Assessment of Liver Iron Overload by Combining Fast T1-Mapping and T2*-Mapping

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Introduction

MRI is increasingly used to assess suspected hepatic iron overload. Methods described in literature for the measurement of hepatic iron overload are usually based on the quantification of T2 or T2* values. Studies using T1 mapping have mostly been restricted to animal experiments or liver biopsy samples (1, 2). Since T1 changes due to iron overload were found to be smaller than T2 or T2* only very few data have been published on the use of T1-mapping for the assessment of hepatic iron overload. The purpose of this study was to investigate if a combination of T2* values and T1 values, obtained with a fast T1 mapping technique, could be beneficial for diagnosis.

Materials and Methods

A total of 97 patients were included into this study. All patients were referred to our radiology department as part of the standard diagnostic procedure for hepatic iron evaluation. MR imaging was performed on a 1.5T whole body MR scanner (Magnetom Avanto, Siemens). For the quantification of liver T2*-values a fat saturated multi-echo gradient-echo sequence with 12 echoes (TR=200ms; TE=0.99ms + n*1.41ms, flip angle: 20°) was used in transversal orientation. During one breath hold a single slice was acquired and the acquisition was repeated for 5 different slice positions. For the quantification of liver T1-values a fast T1-mapping sequence based on an inversion recovery snapshot FLASH sequence as originally described by Haase et al (3) was used which allowed the acquisition of a single T1 map during one breath hold. Details of sequence implementation and T1-calculation have been published elsewhere (4). T1 and T2* acquisitions were obtained for identical slice positions and slice parameters. T2* and T1 maps were calculated off-line using ImageJ (5). The parameter maps were analyzed by placement of region of interests (ROIs) into different hepatic lobe segments, whereby identical ROIs were used in T1 and T2* maps. Care was taken to avoid the inclusion of large vessels.

Results and Discussion

Figure 1a and b show typical T1 and T2* maps for a patient with liver T1 and T2* values clearly below the normal range (T1: 530-610ms; T2*: 18-30 ms). The correlation between T1 and T2* values obtained for all investigated patients is shown in figure 2. The shaded regions thereby represent the ranges of normal liver T1 and T2* values. A total of 38 patients were found to have T1 and T2* values below the normal region. 34 patients had normal T1 values, however, clearly reduced T2* values and 10 patients had normal T1 as well as T2* values. Interestingly a final patient group (n=15), which was later diagnosed with liver steatosis with no iron overload, was identified with normal T2* values, however, increased T1 values. Remarkably, the obtained correlation curve between T1 and T2* values for patients without steatosis resembles the relation between liver T2* and liver biopsy iron concentrations as shown by Anderson et al. (6). There it was found that T2* values change very strongly already for liver iron concentrations which are almost undistinguishable from normal values. High iron concentrations give very low T2* values making a reliable estimation of iron load problematic. For high iron load T1 values seem to be more reliable.

In conclusion, it is shown in this study that the use of a fast T1-mapping technique combined with the widely used T2*-mapping can deliver additional information helpful for diagnosis, as e.g. identification of patients with liver steatosis. In addition the combination of T1 and T2* values seems to allow a classification of different patient groups.

References

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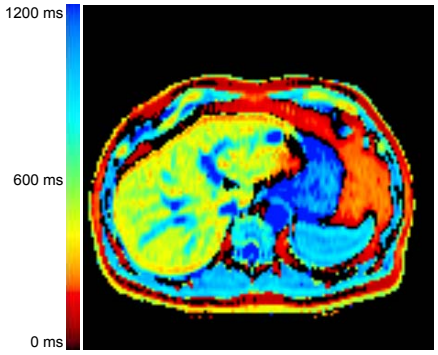

Figure 1a: Typical T1 map for a patient with iron overload (average T1 = 399ms)

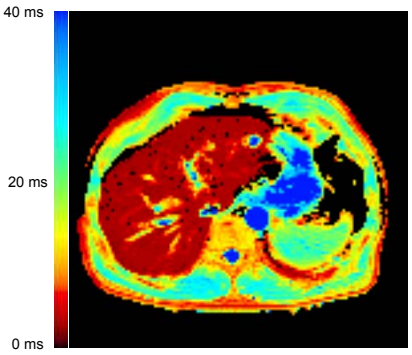

Figure 1b: Typical T2* map for a patient with iron overload. (average T2*= 3ms)

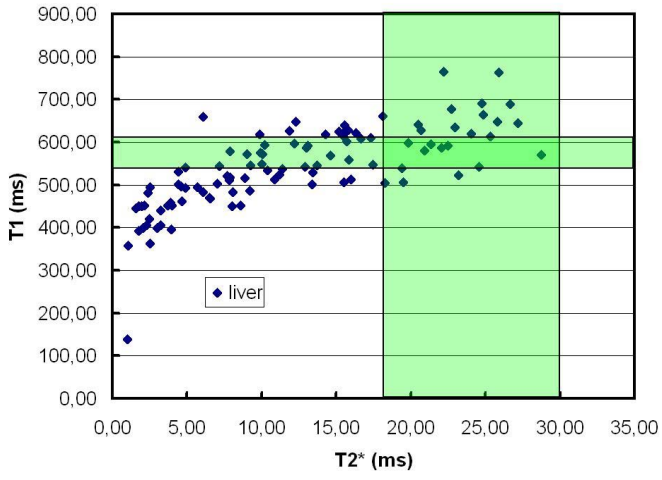

Figure 2: Correlation of liver T1 and T2* values for all investigated patients