strain rate (LAA-SR), and presence

of sleep-disordered breathing (SDB) estimated by means of apnea-hypopnea index (eAHI).

**Methods and Results:** 32 individuals with ischaemic heart disease and impaired left ventricular ejection fraction (EF < 50%) were included in the study. LA function was assessed using 2D STE. eAHI index was calculated by means of the 24-hour ambulatory Holter electrocardiogram monitoring. Patients were categorized into two subgroup with regard to the eAHI: SDB group (eAHI ≥ 15; n=15) and non-SDB group (eAHI < 15; n=17). All 2D STE parameters were decreased in the SDB group compared to non-SDB group: LAS-SR [0.90 (0.60–1.25) 1/s vs 1.25 (1.00–1.27) 1/s, p=0.043], LAE-SR (-0.76 ± 0.49 1/s vs -1.18 ± 0.55 1/s, p=0.033) and LAA-SR (-1.26 ± 0.71 1/s vs -1.48 ± 0.75 1/s, p=0.049). The eAHI was negatively correlated with LA reservoir function: LAS (r=-0.53, p=0.002) and LAS-SR (r=-0.47, p=0.006), while its positive correlation was seen between LAE-SR (r=0.67, p<0.001) and LAA-SR (r=0.46, p=0.009). Moreover, SDB severity (estimated by eAHI) was an independent predictor of impaired LA compliance (p=0.016) and conduit function (p=0.002) in multivariate linear regression model, even after adjustment for age, BMI, gender, LV systolic (EF) and diastolic (E/e') function and comorbidities (diabetes, hypertension, history of myocardial infarction).

**Conclusions:** LA dysfunction and remodeling assessed using 2D STE method in patients with impaired systolic LV function and ischemic heart disease is influenced by the severity of sleep apnea independently from LV function.

## P150

### Left atrial morphological and functional remodeling early after ST elevation myocardial infarction insights from threedimensional echocardiography

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**Purpose:** To assess left atrial (LA) morphological and functional remodeling occurring early after acute ST-elevation myocardial infarction (STEMI).

**Methods:** LA maximal volume (LAVmax), minimal volume (LAVmin), pre-atrial contraction volume (LAVpreA), as well as the LA total, passive and active emptying fractions were measured by three-dimensional echocardiography in 60 patients, in the first week following a first STEMI and in 60 sex- and age-matched healthy volunteers.

**Results:** All three LA volumes were larger in STEMI patients than in controls (Table). However, LA remodeling affected more LAVmin (72% larger than in controls) compared to LAVpreA and LAVmax, which were with 52% and 33%, respectively, larger in STEMI patients than in controls (all p < 0.0001). Similarly, all three LA emptying fractions were significantly lower in STEMI patients than in controls, but the passive and the total emptying fractions were relatively more impaired than the active emptying fraction (-11% and -10%, respectively versus -6%, p < 0.0001 for both) in STEMI patients than in the control group. The passive emptying volume was significantly lower (p=0.025), while the active emptying volume was significantly larger (p < 0.0001) in STEMI group, resulting in similar total emptying volume in the two groups (p=0.5). We found no significant difference in terms of LA volumes and emptying fractions between anterior and inferior STEMI groups.

**Conclusions:** Early LA morphological and functional remodeling following STEMI affects mostly LAVmin and LA passive emptying fraction. A decrease in the passive emptying function concomitant with a compensatory increase in the active emptying function results in a preserved total emptying volume.

Abstract P150 Table. LA 3D Volumes and Function

	Healthy volunteers (n=60)	STEMI patients (n=60)	P-value
LAVmax (ml/m <sup>2</sup> )	33.46 ± 5.94	43.59 ± 11.95	<0.0001
LAVmin (ml/m <sup>2</sup> )	10.77 ± 2.92	18.57 ± 8.29	<0.0001
LAVpreA (ml/m <sup>2</sup> )	21.02 ± 4.71	31.87 ± 9.54	<0.0001
Passive Emptying Volume (ml/m <sup>2</sup> )	12.43 ± 3.78	11.71 ± 7.86	0.025
Active Emptying Volume (ml/m <sup>2</sup> )	10.25 ± 3.05	13.29 ± 3.98	<0.0001
Total Emptying Volume (ml/m <sup>2</sup> )	22.7 ± 4.34	25.01 ± 9.35	0.526

LAVmax, left atrial maximal volume; LAVmin, left atrial minimal volume; LAVpreA, left atrial volume before atrial contraction.

## P151

### Circumferential strain and strain rate at early stages of dobutamine speckle tracking imaging: are they enough to detect ischemia in patients with coronary artery disease?

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**Introduction:** Assessment of myocardial ischemia by dobutamine speckle tracking echocardiography (STE) during high dobutamine doses is a challenge. Value of longitudinal strain and strain rate (SR) at rest and low dobutamine doses has been shown in small previous studies however little is known about circumferential strain, circumferential systolic and diastolic strain rate importance in early stages of dobutamine STE.

