Dependency of the venous phase shift upon positioning angle in Susceptibility Weighted Imaging

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Purpose: Susceptibility Weighted Imaging (SWI) emphasizes difference in local magnetic susceptibility by using phase information of the pixel. It has been used to obtain high-resolution venography, which utilizes phase shift due to deoxyhemoglobin in the veins. Quantitative estimates of local oxygen consumption or blood flow are also possible by using phase information, however, the phase change of the vein is affected not only by the amount of deoxyhemoglobin, but also by the angle between the vein and static magnetic field. The purpose of this study is to analyze the phase change of the vein induced by the change of head positioning angle.

Material and Methods: SWI of a normal volunteer was obtained on a 1.5-T MR scanner (MAGNETOM Avanto, Siemens). SWI was performed (i) with normal head positioning angle for four times (A1 to A4), and (ii) with extension of the head by 5, 10, 15, 20 and 25 degrees (B to F, respectively). Although positioning angles (A1 to A4) were different from extension positioning (B to F), the imaging angle of the SWI was set parallel to AC-PC line. The phase values of approximately 30 veins were analyzed by using profile curve method, in which $\Delta\phi$ was calculated as peak phase value minus background phase value. The average value of $\Delta\phi$ in each scan was compared. The relationship between $\Delta\phi$ change ratio to positioning angle and venous angle to static magnetic field was also analyzed.

Results and discussion: There were no statistically significant differences of the average $\Delta\phi$ with normal head positioning (A1 to A4). However, the average $\Delta\phi$ values with all head extension scans (B to F) were significantly different from A1 (Fig 1). In the analysis of venous angle, the vein which runs along A-P direction in axial image plane have been severely affected by extension positioning angle, while the vein which runs in R-L direction have not been affected (Fig 2). There was a good correlation between venous angle and change in $\Delta\phi$ ratio (Fig 3) (correlation coefficient was 0.818, if the veins near the cranial bone or the other veins, and curved veins were excluded).

Conclusion: The phase values of the vein are affected by the head positioning angle. Our results suggest that it is important to setup head position in the same angle when quantitative analysis of the phase is conducted in SWI.

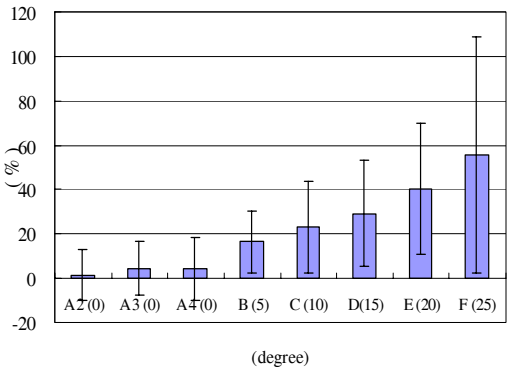

Fig 1. Average $\Delta\phi$ of each scan. Positioning angles are shown in parentheses.

References: (1) E. Mark Haacke, et al. Susceptibility Weighted Imaging. Magnetic Resonance in Medicine 52:612-618(2004)

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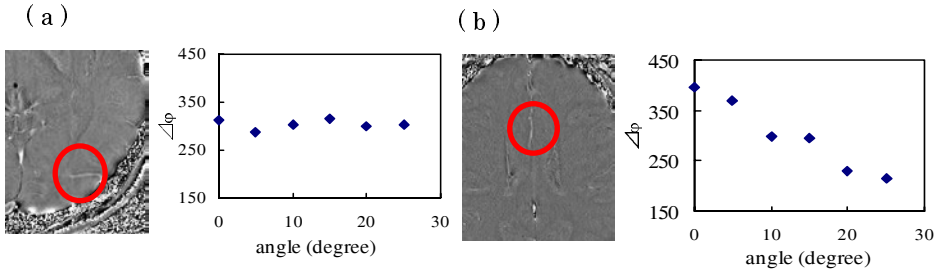

Fig 2. Relationship between $\Delta\phi$ and head positioning angle. $\Delta\phi$ is constant in the vein which runs in R-L direction in axial section (a), while the vein which runs in A-P direction in axial section has a linear relationship between $\Delta\phi$ and head angle.

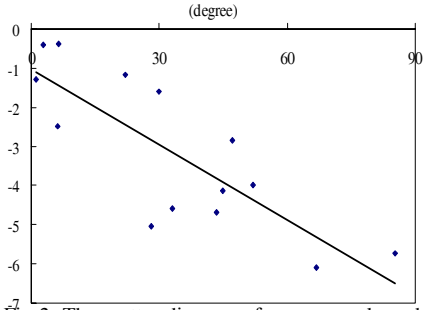

Fig 3. The scatter diagram of venous angle and $\Delta\phi$ change ratio. With the increase of venous angle, the change of $\Delta\phi$ increases.