

NORSKE ABSTRAKTER PRESENTERT PÅ EUROECHO

P117 Impact of echo-guided LV lead placement for resynchronization therapy in patients with QRS<150ms and non-LBBB: analysis from the STARTER trial

J Marek, M Ahmed, K Ryo, K Haugaa, S Saba and J Gorcsan. University of Pittsburgh, Cardiovascular Institute, Pittsburgh, United States of America

Background: Because response to cardiac resynchronization therapy (CRT) is greatest in patients with QRS>150ms and left bundle branch

block (LBBB), recent guidelines have questioned CRT for patients with QRS<150ms and non-LBBB morphologies. Our objective was to test the hypothesis that echo-guided left ventricular (LV) lead placement would enhance CRT response in patients with QRS<150 and/or non-LBBB.

Methods: We analyzed the results of the Speckle Tracking Assisted Resynchronization Therapy for Electrode Region (STARTER) trial which was a prospective, randomized double-blind, controlled trial of 187 heart failure patients with QRS > 120 ms, and EF < 35%. STARTER randomized patients 3:2 to LV lead guided to speckle tracking echo site of latest mechanical activation by speckle tracking echo radial strain vs. routine control. The

predefined primary end-point was first HF hospitalization or death over 2 years. We analyzed patients grouped by QRS duration (<150 vs. ≥150 ms) and morphology (LBBB vs. non-LBBB). A Cox proportional hazards model with interaction terms was used.

Results: Of 187 patients enrolled, paired LV lead and follow-up data were available in 151. There were 48 events over the 2-years. Patients with non-LBBB derived greater benefit from CRT with concordant LV lead placement than LBBB patients ($p = 0.012$) and patients with QRS duration < 150 ms derived greater benefit than patients with QRS duration ≥150 ms ($p = 0.028$). In a model combining both QRS morphology and duration, both were associated with a stronger benefit of concordant LV lead placement (interaction $p < 0.01$ for both).

Conclusion: LV lead location seems to play a particularly important role for CRT in patients with QRS width < 150 ms and/or non-LBBB morphology, and these observations have clinical implications

P133 Reduced septal strain in patients with transposition of the great arteries, early marker of ventricular failure?

P Storsten¹, M Eriksen¹, E Boe¹, ME Estensen², G Erikssen², OA Smiseth³ and H Skulstad³. ¹University of Oslo, Institute for Surgical Research, Oslo, Norway, ²Dept. of Cardiology, Rikshospitalet, Oslo University Hospital, Oslo, Norway, ³Dep. of Cardiology and Inst. for Surgical Research, Rikshospitalet, Oslo University Hospital, Oslo, Norway

Purpose: Patients with transposition of the great arteries (TGA) with a systemic right ventricle (RV) have increased risk for heart failure. We studied the longitudinal (LS) and circumferential shortening strains (CS) in the interventricular septum (IVS) and RV free wall.

Methods: 13 patients (32±6 (mean±SD) years), NYHA I-II were studied 31±5 years after operation with atrial switch (Senning 10/Mustard 3). Shortening was measured as strain by speckle tracking echocardiography (GE Vivid E9). 4 chamber views were used to measure peak LS. Mean values from the basal and mid segments in the IVS and the RV free wall were calculated for each wall. CS was measured from parasternal short axis views. From two septal and two RV lateral wall segments a mean value was given as CS in each wall (5 patients). Ten healthy individuals served as controls (32±7 years).

Results: In TGA patients LS and CS in the IVS were reduced compared to normals (-14±2% vs. -19±1%, $p < 0.01$ and -11±4% vs -27±3% $p < 0.01$, respectively). In the patients, comparing the

IVS and the RV free wall, septal LS (-14±2% vs. -20±3% $p < 0.01$) and also CS (-11±4% vs. -18±4% $p < 0.01$) was reduced. Noteworthy, CS was lower than LS in the IVS and RV free wall in contrast to the opposite seen in the IVS in normals (Figure).

Conclusions: This analysis demonstrated reduced shortening in the IVS in TGA-patients operated with atrial switch. The findings also suggest that circumferential shortening is even more reduced than longitudinal shortening. Thus, strain analyses, in particular in the IVS, may serve as early markers of ventricular failure in TGA patients.

P165 Non-homogenous LV remodeling in patients with moderate to severe aortic regurgitation

K Broch¹, G Kunszt¹, R Massey¹, SF De Marchi², S Aakhus¹, L Gullestad¹ and S Urheim¹. ¹Oslo University Hospital, Department of Cardiology, Oslo, Norway, ²Bern University Hospital, Department of Cardiology, Bern, Switzerland

Background: The aim of the study was to investigate potential mechanisms of altered LV contraction pattern in asymptomatic patients with moderate to severe aortic regurgitation (AR). Patients were compared to healthy controls (C) by real-time three-dimensional echocardiography (RT3DE).

Methods: Twenty two patients and 16 age matched controls were compared (33 ± 8 (SD) and 35 ± 4 years, respectively, $p = NS$). All were examined with transthoracic three-dimensional speckle tracking. LV volumes and EF, LV mass index (LVMI), circumferential end-systolic (ESSc) and meridional end-systolic (ESSm) fiber stresses, the fiber stress ratio (ESSc/ESSm) and global tissue deformation parameters (strain and strain rate) were measured in the three orthogonal axes. The ratio of end-systolic circumferential (CS) and longitudinal (LS) strains (CS/LS ratio) as well as the temporal phase shift (LS-CS TD) calculated as the time difference between the longitudinal and circumferential strain curves (at systolic strain -10,0%) were calculated.