**Purpose:** To determine the diagnostic value of myocardial deformation parameters derived by dobutamine STE at low and high doses for assessment of significant coronary artery stenosis validated by adenosine magnetic resonance imaging (AMRI) in patients with moderate and high probability of coronary artery disease (CAD).

**Methods:** Dobutamine stress echocardiography and AMRI were performed to 91 patients with moderate and high probability of CAD. CAD was defined as ≥ 70% diameter stenosis on coronary angiography validated as hemodynamically significant by AMRI. Patients were divided into two groups based on coronary angiography results: CAD (-) n=57 (62.6%) vs CAD (+) n=34 (37.4%). Circumferential strain, circumferential systolic and early diastolic SR parameters and their changes from rest to low and high dobutamine doses were analysed using 2D STE. Statistical analysis was performed using Student's T-test analysis and ROC curves.

**Results:** There were no significant differences of clinical characteristics, conventional echocardiography and deformation parameters between the two groups at rest. All analysed STE parameters at low dobutamine doses were significantly lower for patients in the CAD (+) group (circumferential strain 23.84 ± 7.25% vs 17.98 ± 4.06%, p=0.01, circumferential systolic SR 2.70 ± 0.74 s<sup>-1</sup> vs 1.76 ± 0.75 s<sup>-1</sup>, p=0.002; circumferential early diastolic SR 2.71 ± 0.74 s<sup>-1</sup> vs 1.76 ± 0.75 s<sup>-1</sup>, p=0.002). The same tendency was observed at high dobutamine doses (strain circumferential 24.37 ± 10.84% vs 16.05 ± 6.09%, p=0.02, early diastolic circumferential SR 2.68 ± 0.68 s<sup>-1</sup> vs 2.03 ± 0.73 s<sup>-1</sup>, p=0.02). According to ROC analysis circumferential strain at low dobutamine doses had strongest predictive value (sensitivity 71%, specificity 75%; AUC 0.76, p=0.02). At high dobutamine doses circumferential strain had sensitivity 93%, specificity 67%, AUC 0.73, p=0.04.

**Conclusion:** Circumferential strain, systolic and early diastolic SR obtained at low dobutamine doses are important markers of CAD and are more accurate indicators for hemodynamically significant coronary stenoses than these parameters obtained at high dobutamine doses.

## P152

### Pulmonary hypertension in hypertrophic cardiomyopathy: a rest and exercise echocardiography study

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**Background:** Heart failure (HF) symptoms, related to pulmonary capillary hypertension, are frequent in hypertrophic cardiomyopathy (HCM). Pulmonary hypertension (PH) is the consequence of left ventricular (LV) diastolic pressure elevation and/or functional mitral regurgitation. We aimed to evaluate determinants and prognostic significance of rest and exercise in HCM.

**Methods and Results:** We included 235 patients referred for clinical work-up of HCM. Rest pulmonary artery systolic pressure (PASP) was measurable in 214 (91%) patients (48 ± 16 years, 161 males). A symptom-limited semi-supine bicycle exercise was carried out in 188 patients. PASP was measurable during exercise in 108 patients (57%). Resting PH (≥ 36 mm Hg) was present in 56 patients (26.2%) and exercise PH (≥ 60 mm Hg) in 38 patients (35.2%). Multivariate correlates of rest PASP were sinus rhythm (β = -0.15, P=0.021), LV obstruction tract (LVOT) peak gradient (β = 0.22, P=0.001) and left atrial volume (β = 0.39, P<0.0001). Multivariate resting correlates of exercise PASP were PASP (β = 0.28, p=0.001) and mitral regurgitation (MR) grade (β = 0.48, P<0.0001). LVOT peak gradient emerged as an independent correlate of exercise PASP when MR was excluded. Patients with rest PH had a worse event-free survival at 4 years (24.8 ± 8.8 vs 66.2 ± 5.2%, P < 0.0001), survival without HF (55.6 ± 10.5 vs 81.8 ± 4.3%, P = 0.005), and overall survival (84.2 ± 7.1 vs 97.1 ± 1.7%, P = 0.001). Patients with exercise PH had also a worse event-free survival (47.7 ± 9.5 vs 65.7 ± 7.5%, P = 0.007) and a worse survival without HF (64.1 ± 9.4 vs 83.4 ± 5.5%, P = 0.016). By contrast, there was no difference regarding overall survival (p = 0.49).

**Conclusion:** In patients with HCM, the main determinants of rest PH are sinus rhythm, LVOT peak gradient and left atrium volume. Determinants of exercise PH are rest PASP, grade of MR and rest LVOT gradient. Rest and exercise PH predict a poor outcome in HCM.