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Poster Abstracts: Clinical MRS

395. Effect of PPARγ Activation on Cardiac and Skeletal Muscle Metabolism in Patients with Type 2 Diabetes Mellitus

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Introduction: Type 2 diabetes mellitus (DM) is an important risk factor for cardiovascular disease. Animal models of DM show insulin resistance and elevated plasma free fatty acid levels (FFA), which impairs glucose uptake and high-energy phosphate metabolism in skeletal and cardiac muscle. It is unknown whether insulin resistance and increased FFAs influence cardiac and skeletal muscle metabolism in patients with DM, and whether lowering of FFAs via PPARγ activation improves metabolism.

Methods: To study this, 25 patients with DM and 15 control subjects matched for age, sex and weight were included in a trial. Fasting blood parameters were measured, and cardiac function was assessed using echocardiography. Skeletal muscle tissue oxygenation was measured using near infrared spectrophotometry (NIRS). Cardiac metabolism was measured using ^{31}P magnetic resonance spectroscopy (MRS) at rest, and skeletal muscle metabolism was assessed using MRS at rest and during and after exercise. Patients were then randomised in a double-blind manner to receive 8 mg of the PPARγ activator Rosiglitazone (RSG) od or placebo for 3 months, at which time all tests were repeated.

Results: Plasma glucose, insulin, lactate, FFAs and highly sensitive C-reactive protein (hs-CRP) were significantly higher in patients with DM compared with controls. Treatment with RSG decreased FFAs and hs-CPR (from 0.58 ± 0.04 to 0.31 ± 0.03 mM and 2.6 ± 0.3 to 1.3 ± 0.3 mg/l, $p < 0.05$ vs. placebo), with no significant effect on glucose and insulin. Skeletal muscle metabolism at rest was not different in patients with DM compared with controls. Exercise tolerance, however, was reduced (7.1 ± 0.6 vs. 10.5 ± 0.6 min, $p < 0.001$ vs. controls), and phosphocreatine (PCr) loss during exercise was faster in patients with DM. After exercise, PCr recovery was slower in patients with DM, suggesting impaired oxidative phosphorylation, and correlated positively with tissue reoxygenation times ($p < 0.01$). Treatment with RSG did not change skeletal muscle energetics. Cardiac function before and after treatment with RSG was not different in patients with DM compared with controls. However, despite normal function, cardiac metabolism, measured as the PCr/ATP ratio, was 33% lower in patients with DM (1.5 ± 0.1 vs. 2.3 ± 0.1, $p < 0.01$ vs. controls), and correlated negatively with FFAs ($p < 0.05$). Chronic RSG increased cardiac PCr/ATP by 0.41 ± 0.18 ($p < 0.05$ vs. placebo), whereas placebo had no effect (-0.04 ± 0.01).

Conclusions: Thus, despite normal cardiac function, cardiac and skeletal muscle metabolism was altered in patients with DM. Whereas treatment with RSG improved cardiac metabolism via lowering hs-CRP and FFAs, it did not influence skeletal muscle energetics. This suggests that cardiac energetic changes are linked to availability of metabolic substrate, whereas energetics in skeletal muscle may be limited by availability of oxygen in patients with DM.

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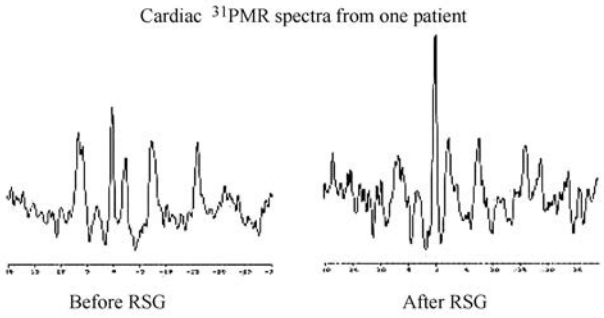

396. Right Heart Cardiac Output by Phase Contrast Imaging is an Important Indicator of Right Ventricular Function in Patients with Pulmonary Hypertension

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Introduction: Advanced pulmonary hypertension (PH) is a disease with very poor prognosis and is often missed. Non-invasive assessment of pulmonary hypertension is an important area of cardiac imaging. Phase velocity mapping with phase-contrast (PC) imaging is a well-established cardiac magnetic resonance (CMR) quantitative method of determining pulmonary artery (PA) flow velocities.

Purpose: To assess the role of PC in the assessment of PH.