Results: Heart rate was similar in the AR and the C group (65 ± 11 and 60 ± 8 bpm, respectively, $p = NS$). Brachial pulse pressure was higher in AR patients (72 ± 17 vs 43 ± 7 mmHg, $p < 0,001$). In the two groups (AR vs C) LVEDV was (241 ± 43 and 146 ± 22 ml ($p < 0,001$), LVESV 89 ± 18 and 58 ± 4 ml ($p < 0,001$), LVEF (63 ± 3 and 61 ± 2%) ($p < 0,05$) and LVMI (137 ± 32 and 87 ± 22 g/m² ($p < 0,001$)). Peak systolic longitudinal strain and strain rates were reduced in the AR group (-15,8 ± 2,0 vs -18,7 ± 1,9 %, $p < 0,001$) and (-0,75 ± 0,12 vs -0,85 ± 0,06 1/s, $p < 0,01$), while peak systolic

circumferential strain increased ($-18,7 \pm 2,6$ vs $-17,1 \pm 1,8\%$, $p < 0,05$) and no change in circumferential strain rate ($-0,86 \pm 0,08$ vs $-0,83 \pm 0,10$, $p = \text{NS}$). Circumferential and meridional fiber stresses in the two groups (AR vs C) were $23,4 \pm 2,9$ vs $18,9 \pm 1,4$ kPa ($p < 0,001$) and $14,1 \pm 1,8$ vs $10,9 \pm 0,9$ kPa ($p < 0,001$). The ESSc/ESSm fiber stress ratio was lower in the AR group ($1,67 \pm 0,05$ vs $1,73 \pm 0,08$ ($p < 0,02$), indicating a relative increase in longitudinal to circumferential fiber stress. A negative correlation was demonstrated between LS and ESSm ($r = 0,56$, $p < 0,01$). A negative correlation was also shown for the CS/LS ratio and ESSc/ESSm ratio ($r = 0,45$, $p < 0,01$). A strong correlation was demonstrated between CS/LS ratio and LS-CS TD ($r = ,92$, $p < 0,01$).

Conclusion: RT3DE identifies non-homogenous remodeling in patients with chronic moderate to severe aortic regurgitation. Isolated reduction of longitudinal strain and strain rate was demonstrated, and correlated strongly to the relative increase in meridional fiber stress.

P168 Global longitudinal strain predicts subsequent ventricular arrhythmia in patients receiving cardiac resynchronization therapy;

NE Hasselberg1, KH Haugaal, A Brunet2, E Kongsgaard1, E Donal2 and T Edvardsen1. 1Oslo University Hospital, Rikshospitalet, Department of Cardiology, Oslo, Norway, 2University Hospital of Rennes, Department of Cardiology and Vascular Disease / CIC-IT 804, Rennes, France

Purpose: Preimplant predictors of ventricular arrhythmia (VA) in cardiac resynchronization therapy (CRT) candidates are not fully investigated. Echocardiographic strain detects subtle myocardial dysfunction and has been shown to be a predictor of VA in different cardiomyopathies. We explored mechanisms of VA in patients treated with CRT by assessing left ventricular (LV) function by echocardiography.

Methods: CRT candidates with heart failure and left bundle branch block were investigated. We performed echocardiography at baseline before CRT-implantation and after 6 months. Systolic myocardial function was assessed as LV ejection fraction (EF) by Simpson's biplane method and global longitudinal strain (GLS) using 2D speckle tracking technique. VA was defined as non-sustained or sustained ventricular tachycardia / fibrillation during 2 years follow-up from CRT implantation.

Results: We included 73 patients (age 64 ± 10 years, NYHA class 2.8 ± 0.4 , EF $28 \pm 9\%$), 44% had ischemic and 56% had non-ischemic cardiomyopathy. VA was documented in 19 patients

(26%) during 24 ± 2 months follow up. LV function by GLS was lower in patients with VA compared to those without VA during 2 years follow-up, both at baseline (-6.5 ± 3.9 vs. $-8.8 \pm 3.6\%$, $p = 0.03$) and at 6 months (-5.9 ± 5.8 vs. $-9.7 \pm 4.7\%$, $p = 0.01$). EF was not a marker of VA, neither at baseline (26 ± 10 vs. $29 \pm 9\%$, $p = 0.26$) nor at 6 months (36 ± 8 vs. $41 \pm 12\%$, $p = 0.18$).

Conclusions: Reduced GLS before CRT implantation was a marker of subsequent VA in heart failure patients, while EF was not. This may indicate that subtle LV dysfunction contributes in ventricular arrhythmogenesis. Our results suggest that GLS may be used as a tool for risk prediction of VA in heart failure patients eligible for CRT.

P176 Increased LV filling pressure in elite football players with large left atrial volumes

G F Gjerdalen1, J Hisdal1, EE Solberg2, TE Andersen3, Z Radunovic1 and K Steine4. 1Oslo University Hospital, Aker, Oslo, Norway, 2Dialkonhjemmet Hospital, Oslo, Norway, 3Oslo Sports Trauma Research Center, Norwegian Football Association, Oslo, Norway, 4Akershus University Hospital, Oslo, Norway

Purpose: Large LA end systolic volume (ESV) and increased ratio between transmitral early diastolic peak velocity (E) and peak early diastolic velocity (E') by tissue Doppler imaging (TDI) are both considered as a non-invasive echo indices for enhanced LV filling pressure in patients. In the present study we therefore wanted to explore if there was any increase in the E/E'-ratio in athletes with large versus those with small LA volumes.

Methods: From our database of 595 male Norwegian football players, the 50 football players with the largest and the 50 with the smallest LAESV were examined. Stroke volume (SV), transmitral E and atrial- (A) peak velocities were measured. Early diastolic peak velocity at the septal and lateral part of the mitral valve were calculated by tissue velocity imaging and averaged (E'). E/A-ratio and E/E' were calculated.

Results: Except for a higher age in athletes with large LA (25.7 ± 4.0 vs. 23.8 ± 4.1 years, $p = 0.025$), there were no significant differences in body surface area, body mass index, systolic-, diastolic blood pressure or E/A-ratio between the groups. No significant correlation was found between E and SV; however E correlated significantly to LAESV ($r = 0.27$, $p < 0.01$). See table for more results.

Conclusions: The present study has demonstrated increased E/E' in those football players with large compared to those with small LA volumes, which might indicate increased LV filling pressures. However, since elevation of E/E' is

based on patients with pathological LV function, we have to consider that our observation also might reflect normal physiology in these athletes, such as increased early diastolic transmitral pressure gradient and thus an increase of E.

P220 Cardiovascular disease and cardiac symptoms: left and right ventricle function in adults with osteogenesis imperfecta

Z Radunovic¹ and KS Steine². ¹University of Oslo, Institute of Clinical Medicine, Oslo, Norway, ²Akershus University Hospital, Oslo, Norway.

Purpose: Prevalence of cardiac disease and function is not known in adults with OI. We aimed to study left ventricular (LV) and right ventricular (RV) function, the prevalence of cardiac disease and symptoms in osteogenesis imperfecta (OI).

