Liver Iron Content Determination using GRE and Signal Intensity Ratio Analysis in MR Systems from Different Vendors

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Target Audience. Clinicians and scientists interested in MRI based Liver Iron Content (LIC) determination.

Purpose. To compare Signal Intensity Ratio (SIR) and resulting LIC values between scanners from different vendors.

Methods. A total of 18 patients (4f, 14m, age range 10 … 33 y, mean 19.9 ± 6 y) suspected for liver iron overload were scanned the same day at two different scanners, A: Siemens Avanto (Siemens Healthcare, Iselin, NY), B: Philips Achieva (Philips Healthcare, Best, The Netherlands), both 1.5 T. Transversal slices of the liver were acquired using whole-body resonator as receiver coil with breathhold gradient echo sequences at TE/TR 1.8/48 ms, FA 60° ('Rose' protocol, cf. 1). Additional scans with TR 120 ms, first in-phase TE and FA of 20° and 90° were acquired. 16 patients were scanned with RF spoiling, 13 without, i.e. 11 patients were scanned both with and without RF spoiling. SIR was measured in two slices by manually drawing three ROIs in vessel-free liver tissue, preferably the right liver lobe, and two in the paraspinal muscles. LIC was calculated according to (2). SIR and LIC values of both scanners were compared to each other by statistical methods including linear correlation and correlation based on power function.

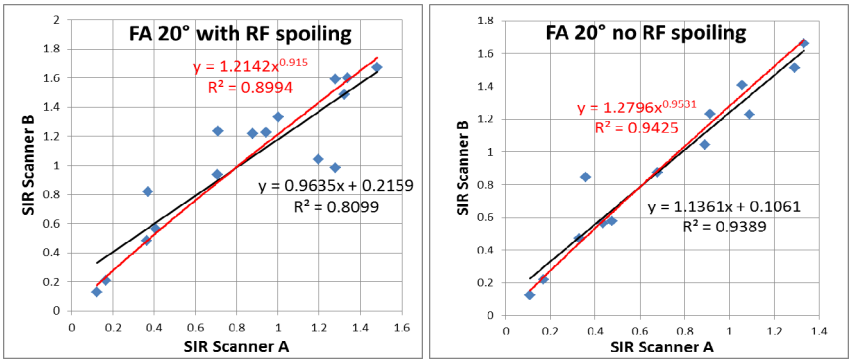

Fig. 1. SIR compared between scanners with (left) and without RF spoiling. Black lines indicate linear regression, red curves show power functions.

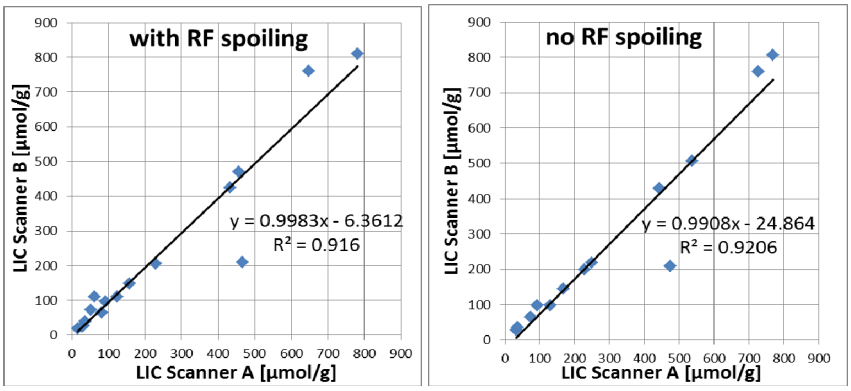

Fig. 2. LIC values compared between scanners, with (left) and w/o RF spoiler. Black lines show linear regression.

Results. Linear correlation of SIR (Tab. 1, Fig. 1) is good, indicated by large R^2, despite the non-zero abscissa values indicate mismatch between values obtained from different scanners.

FA	20°	90°	20°	90°
RF sp.	+	+	-	-
R^2	0.810	0.821	0.939	0.884
slope	0.963	0.801	1.136	0.916
absc.	0.216	0.262	0.106	0.189

Tab. 1. Linear correlation between scanners.

Fit of power function leads to increased R^2 values (Fig. 1), indicating a slight nonlinear correlation between SIR of both scanners.
LIC values show good match between scanners, (Fig. 2), with best match in case with RF spoiling.

Discussion. SIR has been proposed previously for LIC determination (1,3). It has been proven useful even for high liver iron overload at 1.5 and 3 T (4). Use of whole-body resonator is mandatory since signal acquired with surface coils lacks homogeneity. Reasons for deviations are not only due to receiver coil but also to the fact that both scanners operate at different resonance frequency leading to slightly lower first in-phase TE for scanner B (4.6 ms) compared to scanner A (4.76 ms). This explains larger SIR for scanner B since liver signal due to T2* decay is larger in scanner B than in scanner A, whereas muscle signal is less affected due to its longer T2*.

Since the logarithm of SIR correlates to LIC (4), power functions were studied as they give R^2 for correlation of logarithm of values. LIC determination as described in (2) yields results in good agreement between both MRI scanners since LIC is calculated from SIR for both 20° and 90° compensating for the apparent differences in SIR. If LIC exceeds 300 µmol/g, the method of Rose (1) is used. Even though RF spoiling is performed differently on both systems, superior agreement with RF spoiling is achieved.

Conclusion. Our results indicate that SIR values show certain deviations between scanners. Resulting LIC values, however, are in good agreement on both systems over the whole range from normal to severe iron overload, especially when working with RF spoiling (Siemens: flash variant, Philips: no T1 enhancement).

References. 1. C. Rose et al.: Liver iron content assessment by routine and simple MRI procedure in highly transfused patients. Eur J Haematol 2006: 77: 145-149
2. A. Wunderlich et al.: Estimation of Liver Iron Content with different MRI methods. Proc. 17th ISMRM (2010), 4657
3. Y. Gandon et al.: Non-invasive assessment of hepatic iron stores by MRI. Lancet 2004; 363: 357–62
4. A. Wunderlich et al.: SIR between Liver and Muscle Reference in Highly Iron Overloaded Patients: comparing 1.5 T to 3 T. Proc. 22th ISMRM (2014), 3597