Influence of a connected and inactive coil on a MR exam: liver iron load measurement

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Introduction

MR clinical studies are increasingly involving quality assurance, which requires having a good knowledge of in use hardware and the influence of possible connected but inactive coils. In the liver iron load measurement method introduced by Gandon et al. [1], the use of the body coil is recommended for yielding images with homogeneous signal. Hepatic iron concentration (HIC) is correlated with liver to (paraspinal) muscle signal intensity ratio [1]. Usually, this examination is subsequent to a standard liver imaging protocol involving a torso coil which remains plugged while liver iron assessment goes on with the body coil. The connected but inactive torso coil may induce signal intensity nonuniformity, reflecting on liver iron measurement. This preliminary work aims at understanding the effects of a plugged torso coil on liver and muscle signal intensity and possible changes in image quality.

Materials and Methods

Measurements were performed on four healthy volunteers (N=4). Images were acquired on a 1.5T MR unit (SIGNA HDxt, GE Healthcare, Waukesha WI) with body coil while an inactive torso coil is plugged and then with body coil only. A T2* weighted gradient echo sequence (TR/TE/FA = 120ms/21ms/20°) was used for signal-based study, as it is known to be sensitive in case of slight iron overload [1]. Another T2* protocol with a single breath hold multi-echo gradient echo sequence (TR=200ms, FA=20°, 16 echoes: TE=1.2ms to 26.9ms) was performed for measuring HIC (in milligrams of iron per grams of dry liver) according to Wood et al. (R2* method) [2].
ROI-based post-processing was achieved by a senior MR technologist using the GE Functool 4.5.3. Liver to muscle signal intensity ratio (L/M), liver to muscle contrast (Contrast), contrast-to-noise ratio (CNR) and liver ROI noise (ratio of pixel standard deviation to pixel mean, in percent) were measured. Outcomes are presented as mean value ± standard deviation. As values cannot be assumed to be normally distributed, Wilcoxon signed-rank test was carried out with a p-value < 0.05 as significant difference criterion. Minimum sample size (MSS) was also computed.

Results

Fig.1 shows anatomic images with ROIs chosen for the signal-based analysis (A) and for R2* measurement (B). For both methods, ROIs were drawn on the external part of the right hepatic lobe. Signal based HIC calculated on the dedicated website [1] seemed to be inaccurate for our investigated subjects: 5µmol/g ±20µmol/g. R2* method based HIC outcomes (TAB.1) were different for both modes, but Wilcoxon test did not show any statistical difference (p-value=0.857). Computed minimum sample size was also greater than the effective number of subjects (MSS_{HIC}=22). Box plot of image quality parameters (Fig.2) points out a downward trend when only the body coil is used. Corresponding values are recorded in TAB.2. Wilcoxon test confirmed statistical difference for liver to muscle signal intensity ratio and contrast (p-values: L/M=0.028, Contrast=0.029). No statistical difference was obtained for CNR and Noise (p-values: CNR=0.685, Noise=0.3429). Computed minimum sample size suggested a statistical significance for L/M and Contrast results ($MSS_{L/M}$/$MSS_{Contrast}$=6~N). CNR and Noise outcomes were not found to be significant (MSS_{CNR}=35, MSS_{noise}=25).

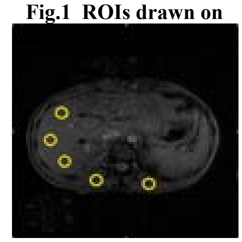
	Body with torso	Body only
Subject 1	1.29	1.15
Subject 2	1.28	1.19
Subject 3	1.43	1.53
Subject 4	1.21	1.41

TAB.1: Subjects HIC in mg/g

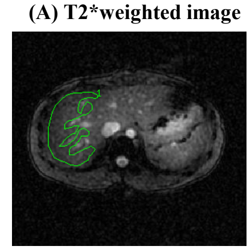
	Body with torso	Body only
L/M	1.59±0.07	1.41±0.06
Contrast	0.11±0.01	0.08±0.01
CNR	2.65±0.39	2.38±0.37
Noise	8.38±0.39	7.61±1.12

TAB.2: Pixel-wise image analysis

Fig.1 ROIs drawn on



(A) T2*weighted image



(B) multi-echo images

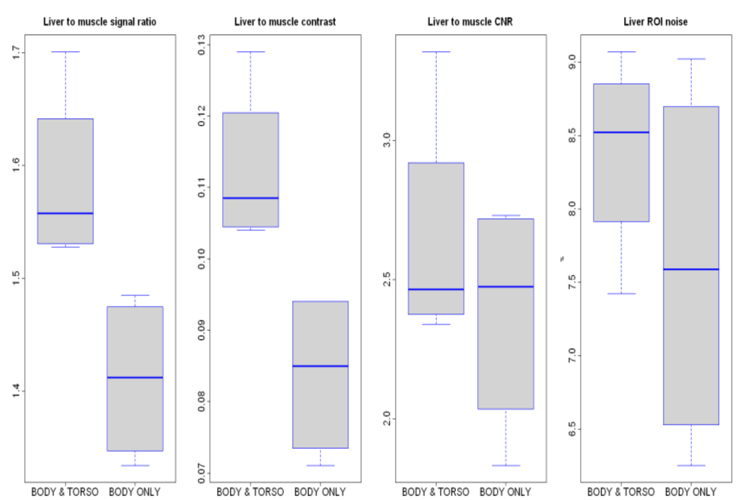


Fig.2: Four subjects ROIs analysis outcomes

Discussion

Liver to muscle signal intensity ratio and contrast results are in accordance with the initial assumption of a torso coil induced inhomogeneity. A more significant result may be expected for CNR and noise measurement as the same downward trend was noticed. Besides CNR and noise measurement were based on liver ROIs. Taking background ROI into account for CNR and noise could have shown more significant difference. Future works involve verification of that hypothesis.
R2* method is known to be more transferable from a scanner to another than signal method [3]. That suggests a major hardware influence on the signal-based method. In accordance with that, our results show that torso coil induces a greater variability on liver to muscle signal intensity ratio than on R2* values.

Conclusion

This preliminary study points out modifications in image quality probably caused by the plugged and inactive torso coil. Further investigation involving more subjects (20 at least) will be required for accurately assessing these modifications and confirm these promising results. Detecting such effects on a larger investigated population would imply a real impact of torso coil on quantitative MR examination. Liver iron assessment and therefore diagnosis should take its effect into account.

References

[1] Gandon et al. The Lancet 2004; [2] Wood et al. Blood 2005; [3] Virtanen et al. MRI 2008;