Methods: We analyzed 12 consecutive patients with significant pulmonary hypertension with both CMR and right cardiac catheterization (RCC) within 24 hours. PC of the PA was acquired with a breathold, 2-D, segmented FLASH sequence with retrospective cardiac gating and fixed velocity encoding of 100 cm/s. Cardiac output from the right ventricle (COR) was calculated from the PC images without background suppression (PCsBS) and with reference area (PCcBS) placed on the chest wall with a mean velocity of zero. Results were compared with COR obtained from RCC and modified Simpson's method using true-FISP sequence. Statistical analysis was performed with Pearson's linear correlation coefficient and paired Student's t test.

Results: COR values from PCsBS were significantly different from PCcBS (5.15 ± 1.58 Vs. 4.89 ± 1.68, $P = 0.017$). Although COR values with or without BS were were not significantly different from RCC values, there was a trend toward significance with PCcBS ($P = 0.078$). RCC correlated slightly better with PCsBS ($r = 0.728$) than PCcBS ($r = 0.708$). COR by true-FISP showed no correlation with RCC ($r = 0.310$). COR by PCsBS correlated better with either the mean PA pressure or the PA saturation ($r = -0.60$ and 0.66 respectively), two important clinical prognosticators of PH, than RCC did ($r = -0.38$ and $r = 0.60$ respectively). COR as determined by True-FISP did not correlate with either clinical prognosticator.

Conclusions: Use of background suppression does not improve the correlation of COR as determined by PC with RCC in patients with PH. COR as determined by PC correlates better with mean PA pressure and PA saturation than COR obtained from true-FISP or RCC. Thus PC can be a useful CMR imaging technique for the initial and follow up evaluation of right heart function in patients with PH.

397. Hemodynamic Parameters as Determined by Phase Contrast Imaging Correlate Well with Right Cardiac Catheterization in Patients with Pulmonary Hypertension

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Introduction: Right heart failure is the main cause of death in patients with advanced pulmonary hypertension (PH). Symptomatic PH carries a very poor prognosis and right heart catheterization (RCC) is currently the gold standard for diagnosing this condition. Cardiac magnetic resonance (CMR) is an important non-invasive imaging for the assessment of PH. Phase velocity mapping with phase-contrast (PC) imaging is a well-established CMR quantitative method of determining pulmonary artery (PA) flow velocities. Phase contrast imaging may be used to quantify and estimate right heart hemodynamics.

Purpose: To assess the relationship between hemodynamics as measured by PC and RCC.

Methods: We analyzed 14 consecutive patients referred for the evaluation of PH with both CMR and RCC within 24 hours. PC of the PA was acquired with

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a breathold, 2-D, segmented FLASH sequence with retrospective cardiac gating and fixed velocity encoding of 100 cm/s. Hemodynamic data (peak flow velocity (PV), average flow velocity (AV), forward volume (FV) and net forward volume (NFV)) from the main pulmonary artery were calculated from the PC images. Correlations of the results were performed using Pearson's linear correlation coefficient with hemodynamic data (mean PA pressure (MPAP), cardiac output (CO), right atrium pressure (RAP), PA saturation (PASat) and pulmonary vascular resistances index (PVRI)) obtained from RCC.

Results: MPAP showed a very good negative correlation with AV ($r = -0.87$) and with PV ($r = -0.73$) but only moderate correlation with NFV and FV ($r = -0.58$ and $r = -0.57$ respectively). CO showed good correlation with AV ($r = 0.81$) and FV ($r = 0.70$) and NFV ($r = 0.70$). RAP correlated only moderately with AV, PV, FV, and NFV. PASat showed good correlation with AV ($r = 0.78$), NFV ($r = 0.72$), PV ($r = 0.64$) and FV ($r = 0.70$). PVRI correlated well with AV ($r = -0.81$), FV ($r = -0.65$), and NFV ($r = 0.64$).

Conclusions: Non-invasive assessment of right heart function using PC correlates well with the hemodynamic parameters obtained using RCC. Among the PC-derived hemodynamic variables, AV showed the best correlation. In addition to routine cardiac function analysis, PC study may be an important part of the initial and follow up CMR assessment of patients with PH.

398. Left Ventricle Morpho-Function Evaluation Detected by LIVE 3D Echocardiography: an MRI Validation Study

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Introduction: Three-dimensional echocardiography can determine cardiac volumes without geometric assumptions.

Purpose: Aim of the study was to validate by magnetic resonance imaging (MRI) a new three dimensional technique (Live 3DE) in the assessment of left ventricular (LV) end-diastolic volume (EDV), end-systolic volume (ESV) and ejection fraction (EF%, as parameters of LV function.

