Estimation of Liver Iron Content with different MRI methods

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Purpose. To compare MR methods based on Spin-Echo (SE) vs. Gradient-Echo (GRE) for estimating liver iron content (LIC).

Methods. 93 patients suspected for liver iron overload were examined by MRI to evaluate the amount of LIC. All examinations were performed at 1.5 T. Gradient echo (GRE) sequences were acquired according to the protocol published by Gandon et al [1] and the supplementary protocol for higher LIC by Rose et al. [2]. Furthermore, examinations with spin echo (SE) were performed with a protocol proposed by St. Pierre et al. [3]. For evaluation of GRE data, signal values are measured in manually drawn circular regions of interest (ROIs) in vessel-free parts of the liver and in the paraspinal muscles. Calculating the ratio of muscle reference value and liver signal, LIC can be estimated according to [1] and [2]. Spin echo data is analyzed using a more sophisticated method [ref. 3 and references cited there] based on calculation of T_2 relaxation time. For each patient, LIC values were compared. The SE methods has an upper limit of 769 mmol/kg liver dry tissue, so patients with values of more than 750 µmol/g determined from SE data were excluded from analysis. Correlation between GRE vs. SE was determined for all values as well as separately for both GRE methods.

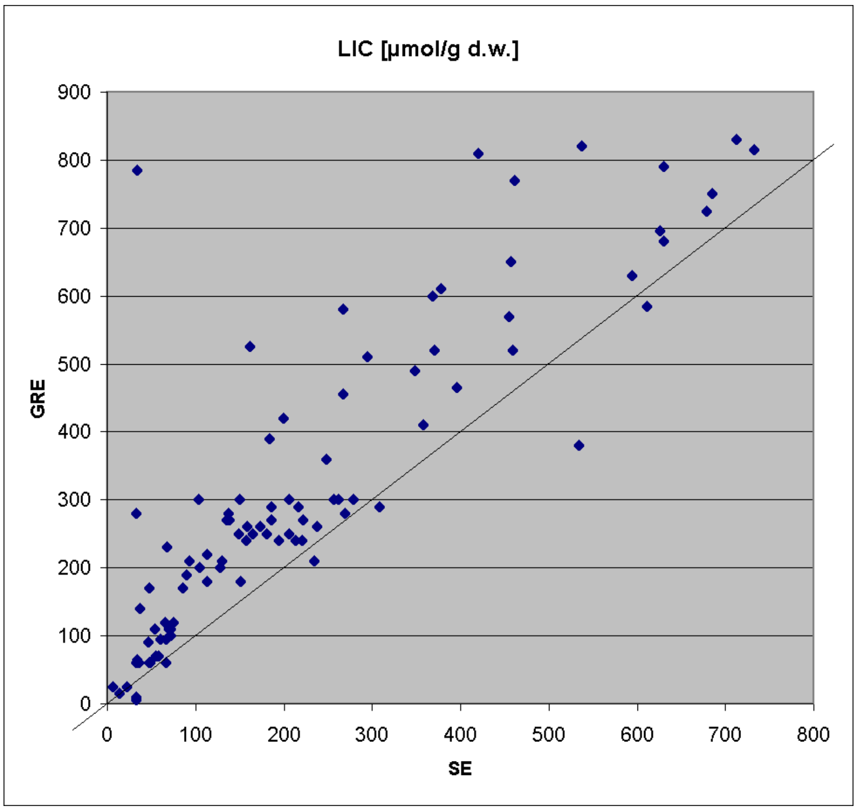

Fig. 1. Liver iron content in µmol/g liver dry tissue determined with GRE vs. SE. The bisector line indicates identical results for both methods.

Results. Both methods correlate moderately with r=0.82. However, the values do not correspond: in the range of 50…100 µmol/g (determined with SE) the GRE values are around 100…300 µmol/g, whereas in the range of 150-300 µmol/g (evaluated from SE data) GRE data yield values of 250...600µmol/g. Correlation for values determined with the GRE protocol for high LIC vs. the SE method was only r=0.57. Since nearly all dots in Fig. 1 are located above the bisector line, GRE overestimates LIC.

Discussion. Iron distribution in the liver is highly non-uniform on different length scales [4]. The distribution depends also on the reason for iron overload: the mechanism observed in primary hemochromatosis differs from those in secondary transfusional hemosiderosis.

Our previously presented results [5] were supplemented by a method addressing high LIC [2]. This is of special interest for evaluating initial therapy success in highly transfused patients. However, due to the short echo time of 1.8 ms in the protocol proposed for this method, it is sensitive to liver steatosis which is a known comorbidity in patients with elevated LIC. This may be a reason for the low correlation observed for values determined with the corresponding GRE protocol vs. the SE method.

The SE method requires a long measurement time of 16 minutes as well as external referencing whereas GRE can be done in a few breathhold acquisitions with paraspinal muscles as internal reference and therefore is more easily accessible in every days routine.

It can be stated that both methods are suitable for a rough estimation of LIC and to differentiate between mild (up to 90 µmol/g) on the one hand and moderate or severe liver iron overload on the other for most of our patients which is of interest for disease management. Initial therapy success can be satisfactory monitored with the appropriate protocol. In general, GRE tends to overestimate LIC.

References. 1. Y. Gandon et al.: Non-invasive assessment of hepatic iron stores by MRI. Lancet 2004; 363: 357–62
2. C. Rose et al.: Liver iron content assessment by ... magnetic resonance imaging procedure in highly transfused patients. Eur J Haematol 2006: 77: 145–149
3. T. G. St. Pierre et al.: Noninvasive measurement and imaging of liver iron concentrations using proton magnetic resonance. Blood 2005; 105 (2): 855-61
4. Ghugre et al.: Mechanisms of Tissue–Iron Relaxivity: Nuclear Magnetic Resonance Studies of Human Liver Biopsy Specimens. MRM 2005; 54: 1185-93
5. A. Wunderlich et al.: Estimation of Liver Iron Content with Spin-Echo vs. Gradient-Echo Sequences. Proc. 16th ISMRM (2009),