Positive Contrast Susceptibility Weighted Imaging of Physiologic Calcification in Humans

J. A. Butman[1], W. Liu[2], T. Schaeffter[3]

[1]Diagnostic Radiology Department, Clinical Center, National Institutes of Health, Bethesda, MD, United States, [2]Philips Research North America, Briarcliff Manor, NY, United States, [3]Philips Research Germany, Hamburg, Germany

Introduction

Susceptibility weighted imaging (SWI) using gradient echo T2* sequences can be used to identify intracranial hemorrhage and calcification. MRI employing SWI has recently been shown to comparable to CT for the detection of acute intracranial hemorrhage in the setting of acute stroke [1]. However, in this study, the variability among the four expert readers was higher for MRI than for CT, presumably because they found interpretation of CT to be easier than interpretation of SWI. Because hemorrhage and calcification both cause signal loss on SWI, conspicuity of lesions may be limited. Positive contrast mechanisms have been proposed to improve contrast and specificity in SWI. In [2], the positive contrast was achieved by dephasing the background signal with a slice gradient, while the signal is conserved in the presence of calcium deposition. In this study, we investigate the use of gradient rephasing positive contrast technique to detect susceptibility induced signal loss arising from physiologic calcium deposition in the normal human brain.

Methods

We studied 13 healthy volunteers (n=13) under an IRB approved protocol on a 3.0 T Intera scanner (Philips Medical System, Best, Netherlands). After obtaining localization scans, the normal brain structure was confirmed by a FLAIR sequence. T2* weighted images were acquired with the following parameters: TR/TE = 993ms/21ms; Flip angle = 25°; FOV = 230mm ×230 mm; data matrix = 256 ×256; slice thickness = 4.0 mm. Positive contrast was generated by modifying the gradient-echo sequence so that the slice refocusing gradient could be varied from 0-100% (full refocusing). A series of positive contrast images were acquired with different scale factors to generate the best positive contrast with the same imaging parameters as the T2* weighted images.

Results

Out of the 13 normal volunteers, calcium deposition was detected in 9 using both the T2* weighed gradient-echo sequence and the positive contrast technique. On positive contrast images, all of the calcium depositions in these 9 volunteers were bright relative to the adjacent brain. However, the optimal refocusing gradient was different in each case. Figure 1 shows SWI using standard T2* weighted and positive contrast images from two volunteers. Calcium deposition appeared as a focal dark spot on T2* weighted gradient-echo images (Figure 1, *A, C*). It is clear that better contrast was achieved using positive contrast technique (Figure 1, *B, D*) and the CNR is illustrated in Table 1. The top image was acquired with 35% refocusing gradient. The lower image was acquired with 25% refocusing gradient. Both positive contrast images show high signal in CSF spaces and in some vessels.

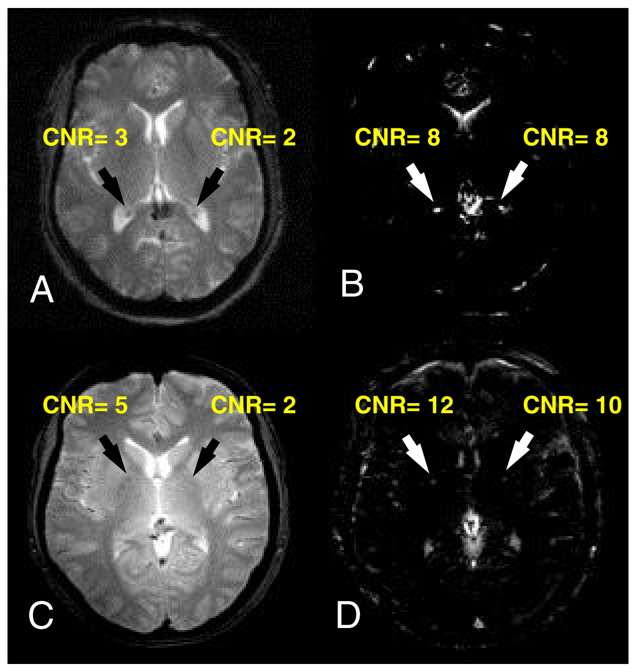

Figure 1. GRE T2* SWI *(A,C)* and positive contrast SWI *(B,D)* in two different volunteers. Calcification of the choroid plexus is identified *(A,B)* in the first volunteer. Mineralization in the basal ganglia *(C,D)* is identified in the second.

Discussion

We implemented a gradient rephasing positive contrast method for the detection of calcium deposition in human brain. In this in vivo study, we have demonstrated that the gradient rephasing technique could provide adequate positive contrast for the detection of calcium deposition. In the current implementation, high signal was also observed in vessels and in CSF. To improve the conspicuity of calcifications, hemorrhage, or other susceptibility inducing lesions, methods of vascular and CSF suppression need to be incorporated into the positive contrast sequence.

Reference:

1. Kidwell et al. JAMA. 2004 Oct 20;292(15):1823-30.
2. Seppenwoodle J et al., MRM 50:784-790, 2003