Methods: We underwent 16 elite rowers (mean age 25 ± 4years) to Live-3DE and MRI. From apical positon, Live-3D image using full-volume procedure was acquired and off-line quantitative analysis was performed. MRI multiple parallel short axis planes were acquired then analyzed off-line. Live-3DE and MRI operators were independent and blinded from each other results.

Results: Live-3D acquisition, including three dimensional dynamic structure rendering, required about 8 ± 2 seconds and quantitative off-line analysis about 8 ± 2 minutes. MRI acquisition time was 50 ± 10 minutes, where off-line analysis required 20 ± 3 minutes. LV-EDV and LV-ESV, assessed by Live-3D, ranged respectively from 145.56 ml to 277.88 ml (mean value 202.8 ± 31.7 ml) and from 52.7 ml to 114.48 ml (mean value 91.1 ± 14.0 ml); EF% ranged from 42.9% to 62.8% (mean value $54.9 \pm 4.9\%$). Values obtained by MRI ranged from 126.9 ml to 266.4 ml (mean value 193.7 ± 40.5 ml) for EDV and from 53.3 ml to 110.3 ml (mean value 83.4 ± 15.4 ml) for ESV; EF% was between 46.1% and 67.7% (mean value $56.3 \pm 6.4\%$). Good correlation was found between the two methods (ESV $r = 0.73$ $p = 0.01$; EDV $r = 0.76$ $p = 0.006$; EF $r = 0.77$ $p = 0.005$) (Fig. 1).

Conclusions: Live-3DE is a new technique which has shown to be very accurate and time-saving in determining LV morphology and function.

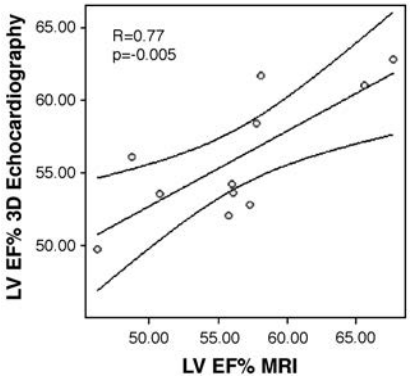

Figure 1.

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399. Left Atrial Morpho-Functional Evaluation Detected by LIVE 3D Echocardiography: an In-Vivo Validation Study

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Introduction: Left atrial (LA) volume is an important parameter that reflects subacute or chronic diastolic dysfunction.

Purpose: Aim of the study was to validate by MRI Live-3D echocardiography (Live 3DE) in the assessment of LA volumes and ejection fraction (EF%) as a parameter of LA function.

Methods: We underwent 20 normal subjects (mean age 25 ± 4 years) to Live-3DE and Magnetic Resonance Imaging (MRI). From the apical position, Live-3DE image using full-volume procedure was acquired and off-line quantitative analysis was performed. MRI multiple parallel short axis planes were acquired and then analysed off-line. Live-3DE and MRI operators were independent and blinded from each other results.

Results: Live-3DE acquisition required about 8 ± 2 seconds, quantitative off-line analysis about 5 ± 2 minutes. MRI acquisition time was 50 ± 10 minutes, where off-line analysis required 20 ± 3 minutes. Good correlation was found between the two methods for EF% (r = 0,75, p = 0,003), end-diastolic (r = 0,87, p = 0,001) and end-systolic volume (r = 0,92, p = 0,001). Inter and intra observer variability was negligible (Fig. 1).

Conclusions: Live-3DE is an accurate method in quantifying LA function and, compared to other techniques, is time saving.

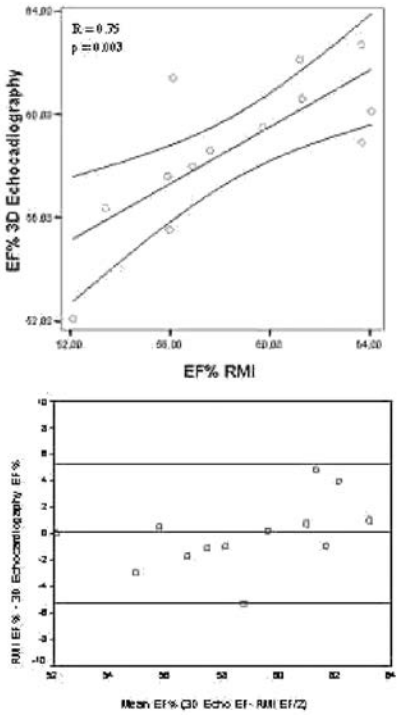

Figure 1.

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