Methods: Ninety-nine adults with OI, divided in type I, III and IV, and 52 controls were included in the present survey. Clinical examination, electrocardiogram (ECG), pulsed Doppler and pulsed tissue velocity imaging (TVI) were performed on RV and LV. Systolic peak velocities (S') at basal part of RV and LV reflected systolic function, while the ratio between pulsed Doppler diastolic peak transicuspidal (E) and TVI E' velocities at basal part of both ventricles, E/E' , reflected RV and LV diastolic function, respectively.

Results: RV and LV systolic (S') were significantly lower and diastolic E/E' increased in OI group when compared to the controls, 5.7 ± 1.2 vs. 6.3 ± 1.2 cm/s ($p < .05$) and 8 ± 1.8 vs. 9.5 ± 1.4 cm/s ($p < .05$) and 9.8 ± 2.6 vs. 7.4 ± 2.0 ($p < .05$) and 8.6 ± 3.3 vs. 6.1 ± 1.4 , respectively. Multiple regressions analyses pointed only at OI as the most significant confounder for the reduced systolic and diastolic function in the RV. Forty-nine of the OI patients and 10 controls had one or more ECG abnormalities. Similarly, the cardiac symptoms were significantly more frequent among the OI patients than the controls.

Conclusion: The study demonstrates subclinical reduced diastolic and systolic LV and RV function in adults with OI compared to matched controls. Although the OI disease involves skeletal manifestations often associated with fractures and pain, cardiac symptoms in combination with unspecific ECG changes were frequent, and possible cardiac disease should be considered in these patients.

P245 Discrepancy between changes in global longitudinal strain and ejection fraction may be explained by geometric factors

E W Remme, MK Smedsrud, NE Hasselberg, O A Smiseth and T Edvardsen. Oslo University Hospital, Institute for Surgical Research, Oslo, Norway

Purpose: We investigated the hypothesis that left ventricular (LV) global longitudinal strain (GLS) can be significantly reduced without a significant reduction in ejection fraction (EF), and that this discrepancy may be explained by the geometric relation between EF and GLS.

Methods: EF, GLS and global circumferential strain (GCS) were assessed by echocardiography in 10 patients with non-significant (nsCAD) and 10 patients with significant coronary artery disease (CAD), as evaluated by angiography. From a mathematical ellipsoidal model of the LV we derived that $EF = (1 - (1 + GCS/100\%)^2) / (1 + GLS/100\%) \times 100\%$, which implies that EF has a quadratic dependency on GCS but only a linear dependency on GLS.

Results: EF was similar in the nsCAD and CAD groups ($57.6 \pm 5.5\%$ (mean \pm SD) and $55.1 \pm 4.2\%$, $p = ns$). GLS was $-20.4 \pm 2.3\%$ and $-17.5 \pm 2.8\%$ ($p < 0.05$), respectively, and GCS was $-23.3 \pm 2.5\%$ and $-22.1 \pm 2.9\%$ ($p = ns$), respectively. There was a relatively flat relation between EF and GLS in the mathematical model, i.e. the slope was between 0 and -1 which means a 1% change in GLS resulted in $< 1\%$ change in EF while the opposite was the case for the steeper relation between EF and GCS (Figure).

Conclusions: The geometric relation between EF and GLS allows a larger change in GLS with a relatively small change in EF. This could explain the intuitively inconsistent finding that there may be a significant reduction of GLS with no significant change in EF, and it may suggest that GLS is a more sensitive marker of myocardial function than EF.

P255 Fully automatic estimation of mitral annular parameters from apical four-chamber echocardiographic views

S Storve¹, H Dalen², SR Snare³, BO Haugen⁴ and H Torp¹. ¹Norwegian University of Science and Technology, Dep. of Circulation and Medical Imaging, MI Lab, Trondheim, Norway, ²Levanger Hospital, Levanger, Norway, ³GE Vingmed Ultrasound, Oslo, Norway, ⁴St. Olavs Hospital, Department of Cardiology, Trondheim, Norway

Purpose: Pocket-sized ultrasound equipment is becoming more widespread and cost effective, but is still challenging to use for non-experts. As a step towards increased user-friendliness, we have developed and evaluated a real-time automatic algorithm for estimating four standard clinical left ventricular parameters: Firstly, mitral annular velocities (1) peak early diastolic (2) peak late diastolic and (3) peak systolic, and secondly (4) the mitral annular excursion. The parameters were estimated at both the septal and lateral positions. A possible application of this technique is to convert the automatically estimated parameters into an easily interpreted heart function index value.

Methods: The estimation algorithm uses B-mode and color tissue Doppler echocardiography in the apical four-chamber view. Fitting a deformable left ventricle model onto the B-mode ultrasound frames initializes a color tissue Doppler based tracking algorithm for the lateral and septal atrioventricular points. The positions and velocities of the tracked points are stored and analyzed in order to provide the peak estimates and the excursion estimate, respectively. Successive heart cycles are separated using ECG information.

Results: The evaluation used 33 recordings from HUNT, a Norwegian health study consisting of healthy subjects. Percentage estimation errors when comparing the automatic parameter estimates with the ground-truth measurements supplied by an expert are summarized in the table, which also shows the distribution of the ground-truth values.

Conclusion: The achieved estimation accuracy, at least for the septal point, and the algorithm's capability of real-time operation suggest its possible use in automatic heart assessment applications by automatically interpreting the estimates. The poorer estimation accuracy at the lateral point is consistent with previous studies.

P413 Pocket-size cardiac ultrasound in the hands of medical students improves diagnostic accuracy of bedside clinical examination

T M Stokkel, V Ruddox, S I Sarvari, J E Otterstad, E Aune and T Edvardsen. 1Oslo University Hospital & University of Oslo, Dept of Cardiology, Oslo, Norway, 2Division of Cardiology, Internal Medicine Clinic, Vestfold Hospital Trust, Tonsberg, Norway

Purpose: Physical examination and auscultation can be challenging for medical students. Novel pocket-size cardiac ultrasound (PCU) devices can potentially increase the diagnostic accuracy of the physical examination. We evaluated if

medical students after an introductory session could improve clinical diagnosis with the use of PCU.

Methods: Twenty-one medical students in their clinical curriculum completed 4 hours of PCU training in groups. The students examined patients referred for echocardiography. Medical history and physical examination with emphasis on auscultation, was followed by a PCU examination. Findings and diagnostic conclusions from physical examination and PCU were compared to findings from standard echocardiographic studies performed and analyzed by experienced cardiologists.

