

Investigating Iron Deposition in Hepatic Diseases Using Susceptibility Weighted Imaging - Initial Experiment

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Purpose: As liver is the central organ of digestive and reticuloendothelial function, it will be heavily involved in the deposition and distribution of iron. Some diseases such as hemochromatosis, siderosis, hepatitis, aplastic anemia, hemolytic anemia, thalassemia and cirrhosis will involve hepatic iron deposition at different levels. Up to now, T2, T2* and even signal intensity (SI) change in liver are the most common methods used for iron deposition research. An alternate approach would be to use the high-pass filtered phase images developed for susceptibility weighted imaging (SWI) to study iron deposition. In this study, we extend the use of SWI for measuring iron content at 3T from the brain to the liver.

Methods: Six patients (4 females, 2 males, from 21~82 years, with diseases including aplastic anemia, hepatitis, hemolytic anemia, thalassanemia and cirrhosis(2)) and six age matched healthy volunteers underwent clinical measurement on a whole body 3T scanner (Siemens, MAGNETOM Verio) equipped with a 12-channel body matrix coil. T1, T2 weighted and SWI images were taken in axial or coronal directions for liver coverage. The imaging parameters for the SWI scans were: 2D gradient echo sequence, FOV 380*285mm, TE/TR = 2.5/135 ms, FA = 20°, parallel imaging (iPAT = 2), several times of breath-hold, 30 slices per measurement, acquisition time is less than 1 minute. An ROI of whole livers is drawn on the SWI filtered phase images by two radiologists independently with software SPIN (Signal Processing in NMR, MRI Institute of Biomedical Research, Detroit). The mean of liver phase values that lie below two standard deviations away from zero phase was taken as an iron content indicator (since iron is paramagnetic and causes a negative phase shift for a right handed system). The mean phase value of livers for patients, volunteers and patients' serum ferritin level from clinical examination were compared.

Results: The mean phase values of all six patients and their serum ferritin levels appear to have a linear correlation (Fig. 1). There is a major difference in mean phase values between patients and volunteers (Fig. 2). Moreover, signal intensity change in liver due to high iron deposition and iron distribution in liver could be seen on both SWI images and SWI high pass filtered phase images clearly (Fig. 3). Note that the vessels now appear bright relative to the liver parenchyma in the phase image because the iron causes such a large negative shift. Since the vessels are at different angles to the main field they have a varied phase response but all lie above that of the liver iron phase.

Conclusions: To our knowledge, this is the first SWI study of human liver for iron deposition and distribution. From these results, one can see that SWI high pass filtered phase images provide a new opportunity to develop a non-invasive and sensitive method for hepatic iron research and its potential for iron level grading. A comparison to T2 and T2* mapping techniques, which are commonly used in clinical routine in this patient group will be performed as the next step.

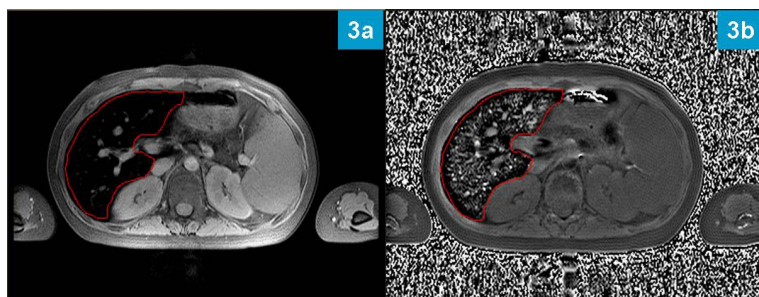


Fig. 3 a) SWI image for high iron overloaded liver of one patient; b) Corresponding SWI phase image of the same patient. The region inside the liver that lies below two standard deviations below zero phase are used in the estimate of iron induced phase shift.

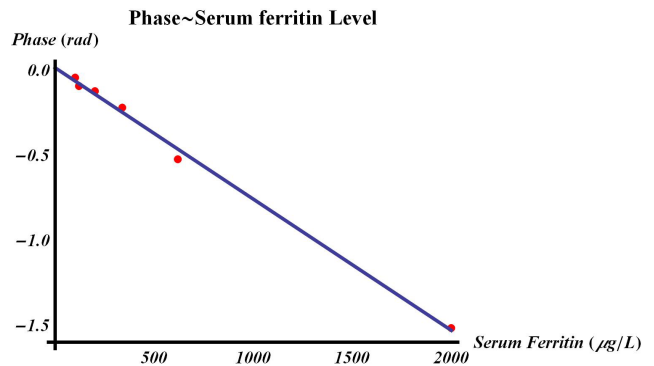


Fig.1 Mean phase values of liver of patients correspond to their serum ferritin level.

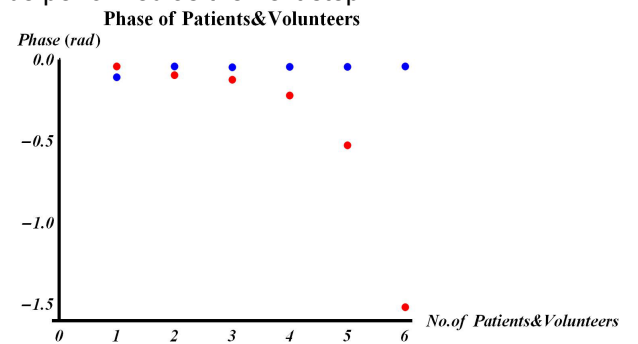


Fig. 2 Mean phase values of liver of both patients and age matched volunteers. Blue points represent volunteers and red ones represent patients.

References: 1) E.M. Haacke, et al, JMRI, 26: 256-264, 2007. 2) Paul C. Adams, Hepatology, 11: 805-808, 1990