

Evaluation of the liver iron concentration (LIC) at 3T in comparison to 1.5T in patients with Thalassemia and Falciforme Anemia

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Introduction:

Iron in the human organism is very important for the correct function. An iron overload in the liver can occur in patients with chronic anemia and hemocromatose due to frequent blood transfusions. A quantitative evaluation of the iron concentration is very important for the adequate treatment of the patients. Relaxometry ($T2^*$) in addition with the calibration of the MR equipment using a phantom is a well known method to determine the liver iron concentration, which has been used in several studies at 1.5T. With the increasing availability of 3T MR scanners, it is necessary to reevaluate the relationship between relaxation times and iron concentration for this higher field strength.

Objective:

The purpose of this study is to determinate the LIC at 3T and 1.5T using relaxometry ($T2^*$) and to compare the results of both field strengths in establishing a relationship between them. A correction factor for the $T2^*$ measurements at 3T is tried to be found for determination of the LIC that makes the use of the same calibration equation of the 1.5T experiment possible when no phantom is available.

Materials and Methods:

The measurement of the relaxation time $T2^*$ (known as Relaxometry) from MR images, can be used for evaluation of the iron concentration in the liver. MR images of the liver of 15 patients were obtained at two different MR field strengths, 1.5T and 3T, using Gradient-Echo (GRE) sequences with 15 different echoes. The echoes were chosen to be as short as possible to achieve adequate sampling of short $T2^*$ values, that correspond to high iron concentration. At both field-strengths $T2^*$ measurements were performed on a ROI-based analysis. The results were compared by combining the data through linear regression (giving the slope and intercept of the curve). The LIC at 1.5T was calculated using the previously determined calibration equation with a phantom at 1.5T and considering the linear relationship, a correction factor (the slope of the previously linear combined $T2^*$) was applied to the $T2^*$ values at 3T to calculate the LIC at 3T using the same calibration equation of the 1.5T measurement.

Results:

The combined $T2^*$ data of all subjects at 1.5 and 3T showed high linear relationship with $r=0.98$ ($p<0.001$). The curve of the linear fit had a slope of (1.39 ± 0.27) with an intercept of (0.15 ± 0.61) ms. The calculated LIC covered a range from 1.5 to 21 mg/g and the slope of the combined data at different field strengths was (0.85 ± 0.21) and the intercept (0.29 ± 2.48) ms ($r=0.98$, $p<0.001$).

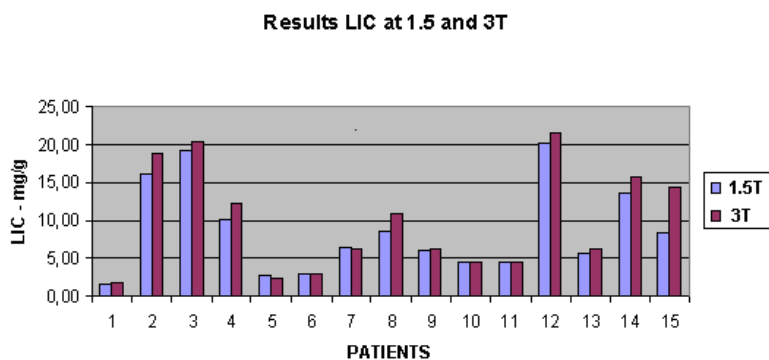
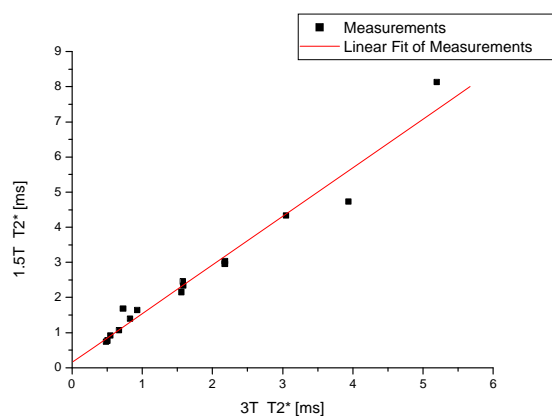


Figure 1: Combined $T2^*$ data. Linear regression yields the correction factor of 1.39, the slope of the curve. **Figure 2: Calculated LIC at 1.5T (blue) and 3T (red).**

Conclusion:

The $T2^*$ measurements at 3T and 1.5T showed a high linear relationship within the available iron concentration range. It suggests that $T2^*$ scales linearly with field strength. Considering this high linearity, the correction factor can be applied to the $T2^*$ measurements at 3T and the LIC can be determined at 3T using the same calibration equation of the 1.5T equipment. To minimize error propagation due to application of the estimated correction factor, calibration of the 3T scanner is suggested.

References:

Storey, P., Thompson, A.A., Carqueville, C.L., Wood, J.C., Freitas, R.A., Rigsby, C.K. $R2^*$ Imaging of Transfusional Iron Burden at 3T and Comparison with 1.5T. *Journal of Magnetic Resonance Imaging* 25: 540-547 (2007)