Results: A total of 112 examinations were performed by the students. Physical examination showed poor sensitivity for detection of clinically relevant mitral regurgitation (MR) (30%) and aortic regurgitation (AR) (33%), but showed better score for detection of aortic stenosis (AS) (65%). PCU improved sensitivity to detect MR (70%, $p < 0.001$). However, sensitivity to detect AR (43%) and AS (73%) did not improve significantly. Specificities varied from 90% to 100% for physical examination, and from 89% to 97% for PCU. With PCU, sensitivity to detect severe left ventricular (LV) dysfunction (76%) and moderate pericardial effusion (100%) was excellent, while detection of dilated left atrium (53%), right atrium (49%) and aortic root (25%) was moderate to poor. Specificities varied from 72% to 93%.

Conclusions: Medical students using PCU after 4 hours of group training successfully identified severe LV dysfunction and pericardial effusion. Furthermore, diagnosis of clinically relevant MR was significantly improved compared to auscultation, however detection of AR and AS did not improve significantly.

P429 Mechanical dyssynchrony is a marker for ventricular arrhythmia in patients with cardiac resynchronization therapy

NE Hasselberg¹, KH Haugaal, A Brunet², E Kongsgaard¹, E Donal² and T Edvardsen¹. 1Oslo University Hospital, Rikshospitalet, Department of Cardiology, Oslo, Norway, 2University Hospital of Rennes, Department of Cardiology and Vascular Disease / CIC-IT 804, Rennes, France

Purpose: Mechanisms and predictors of ventricular arrhythmia (VA) in patients receiving cardiac resynchronization therapy (CRT) are not fully clarified. Mechanical dispersion reflects dyssynchrony of the left ventricle (LV) and has been shown to predict VA in different cardiomyopathies. We assessed LV function and dyssynchrony by speckle tracking strain echocardiography to explore mechanisms of VA in patients

eligible for CRT. We hypothesized that improvement of mechanical dyssynchrony by CRT, would be associated with less VA.

Methods: We investigated CRT candidates with NYHA class 2-4, wide QRS and no VA prior to CRT treatment. 2D speckle tracking echocardiography was performed at baseline before CRT implantation and after 6 months (CRT turned on). Mechanical dispersion was calculated as standard deviation of time to peak negative strain from each of the 16 LV segments. VA was assessed as non-sustained or sustained ventricular tachycardia/fibrillation during 2 years following CRT implantation.

Results: We analyzed 56 patients (age 64 ± 9 years, NYHA class 2.8 ± 0.4 , EF $29\pm 10\%$), 41% with ischemic and 59% with non-ischemic cardiomyopathy. Mechanical dispersion was reduced by CRT from baseline to 6 months (122 ± 54 ms vs. 79 ± 33 ms, $p<0.001$). VA was documented in 11 patients (20%). Mechanical dispersion at 6 months was higher in patients with VA compared to those without VA during 2 years follow-up (104 ± 47 vs. 75 ± 28 ms, $p=0.02$).

Conclusions: Patients with reduced mechanical dispersion, reflecting less dyssynchrony, 6 months after CRT implantation had reduced risk of VA during 2 years follow-up. We propose mechanical dyssynchrony as a mechanism for VA in CRT patients, indicating that patients experiencing improvement of mechanical dyssynchrony by CRT will have reduced arrhythmic risk.

P451 A comparative study of 2 dimensional versus 3 dimensional echocardiography in a general hospital to evaluate systolic left ventricular function

V Ruddox1, IB Norum1, T Edvardsen2, M Baekkevar1 and JE Otterstad1. 1Vestfold Hospital Trust, Toensberg, Norway, 2Oslo University Hospital & University of Oslo, Dept of Cardiology, Oslo, Norway

Purpose: The European Association of echocardiography (EAE) recommends 3 dimensional echocardiography (DE) to be the method of choice over 2DE in the evaluation of left ventricular (LV) volumes and ejection fraction (EF). We sought to compare LV EF measurements by these two methods as performed by general echocardiographers in a general hospital, as LV EF is used as a predictor for many conditions in cardiology.

Methods: Hospitalized patients referred for echocardiography on admission to ward were included. In the 303 referrals, a complete 2DE was performed. A subsequent 3DE was obtained in 202 patients on median 5 minutes (range 0-18) following 2DE. Reasons for exclusions were; no informed consent ($n=30$), poor image

quality ($n=13$) and irregular heart rhythm ($n=58$). All examinations were performed with a GE Vivid 9 scanner by 3 level III echocardiographers. 2DE results were obtained with the biplane Simpson method and 3DE with full volume acquisition stitched from 4-6 cardiac cycles during breath hold.

Results: A Bland-Altman plot (figure 1) of EF measured by 2DE minus 3DE against the mean of EF, using 3DE as reference showed that 2DE derived LVEF overall was overestimated by 2DE with 1.08 percentage points (95% CI 0.03-2.12). Few large differences were observed. 2DE had a tendency underestimate EF when EF (by 3DE) was below 35%, while an overestimation was seen in the higher ranges of EF.

Conclusions: Routine examination with 3DE in general practice was limited to a subset of patients, as 3DE LV study was unfeasible in 33% of patients with complete 2DE measurements, mainly due to poor image quality and atrial fibrillation. 2DE tended to overestimate LV EF compared to 3DE when EF was greater than 35%. The clinical significance of these differences remains to be settled.

P475 Enlarged atria in athletes lead to higher prevalence of valvular regurgitation but no change in function

G F Gjerdalen1, J Hisdall1, EE Solberg2, TE Andersen3, Z Radunovic1 and K Steine4. 1Oslo University Hospital, Aker, Oslo, Norway, 2Dialkonhjemmet Hospital, Oslo, Norway, 3Oslo Sports Trauma Research Center, Norwegian Football Association, Oslo, Norway, 4Akershus University Hospital, Oslo, Norway

Aims: The main aim of this study was to study remodeling of both left atrium (LA) and right atrium (RA) in endurance athletes and to explore if a large LA size increase would have any impact on LA function. We also wanted to study if this might lead to increased regurgitation in both atrioventricular valves.

Methods: 595 male football players and 47 controls were included. End-systolic LA volume and RA area and end-diastolic LV volume and RV area were measured by 2D echo. Pulsed and color Doppler were used to estimate tricuspidal (TR) and mitral regurgitations (MR). 50 football players with the largest and 50 with the smallest LA volumes were compared by two-dimensional longitudinal strain.

