Susceptibility weighted imaging of brain masses

Z. Delproposto[1], V. Sehgal[1], M. E. Haacke[1], D. Haddar[2], A. E. Sloan[3], L. J. Zamorano[3], W. J. Kupsky[4], Y. Xu[2], K. Prabhakaran[5], I. R. Elangovan[5], J. R. Reichenbach[6], K. Tong[7]

[1]Radiology, Wayne State University, Detroit, MI, United States, [2]MRI Institute for Biomedical Research, Detroit, MI, United States, [3]Neurological Surgery, Wayne State University, Detroit, MI, United States, [4]Pathology, Wayne State University, Detroit, MI, United States, [5]Biomedical Engineering, Wayne State University, Detroit, MI, United States, [6]Diagnostic and Interventional Radiology, Friedrich-Schiller University, Jena, Jena, Germany, [7]Radiology, Loma Linda University, Loma Linda, California, United States

Introduction: The goal of this paper was to evaluate the diagnostic value of SWI in the study of brain masses. Part of the characterization of tumors lies in understanding the angiographic behavior of lesions both from the perspective of angiogenesis and micro-hemorrhages. Aggressive tumors tend to have rapidly growing vasculature and many microhemorrhages. Hence, our ability to detect these changes in the tumor or the presence of these behaviors could lead to a better characterization of the tumor status.

Materials and Methods: A series of 44 patients with brain masses were imaged using conventional imaging techniques such as spin echo imaging, turbo spin echo imaging, FLAIR, diffusion and finally SWI. The SWI scans were run with the following parameters: 3D velocity compensated sequence, TR = 65ms, TE = 40ms, flip angle = 20^{o}, 64 mm thick slab, 32 partitions, 2 mm thick slices, and a scan time of roughly 8 minutes. Post-processing was applied using both magnitude and phase images to increase the conspicuity of the veins and other sources of susceptibility effects. Out of the 44 cases, we obtained pathology and surgical reports for 17 cases. The SWI sequence was obtained pre-contrast in 3 cases, post-contrast in 27 cases, pre and post-contrast in 14 cases. 36 cases had T1 comparisons both pre and post contrast. Seventeen cases were post-surgery. Conventional sequences and SWI were compared concerning the: tumor detection, boundaries, venous vasculature, blood products, internal architecture, edema and image quality.

Results : SWI provided new and complementary information in many cases, particularly in tumor detection and delineation. SWI was a more sensitive technique for hemorrhage detection, venous blood identification and venous abnormalities and possibly in the detection of necrotic tissue. Late enhancement SWI appeared to be a unique identifier of necrotic tissue, information usually not obtained in conventional scanning. SWI showed a useful FLAIR-like contrast and added complimentary information to conventional T1 post-contrast sequences for evaluating the internal architecture of lesions. The injection of contrast agent improved the results of SWI in tumor detection, veins and boundary visualization. Good pathologic correlations were found for blood products and in some cases for identifying venous vasculature.

Discussion : SWI not only maximizes the sensitivity to susceptibility effects by using a long TE, high resolution 3D gradient echo scan, but also uses filtered phase information in each voxel as a means to both enhance the contrast in the magnitude image and as a source of information itself (1). These characteristics permit SWI to have exquisite sensitivity to the venous vasculature and blood products. Our series showed that SWI was better than any other sequence for the detection of hemorrhage and the venous vasculature with some promising pathological correlations. SWI also had the unique property of a FLAIR like contrast for suppressing CSF and yet enhancing edema relative to normal tissue and added complementary information to the conventional sequences for interpretation of the internal architecture of the lesions. Still SWI does suffer some artifacts near air tissue boundaries even though the phase image is filtered prior to creating the phase mask. This may be removed with special double echo acquisitions but this was not done here. Also the coverage was only 64 mm and ideally this should be twice as large in the same time interval. At 3T it becomes possible in the same time to double the current coverage from 64 mm to 128 mm with an increase by a factor of 2 in SNR (3). In conclusion, SWI should prove useful for tumor characterization because of its ability to better highlight blood products and the venous vasculature.

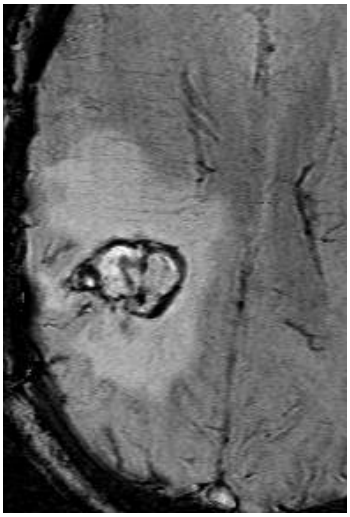

Figure 1a

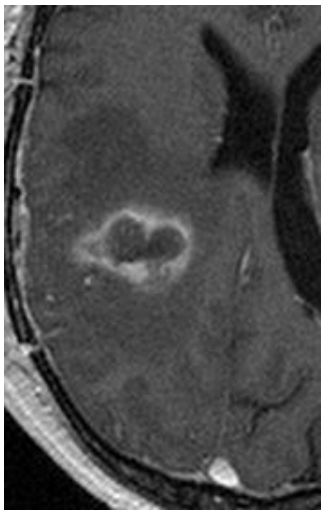

Figure 1b

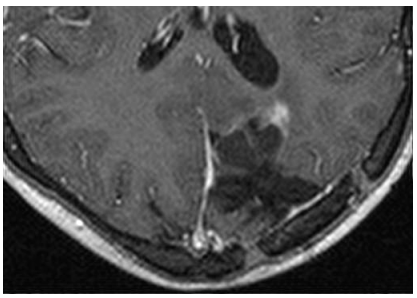

Figure 2a

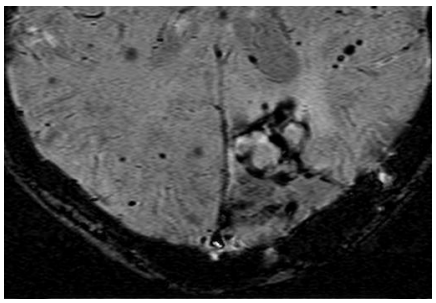

Figure 2b

Fig. 1. Glioblastoma Multiforme. SWI CE (a) and T1 CE (b).
Fig 2. Recurrent Anapalastic astrocytoma. T1 CE (a) and SWI CE (b). Both do not display the same pattern of the internal architecture.

References:
1. J.R. Reichenbach et al, *Radiology* 204: 272-277, 1997. 2. K. Tong et al, *Radiology* 227 :332-339, 2003. 3. M. Barth et al, *Invest Radiol*, 38(7):409-414, July 2003.