Magnetic Field Dependence of Myocardial R2* Values and Segmental Myocardial Field Inhomogeneity Assessed at 1.5 T, 3.0 T and 7.0 T.

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Introduction. Parametric T2* is of proven clinical value for noninvasive quantification of cardiac iron overload [1,2]. A segmental approach can detect heterogeneous iron distribution, but could be affected by the presence of geometric and susceptibility artifacts, that may affect myocardial segments in a different way [3] and can be pronounced at high and ultrahigh magnetic fields. Moreover, R2* (1000/T2*) in normal myocardium is expected to increase with static magnetic field, due to the faster relaxation of tissue. For all these reasons this study examines the relationship between myocardial R2* values and magnetic field strength with the ultimate goal to develop a segmental field inhomogeneity map of the human heart at 1.5T, 3T and 7T.

Materials and methods. For 1.5T and 3T data, healthy subjects involved in previous studies were considered [4,5]. Ten healthy subjects (4 males, 27.8±2.6 years) underwent MRI exams at 7T (Magnetom, Siemens, Erlangen, Germany) using a dedicated 16-element TX/RX cardiac coil array. Three parallel short-axes of the left ventricle (LV) were obtained using a T2* weighted GRE multi-echo technique. For each single short-axis view (thickness 4 mm; pixel size 1.6X1.6 mm) a set of 9 echo times (1.56–9.72 ms, ΔTE=1.02 ms) was acquired in a single end-expiratory breath-hold. An MR-stethoscope (MRI.TOOLS, Berlin, Germany) was used for cardiac gating. Macroscopic B0 inhomogeneities were reduced by applying volume selective shimming. Image analysis was performed using a validated software (HIPPO MIOT®) [2,4]. The LV was divided into 16 segments according to a standardized model [6]. Figure 1 shows the dependence of global heart (left) and mid-septum (right) R2* values on the static magnetic field strength. The mean R2* values increased approximately linearly with the field strength. For the global R2*, the regression line had a slope of 6.1 and an intercept of 17.6. The R-squared value was 0.992. For the mid-septum R2*, the regression line had a slope of 5.1 and an intercept of 20.0. The R-squared value was 0.995.

Conclusion. Although R2* relaxation is a complicated process, with possible contributions non-linear with the field strength, our results suggest a nearly linear field dependence of cardiac R2*. Similar results have been reported for the brain R2* [7]. This suggests that the dramatic susceptibility contrast available with 7T MRI could be exploited to quantitatively study iron accumulations in different organs with high sensitivity and resolution. Admittedly, at 7T the pronounced propensity to macroscopic susceptibility artefacts is challenging and it seemed to spare only the septal regions. The most severe artifact source was the heart-lung interface. A recognized limitation of this study is that different groups of healthy subjects were considered for different magnetic field strengths. However, the mean R2* values of healthy subjects are not expected to change in between volunteer cohorts assuming that the T2* mapping technique is applied.