Results: LA volume and RA size were 32 % and 22 % larger in the athletes than the controls, while LV volume and RV area only increased by 17 and 11 %, respectively. There was more than three times the difference in LA volume among the athletes. 2D strain, however, could not reveal

any impairment of LA function in the players with the largest, 57.5 ± 5.7 ml/m², compared to those with the smallest LA, 21.1 ± 3.1 ml/m² ($p < 0.01$). TR was found in 343 (57.8 %) of the athletes compared to 17 (36.2 %) among the controls ($p < 0.01$), while MR was found in 116 (19.6 %) football players and seven (14.9 %) controls (NS). There was a larger RA area in those athletes with TR than without, 11.0 ± 1.9 vs. 10.4 ± 1.9 cm²/m² ($p < 0.05$), while LA volumes were similar.

Conclusion: The present study has demonstrated that both RA and LA are remarkably increased both compared to healthy individuals and relatively to their respective ventricles. We could, however, not show that this had any negative impact on LA function by 2D strain. Although there was significantly more TR among the athletes, we do not consider this to be of clinical significance.

P511 Strain echocardiography reveals subclinically reduced myocardial function in patients with LQT2 compared to LQT1

IS Leren¹, NE Hasselberg¹, J Saberniak¹, TP Leren², T Edvardsen¹ and KH Haugaal.¹
¹Dept of Cardiology, Oslo University Hospital, Rikshospitalet, Oslo, Norway, ²Dept of Medical Genetics, Oslo University Hospital, Rikshospitalet, Oslo, Norway

Purpose: The long QT syndrome (LQTS) is an inherited cardiac disease predisposing to life threatening ventricular arrhythmias. LQTS is caused by cardiac ion channel mutations. Potassium channels are most commonly affected, including IKs (LQT1) and IKr (LQT2). Of these, most severe phenotypes are seen in LQT2 subjects. Recent reports have indicated that strain echocardiography can detect subtle myocardial contraction abnormalities in LQTS subjects, reflecting the mechanical translation of electrical dysfunction. We wanted to explore if there were differences in myocardial function assessed by strain echocardiography between LQT1 and LQT2 patients.

Methods: A total of 154 mutation positive LQTS subjects were included of which 29 were index patients and 124 were family members. Echocardiography, including left ventricular (LV) speckle tracking strain, was performed. LV global longitudinal strain was calculated as the average of longitudinal maximal shortening from 16 LV segments. LV ejection fraction (EF) was calculated by Simpson's formula.

Results: Of the 154 subjects, 108 had LQT1 (mean age 40 ± 15 years, 65% female) and 46 had LQT2 (mean age 40 ± 19 years, 54% female). Myocardial function by LV global longitudinal strain was lower in subjects with LQT2 compared

to LQT1 (-20.8 ± 2.2 % vs. -21.7 ± 1.9 , $p = 0.013$) (Figure), while EF did not differ (61 ± 7 % vs. 61 ± 5 %, $p = 0.887$).

Conclusions: Myocardial function by global strain was significantly lower in subjects with LQT2 compared with LQT1 while EF did not differ. This result shows that strain echocardiography detects subtle myocardial dysfunction in patients with ion channel dysfunction. One might speculate that there is a link between specific ion channel defects and myocardial mechanical alterations.

P656 Using echocardiography when monitoring inopressor treatment in cardiogenic shock. An experimental study in pigs

A Rosner¹, AB Kildal², TA Stenberg², T Myrnes² and OJ How².
¹Cardiological Department, University Hospital of North Norway, Tromsø, Tromsø, Norway, ²University of Tromsø, Faculty of Health Sciences, Cardiovascular Research Group, Tromsø, Norway

Background: In cardiogenic shock, inopressor therapy can lead to increments in systemic vascular resistance with deleterious effects on cardiac work load and performance. This study was designed to test global 2D strain and conventional echocardiographic parameters reflecting changes in stroke volume expressing changes in ventriculo arterial coupling. The aim was to investigate whether echocardiographic global strain measures can better reflect inopressor induced increase of systemic vascular resistance (SVR) than conventional echocardiographic parameters (i.e. long-axis or short-axis derived ejection fraction (EF) and velocity time integral of the left ventricular outflow tract (LVOT VTI)).

Methods: In a closed chest pig model ($n = 16$), echocardiographic indices were validated in post ischemic cardiogenic shock, dobutamine ($2 \mu\text{g}/\text{kg}/\text{min}$) alone and combined with either norepinephrine (NE, $100 \text{ng}/\text{kg}/\text{min}$; $n = 8$) or the pure vasopressor arginine vasopressin (AVP, $0.001 \text{u}/\text{kg}/\text{min}$; $n = 8$). Echocardiography with 2D speckle tracking derived strain and invasive hemodynamic measurements were performed at each experimental stage. Invasive hemodynamic data have been published previously.

Results: All strains correlated well with the contractility marker preload recruitable stroke work (PRSW) (Longitudinal strain: $R^2 = 0.313$; radial strain: $R^2 = 0.355$; circumferential strain: $R^2 = 0.381$). Circumferential and radial strain and SR increased significantly during low dose dobutamine, while longitudinal strain did not. In non-ischemia only radial but not longitudinal or circumferential strain showed significant relation to increased SVR. However, in cardiogenic shock, EF derived from short axis (SAX) area (EF

60±7% in the NE group; EF 46±11% in the AVP group; p=0.009), but not LVOT VTI, EF from apical views or any strainsys reflected sufficiently changes in ventriculoarterial coupling.

Conclusion: Strainsys measurements were not advantageous to conventional echocardiographic parameters expressing changes in ventriculo-arterial coupling. Due to the higher sensitivity of radial and circumferential deformation to inotropy, SAX EF and not long axis derived EF was the only echocardiographic parameter capable to signal increasing SVR during inopressor treatment.

797 Echocardiographic mechanical dispersion is a marker of ventricular arrhythmias in Lamin A/C mutation positive subjects

NE Hasselberg1, J Saberniak1, KE Berge2, T Edvardsen1 and KH Haugaal1. 1Oslo University Hospital, Rikshospitalet, Department of Cardiology, Oslo, Norway, 2University of Oslo, Rikshospitalet University Hospital, Department of Medical Genetics, Oslo, Norway

Purpose: Mutation in the Lamin A/C gene causes a malignant type of familial dilated cardiomyopathy (DCM) including increased risk of ventricular arrhythmias (VA) and sudden cardiac death even before development of DCM. Echocardiographic mechanical dispersion, reflecting contraction heterogeneity, has been shown to accurately predict VA in different cardiomyopathies. We explored if mechanical dispersion could predict VA in Lamin A/C mutation positive subjects.

