Myocardial metabolism in amyloidosis quantified by proton MR spectroscopy

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Introduction: Cardiac involvement of amyloidosis deteriorates prognosis and can cause heart failure[1]. Therefore, Cardiovascular Magnetic Resonance (CMR) has emerged as a promising tool for the diagnosis of cardiac amyloidosis and for further characterization of myocardial tissue alterations. For example, late gadolinium enhancement has allowed identification of diffuse patterns. Beyond imaging, proton spectroscopy (^{1}H-MRS) holds the potential to non-invasively assess myocardial metabolism including triglycerides (TG) and creatine (CR). Accordingly, the aim of the present study was to assess myocardial TG and CR content in a group of patients with cardiac amyloidosis in comparison to healthy controls.

Methods: CMR including ^{1}H-MRS was acquired on a 1.5T system (Achieva, Philips, Best, Netherlands) using a 5-channel coil in 11 patients with cardiac amyloidosis (61±11 years, 8 males) and in 11 controls (63±19 years, 8 males). Cardiac morphology was assessed using cine imaging in standard views. Afterwards, shimming in breathhold was performed followed by the acquisition of ^{1}H-MRS spectra in the interventricular septum (IVS) at peak systole using a PRESS (point-resolved spectroscopy) sequence with CHESS for water suppression (voxel volume: 8ml). ECG triggering and pencil beam navigator-based respiratory gating on the liver were used to acquire 16 non-water-suppressed and 96 water-suppressed spectra. ^{1}H-MRS data were reconstructed in MATLAB using a reconstruction pipeline implemented in ReconFrame (GyroTools LLC, Zurich, Switzerland). Signal-intensities were obtained by fitting the spectra in in jMRUI/AMARES (version 5.2) and the TG/CR-to-water ratios (TG/W, CR/W) were calculated. Further CMR parameters obtained from cine images were: 1) left ventricular mass per body surface (LVMi), 2) IVS thickness.

Results: Besides a significantly thickened IVS (18.0±4.6 vs. 8.1±1.6mm, p<0.01) and an elevated LVMi (85.2±25.1 vs. 46.7±9.2g/m^2, p<0.01), patients with cardiac amyloidosis presented with decreased TG/W ratios (0.41±0.23 vs. 0.80±0.24%, p=0.01, *Figure 1*). CR/W were not significantly different, but with a higher standard deviation within the amyloidosis group.
Pearsons correlation showed a significant correlation between increasing IVS thickness and decreasing TG/W ratios (R=0.46, p=0.03) and between increasing LVMi and decreasing TG/W ratios (R=0.6, p=0.003, *Figure 2*).

Discussion: ^{1}H-MRS revealed decreased myocardial TG/W ratios in cardiac amyloidosis alongside a correlation to LVMi and IVS. This is in line with results from literature that showed reduced TG/W ratios in patients with advanced heart failure or hypertrophic cardiomyopathy. However, controversial results exist for different forms of left-ventricular hypertrophy[2-4] indicating an individual, pathology-dependent change in myocardial substrate utilization.

Conclusion: As TG/W ratios were reduced in patients with cardiac amyloidosis, ^{1}H-MRS may provide a biomarker to examine the progression of cardiac amyloidosis in addition to standard imaging sequences.

References: [1]Quarta et al. (2012), Circulation 126, [2]Neubauer S. (2007), *N Engl J Med* 356:1140–1151, [3]Nakae et al. (2010), J Card Fail 16:812-822, [4]Mahmod et al. (2013) Circ Cardiovasc Imaging 6:808-18.

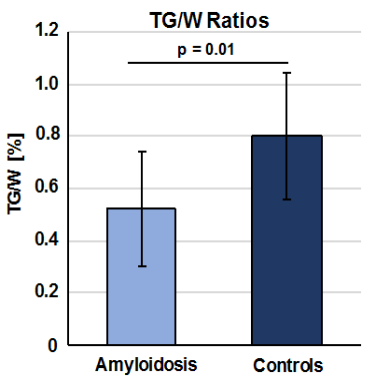

Figure 1: Triglyceride-to-water ratios in cardiac amyloidosis compared to controls.

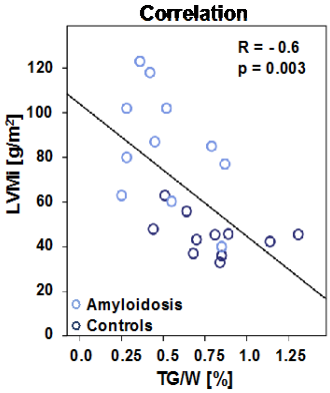

Figure 2: Correlation between left-ventricular mass and triglyceride-to-water ratios.