Improved Method for Liver Iron Imaging Using MR Susceptibility Weighted Imaging (SWI)

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NTRODUCTION: Iron overload occurs when the body absorbs an abundance of iron which builds up in organs such as the liver. It is commonly associated with hemochromatosis or blood transfusion dependent patients. An accurate assessment of tissue iron levels is clinically important. Liver iron concentration can be used as an index for total body iron measurement. MRI is sensitive to tissue iron overload in liver and has been considered a promising technique for non-invasive liver iron quantification. T2 or T2* can be used to estimate the amount of iron [1, 2, 3] but require very good singal-to-noise (SNR) . Recently, susceptibility weighted imaging (SWI) has been used to quantify local iron content and appears to be a factor of 8 times more sensitive than T2 or T2* techniques [4]. The purpose of our study was to evaluate the use of SWI phase imaging in quantifying iron.

METHODS: Four patients with iron overload and 6 normal subjects were evaluated with a multi-echo SWI sequence. MR studies were carried out on a 1.5 T Siemens Sonata system using a standard body coil. The MR protocol includes a breath-holding 2D multi-echo gradient sequence with flow compensation in the readout direction. The acquisition parameters were as follows: FA= 20°, TR=65ms, TE=10/20/30/40 ms. Both magnitude and phase images were saved for further post-processing and analysis. T2* fitting was applied to the multi-echo magnitude images and high phase filtering was applied to the phase images. The phase profile of the hepatic vessel was measured and the maximum phase difference between the vessel and surrounding liver parenchyma taken as a measurement index for iron content.

RESULTS: On normal subjects (Fig 1 c, d), little phase shifts existed between the hepatic vessels and surrounding liver tissue at TE of 10 ms. However, significant phase shifts were observed between the hepatic vessels and surrounding liver tissue was observed for the iron overloaded patient (Fig 1 a, b). These phase shifts between the hepatic vessel and surrounding liver parenchyma were observed among the heavy iron overloaded patients. In these cases, the signal in the magnitude was so low that it was not possible to estimate the T2* of liver.

DISCUSSION AND CONCLUSION: SWI filtered phase images offer the potential to better estimate iron overload in the heavily iron overloaded situation. This can be advantageous when the signal is so reduced that the conventional T2 or T2* approach fails. Further systematic studies need to be conducted to evaluate the correlation of liver iron (biopsy iron measurement) with the phase difference between the vessel and liver parenchyma.

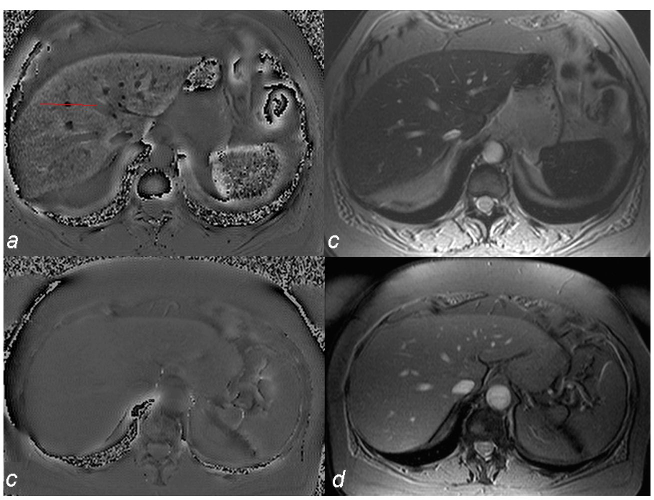

Fig 1: SWI phase (a), magnitude (b) for a heavily iron loaded patient. There is very low signal in the magnitude image in the liver due to short T2*. However, there was a large phase difference between the veins in the liver and the surrounding parenchyma. (c, d) are phase and magnitude images for a normal liver. Both data were with TE=10ms.

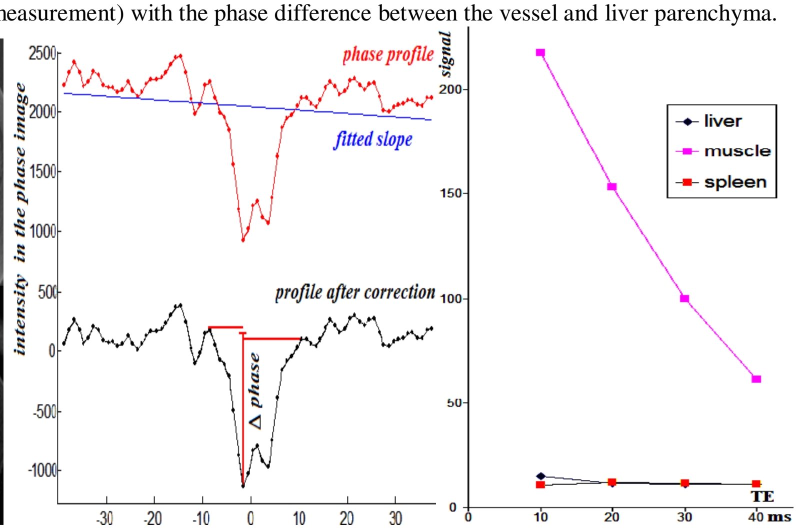

Fig 2: Phase profile across a hepatic vessel in figure 1 (a). Correction was applied to remove the phase slope. The phase difference between the vessel and the surrounding parenchyma was estimated to be about 103.6°. The right is the signal curve vs TE for liver, muscle and spleen for the same patient. T2* of muscle was about 23.8 ms, however, the data from the liver are too noisy to find T2*.

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