Methods: We included 33 Lamin A/C mutation positive probands (39%) and family members (61%) (age 35±16 years, follow-up time 42 [31] months). VA were documented and defined as non-sustained ventricular tachycardia (VT) or sustained VT/VF. By echocardiography, left ventricular (LV) function was assessed as ejection fraction (EF) and global longitudinal strain (GLS) from 2D speckle tracking. Subjects with ventricular pacing were excluded. Mechanical dispersion was defined as the standard deviation of time to peak negative strain from the 16 LV segments.

Results: Eleven (33%) subjects had documented VA (6 with non-sustained VT and 5 with sustained VT/VF). Mechanical dispersion was significantly increased in those with VA compared to those without (49±14 ms vs. 38±10 ms, p = 0.02). GLS and EF were not markers of VA (-19.2±5.3% vs. -21.0±2.9%, p=0.22 and 53±7% vs. 47±15%, p=0.14). By ROC analyses, mechanical dispersion showed higher AUC in identifying subjects with VA (AUC=0.74, 95%CI 0.55-0.93) than EF (AUC=0.64, 0.41-0.86) and GLS (AUC=0.54, 0.30-0.78).

Conclusions: Mechanical dispersion was a marker of VA in Lamin A/C mutation positive subjects indicating heterogenous contraction as an arrhythmic factor. We propose that mechanical dispersion may act as an EF independent predictor of VA in Lamin A/C mutation positive subjects.

P836 The impact of coronary calcium on improvement over a year of diagnostic accuracy for coronary artery stenosis with low dose cardiac CT in 402 patients without previous coronary revascularisation

H Schirmer1, SH Forsdahl2, T Sildnes2, T Trovik3 and A Iqbal3. 1University of Tromso, Faculty of Health Sciences, Cardiovascular Research Group, Tromso, Norway, 2University Hospital of Northern Norway, Department of Radiology, Tromso, Norway, 3University Hospital of Northern Norway, Department of Cardiology, Tromso, Norway

Purpose: Increase in coronary calcium is significantly correlated to coronary stenosis but also an obstacle to accurate detection of stenosis. This study explores the impact of coronary calcium on improvement of diagnostic accuracy over a year in a tertiary cardiac centre establishing cardiac CT service.

Method: We examined 402 consecutively referred patients both with invasive and CT angiography and CT calcium score with observers blinded for each other's evaluation of images. Exclusion criteria were GFR < 30%, iodine allergy, pregnancy, acute coronary syndrome, heart rate >110 despite adequate medication. 65% of eligible population consented to the trial which were approved by the regional board of ethics (Clinicaltrials.gov: NCT01476579) A Siemens, Somatom Definition Flash 256 slice dual source was used. After blinded readings were entered in the database, the radiologists were given access to the angiography report. The inclusion period were divided in two and specificity, sensitivity, positive and negative predictive value were calculated for invasively determined significant stenosis >50% or revascularisation on a per patient level. Calcium score was graded in 5 with 0, 10, 100, 400 and 800 as cut off levels.

Results: The prevalence of significant stenosis was 38% and 29% were treated with revascularisation. Decision to revascularise was supported by measurement of fractional flow reserve in 7.4% of patients. Calcium score did not influence sensitivity for stenosis (93% 87-96) or revascularisation (98% 93-99), which was high throughout the study period. Specificity for stenosis and revascularisation increased significantly during

the study period significantly more for higher than lower calcium score ($p=0.04$). This reduced overall mismatch between CT and invasive angiography significantly (from 45-30%, $p=0.001$) mainly by reducing false positives among those with high calcium score in the latter half of the study period. With increasing calcium score, age increased from 56 to 72 years and there were an increasing proportion of men (43-73%).

Conclusion: Improvement in diagnostic accuracy for coronary CT angiography was highest where coronary calcium was highest. Although the reduction in false positives was lowest for low calcium score, this has the highest clinical impact as all those with calcium score above 400 had a prevalence of coronary stenosis justifying invasive angiography.

P865 Gender-related differences in LV diastolic function in lymphoma survivors

K Murbraech¹, KH Smeland², H Holte², JH Loge², CE Kiserud² and SA Aakhus¹. ¹University of Oslo, Rikshospitalet University Hospital, Department of Cardiology, Oslo, Norway, ²Norwegian Radium Hospital, Oslo, Norway

Purpose: Lymphoma survivors (LS) have increased cardiovascular disease burden because of cardiotoxic treatment, in particular anthracyclines (AC) and mediastinal radiotherapy. Studies have shown that women might be more prone to late cardiotoxic effects than men. Therefore we wanted to assess diastolic function between genders in LS after high dose chemotherapy with autologous stem cell transplantation (HDT).

Methods: We studied 100 patients (70 men - mean age $57\text{yr}\pm 11\text{yr}$ and mean body mass index (BMI) $26.3\text{ kg/m}^2\pm 3.5\text{ kg/m}^2$ and 30 women - mean age 56 ± 15 , $p=0.84$ and mean BMI 25.8 ± 6.6 , $p=0.60$) in a Norwegian national cross-sectional follow-up study of LS after HDT. Mean time since primary treatment was 10 years for both genders, and all patients received AC (mean cumulative dose $311\text{ mg/m}^2 + 94\text{ mg/m}^2$ for men vs $320+80$, $p=0.61$). Echo pulsed wave Doppler was performed to measure peak mitral inflow velocities at early (E) and late (A) diastole and early deceleration time (EdecT). Tissue Doppler echocardiography was performed with the sample volume positioned at the basal septal and lateral part of the mitral annulus to obtain peak early (e) diastolic myocardial tissue velocities. We used the mean of e'-septal and e'-lateral to calculate e'.

Results: Both E (female; $72\text{ cm/s}\pm 19\text{ cm/s}$ vs male; 58 ± 14 , $p<0.0001$) and A (female; $75\text{ cm/s}\pm 21\text{ cm/s}$ vs male; 64 ± 14 , $p=0.01$) were significantly higher in women than men. Correspondingly there was a significantly higher Ee'-ratio

(8.5 ± 2.9 vs 6.7 ± 1.8 , $p<0.0001$) among women. See table 1 for other results.

Conclusions: Thus, our results indicate a slight impairment in LV diastolic function, in spite of lower blood pressures, in women compared to men in LS after HDT.

P873 Detection of occlusions in the three main coronary arteries using transthoracic Doppler

J Vegsundvag¹, E Holte¹, R Wiseth², K Hegbom³ and T Hole¹. ¹Ålesund Hospital, Department of Internal Medicine, Ålesund, Norway, ²Norwegian University of Science and Technology, Department of Circulation and Medical Imaging, Trondheim, Norway, ³St. Olavs Hospital, Department of Cardiology, Trondheim, Norway

Background: We aimed to determine whether antegrade flow velocities in septal perforating branches could identify an occluded contralateral main coronary artery, and to assess the feasibility and accuracy of demonstrating main coronary occlusions by use of several parameters indicating collateral flow.

Methods: A total of 108 patients scheduled for coronary angiography because of chest pain or acute coronary syndromes were studied using transthoracic Doppler echocardiography.

Results: Antegrade peak diastolic flow velocities (pDV) in septal perforating branches were higher in patients with angiographically occluded contralateral artery compared with corresponding velocities in patients without significant main coronary disease ($0.80\pm 0.31\text{ m/sec}$ versus $0.37\pm 0.13\text{ m/sec}$, $p<0.001$). Receiver operating characteristic curve showed pDV $\geq 0.57\text{ m/sec}$ to be the optimal cutoff value to identify occluded contralateral artery, with sensitivity of 79% and specificity of 69%. Demonstration of at least one positive parameter (findings of retrograde flow in main coronary arteries, reversed flow in septal perforating and left circumflex marginal branches, pDV $\geq 0.57\text{ m/sec}$, and findings of other epicardial or intramyocardial collaterals) indicating collateral flow to an occluded main coronary artery had sensitivity, specificity, positive predictive value, and negative predictive value of 89%, 94%, 63%, and 99%, respectively, for detection of coronary occlusion. Collateral flow findings identified 25 of 28 main coronary occlusions.

Conclusions: By investigating several parameters indicating collateral flow, we were able to identify most of the main coronary occlusions in the patient cohort, underscoring the value of transthoracic Doppler echocardiography in demonstrating collateral flow to occluded

coronary arteries in patients with suspected or documented coronary disease.

P933 Aerobic interval training improves diastolic dysfunction in patients with type 2 diabetes, a tissue Doppler study

SM Hollekim1, MR Bjorgaas2, AE Tjonna1, U Wisloff1 and CB Ingul1 Cardiac Exercise Research Group (CERG). ¹Norwegian University of Science and Technology, Department of Circulation and Medical Imaging, Trondheim, Norway, ²Norwegian University of Science and Technology, Department of Cancer Research & Molecular Medicine, Trondheim, Norway

Background: Type 2 diabetes (T2D) is associated with diastolic dysfunction (DD) Purpose: To compare the effect of high-intensity exercise (HIE) and moderate-intensity exercise (MIE) in accordance to present guidelines in patients with T2D (duration <10 years) and DD.

Methods: 47 subjects (56,6 years, 31 male) with DD defined as early diastolic tissue velocity (E') < 8 m/s were included and randomized to HIE (4x4minutes) at 90-95% of HRmax 3 times/week (n=24) or MIE 210 min/week (n=23), both 12 weeks. Echocardiography including tissue Doppler, VO₂peak-test and biochemical measurements were performed at baseline pre-, post- and 12 months after inclusion.

Results: There were no difference between groups and 38 completed the intervention (MIE n=17, HIE n=21). HIE significantly improved DD; E' by 21%, early mitral filling velocity (E) by 16% and shortened isovolumic relaxation time (IVRT) by 11% (Table). Systolic tissue Doppler velocity (S') increased with 15% and stroke volume with 11%, waist circumference (WC) reduced with 2 cm, VO₂peak increased with 4.1 ml/kg/min, HbA1c reduced with 6% (Table). The MIE group reduced WC with 2,1 cm and reduced insulin resistance (IR) with 8% (Table). There were no changes in resting heart rate or blood pressure after intervention. At 12 months, fat percent had decreased (1,5%, p>0.001) and all results (except HbA1c) were sustained in the HIE group. VO₂peak, WC and HOMA-IR returned to baseline values in the MIE group at 12 months.

Conclusions: In patients with T2D, HIE improved diastolic dysfunction and decreased HbA1c, in contrast to MIE.

P1024 Left ventricular diastolic function in diabetes mellitus: a 3-year follow-up study

E S Davidsen1, C Bergerot2, L Ernande2, M Barthelet2, S Thivolet2, A Decker-Bellaton2, M Altman2, H Thibault2, P Moulin2 and G Derumeaux2. ¹Haukeland University Hospital, Department of Heart Disease, Bergen, Norway. ²University Hospital of Lyon - Hospital Louis Pradel, Department of Cardiology, Lyon, France

Background: Extensive literature exists on the prevalence of left ventricular (LV) diastolic dysfunction in type 2 diabetes mellitus (DM2). Less is known about deterioration in LV diastolic function from longitudinal studies. We aimed to describe changes over 3 years in LV diastolic function in DM2 patients by repeated echocardiography.

Methods: We prospectively enrolled DM2 patients without overt cardiac disease or myocardial ischemia at noninvasive test. Patients were grouped according to history of hypertension (HT). LV diastolic function was assessed from left atrial (LA) area, mitral flow velocity (E and A) and early diastolic lateral mitral annulus velocity (e') at inclusion and after 3 years.

Results: 214 patients (59±8 years, 54% males, DM2 duration 13±8 years) were included. At inclusion, hypertensives (HT) had higher LA area, lower e', and higher E/e' ratio than non-HT (all p<0.05). During follow-up, LA area increased and E and in e' decreased in both HT and non-HT groups.

In multivariate analyses, LA area increase was associated with BMI ($\beta = -0.19$, p=0.02) and insulin use ($\beta = 0.19$, p=0.04). E' decrease was associated with HbA1C ($\beta = 0.139$, p=0.03), age ($\beta = 0.14$, p=0.03), and female gender ($\beta = 0.134$, p=0.03).

Conclusion: In DM2 patients, changes in LV diastolic function over time are primarily influenced by DM2 control.

P1032 Covariates of the aortic pulse wave velocity in young patients with ischemic stroke

S Saeedi1, MV Kokorina1, A Fromm2, H Oeygarden3, U Waje-Andreassen3 and E Gerdt4. ¹Haukeland University Hospital, Department of Cardiology, Bergen, Norway, ²University of Bergen, Department of Clinical Medicine, Bergen, Norway, ³Haukeland University Hospital, Department of Neurology, Bergen, Norway, ⁴University of Bergen, Department of Clinical Science, Bergen, Norway

Purpose: Aortic pulse wave velocity (PWV) reflects arterial stiffness, and is an independent

predictor of stroke in elderly subjects and in hypertension. Less is known about PWV in young patients with ischemic stroke.

Methods: Arterial stiffness was derived from carotid-femoral PWV (Sphygmocor, Sydney, Australia) in 185 patients <60 years with acute ischemic stroke (Table1). High for age PWV was identified as outlier in the reference normogram.

Results: In univariate analysis, higher PWV was associated with higher age, blood pressure (BP), pulse pressure, fasting blood glucose and serum creatinine, and with known hypertension and obesity (all $p < 0.001$). Higher PWV was also associated with higher serum low-density lipoprotein cholesterol and triglycerides, and with lower serum high-density lipoprotein (HDL) cholesterol (all $p < 0.05$). In multivariate linear regression analysis, higher age, systolic BP, creatinine, lower HDL and known hypertension were all independent covariate (all $p < 0.05$) of higher PWV (multiple $R^2 = 0.50$, $p < 0.001$). High for age PWV was found in 17% of patients. In multiple logistic regression analysis, higher systolic BP (OR 1.05 [95%CI 1.02-1.08]), known hypertension (OR 3.62 [95%CI 1.39-9.41]), lower HDL cholesterol (OR 4.55 [95%CI 1.15-16.67]) and higher serum creatinine (OR 1.03 [95%CI 1.02-1.05], all $p < 0.05$) were independent determinants of high for age PWV.

Conclusions: Higher age, BP, known hypertension, increased serum creatinine and low HDL cholesterol are important modulators of arterial stiffness in young ischemic stroke patients.

P1192 Athletic activity impairs biventricular myocardial function in subjects with arrhythmogenic right ventricular cardiomyopathy

J Saberniak¹, NE Hasselberg¹, R Borgquist², PG Platonov², AG Holst³, T Edvardsen¹ and KH Haugaal.¹Oslo University Hospital, Rikshospitalet, Dept of Cardiology, Oslo, Norway, ²Lund University, Lund, Sweden, ³Rigshospitalet - Copenhagen University Hospital, Heart Centre, Department of Cardiology, Copenhagen, Denmark

Purpose: Athletic activity is supposed to increase risk of ventricular arrhythmias in patients with arrhythmogenic right ventricular cardiomyopathy (ARVC). However, the impact of athletic activity on myocardial function has not been fully investigated.

Methods: We studied 112 consecutive ARVC index patients ($n=65$) and mutation-positive family members ($n=47$) from the Nordic ARVC registry (age 42 ± 17 years, 58% male). ARVC subjects with physical activity level > 1440 metabolic equivalents (METs)-min/week or > 4

hours of vigorous exercise a week over > 3 years were defined as athletes. RV diameter (RVD) was assessed by echocardiography. Myocardial function was assessed as RV fractional area change (FAC), by LV ejection fraction (EF), and by speckle tracking myocardial strain. RV global longitudinal strain (GLS) included 6 RV segments and LV GLS included 16 LV segments.

Results: Athletes definition was fulfilled in 37(33%) and 75(67%) of the ARVC subjects were non-athletes. RVD was increased in athletes compared to non athletes (47 ± 9 mm vs. 41 ± 8 mm, $p < 0.01$) and RV function was decreased (FAC: $34 \pm 10\%$ vs. $41 \pm 10\%$, $p < 0.01$, RVGLS $-18 \pm 6\%$ vs. $-22 \pm 5\%$, $p < 0.01$). LV function was reduced in athletes compared to non athletes (EF: $50 \pm 10\%$ vs. $57 \pm 5\%$, $p < 0.01$, and LVGLS: $-17 \pm 4\%$ vs. $-19 \pm 3\%$, $p < 0.01$). Heart rate and cardiac output did not differ (HR: 59 ± 12 bpm vs. 64 ± 13 bpm $p = 0.06$, CO: 3.3 ± 1.3 l/min vs. 3.6 ± 1.1 l/min, $p = 0.42$). In athletes participating in high dynamic, low static sports ($n=23$), activity level correlated with reduced EF (Figure).

Conclusion: ARVC athletes showed increased RV diameters and reduced biventricular function compared to ARVC non-athletes. Reduced LV function correlated with high dynamic activities. These results indicate that athletic activity may aggravate biventricular myocardial dysfunction.

P1227 Strain rate measurements with ultra-high frame rate tissue doppler imaging

L C Lervik Nilsen, J Lund, B Brekke and A Stoylen, Norwegian University of Science and Technology, Dep. of Circulation and Medical Imaging, MI Lab, Trondheim, Norway

Background: Strain rate imaging by tissue Doppler is vulnerable to noise, and has a low signal to noise ratio. To compensate for the low signal to noise ratio, temporal smoothing is required. A novel tissue Doppler acquisition method, Ultra-high Frame Rate Tissue Doppler Imaging (UFR-TDI), allows for a frame rate of 1200 frames per second (fps). This makes temporal smoothing feasible over far more samples than in conventional Tissue Doppler Imaging (TDI), which has a frame rate of 100-150 fps in a full sector view. In this study we examined whether a frame rate of 1200 fps would improve the repeatability of systolic strain rate measurements.

Method: UFR-TDI was implemented on a Vivid E9 scanner with a M5S-D probe. Peak systolic strain rate was measured in ten young healthy male volunteers with both UFR-TDI and conventional TDI. Similar analysis settings were used in both acquisitions: Spatial averaging over a region of interest of $12\text{mm} \times 6\text{mm}$, strain length 12mm

and temporal smoothing (non Gaussian) over 30 ms. Peak systolic strain rate was measured twice in the same recording by both methods in the mid-septal and mid-lateral wall. Mean values and intra-method repeatability were compared.

Results: Results are given in table 1. UFR-TDI showed a trend towards measurements of higher magnitude in the septum and lateral wall. There was also a trend towards better repeatability

with UFR TDI in both the septum and lateral wall. However, the differences were not statistically significant ($p>0.05$).

Discussion: UFR-TDI showed a trend towards improved repeatability and lower peak values in measuring peak systolic strain rate. This indicates that increased frame rates may better temporal smoothing and reduce the influence of random noise on strain rate measurements.