

Differentiating Calcification and Hemorrhage in Brain Tumors: Susceptibility Weighted MR Imaging with Tissue Validation

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Purpose

MR based susceptibility-weighted imaging (SWI) can sensitively detect blood products (hemosiderin, ferritin), deoxygenated blood, calcium, iron, and small veins as well as calcification [1, 2]. However, their differentiation based on SW images alone is challenging or even impossible. This study aims to assess the value of SW phase imaging for the detection and differentiation of calcification and hemorrhage in brain tumors based on visual as well as histogram analysis, and to validate the data by histopathological examination.

Materials and Methods

Oligodendroglioma WHO grade II and III (OD, n = 5) and glioblastoma WHO grade IV (GBM, n = 8) patients were studied. All patients underwent CT and 1.5T MR imaging. Positivity for calcification on CT and phase images was visually evaluated. From MR phase images pixel values were measured with region-of-interest (ROI) analysis in tumors and contralateral normal brain parenchyma. Tumor tissue was stained histochemically (HC) for hemosiderin and calcification.

Results

HC yielded calcification in all OD but not in GBM. 4/8 GBM stained positive for hemosiderin. Analysis of phase images confirmed the calcification and hemorrhage for every patient with higher sensitivity than CT (Fig. 1). The average phase image pixel value for calcification was negative (-150.0 ± 58.3) and was hypointense on the phase image (Fig. 2A). For hemorrhage, the phase image pixel value was positive (206.8 ± 57.9) and was hyperintense on the phase image (Fig. 2C). In normal brain parenchyma an average PS value of 3.0 ± 0.8 was measured (Fig. 2B).

Conclusions

Phase image analysis is a promising method to differentiate calcification from blood products. This has implications for the differential diagnosis of space occupying lesions as well as for the investigation of the natural course and treatment effects in gliomas.

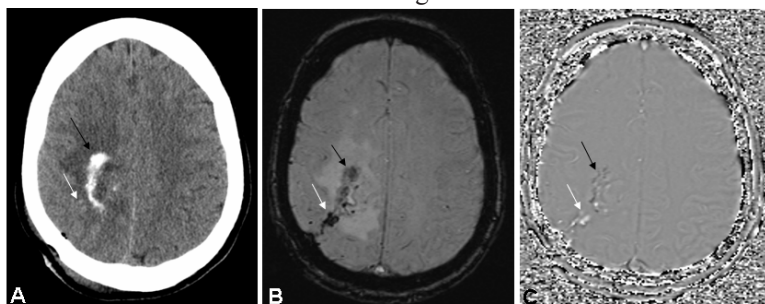


Figure 1. Calcified OD after biopsy. Hyperdensity shown on CT (A). SWI (B) and phase (C) image revealing the intra-tumoral hemorrhage along the biopsy track (white arrow) as well as the calcified tumor (black arrow).

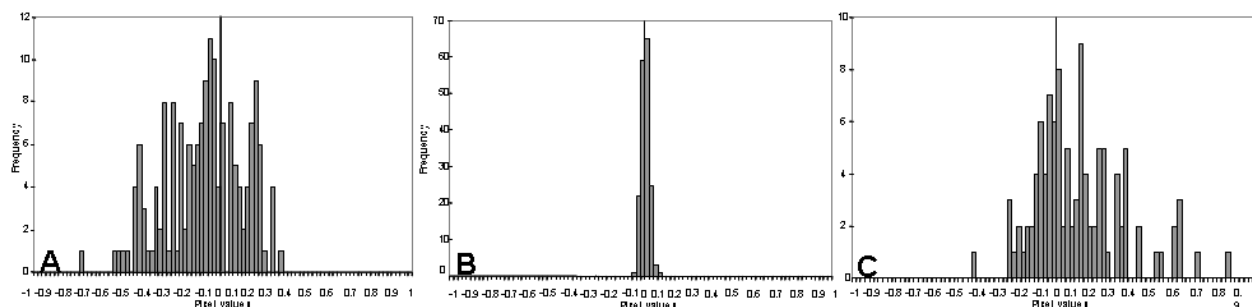


Figure 2. Oligodendroglioma. Histograms of normalized phase image pixel values on (A) calcified tumor, (B) normal brain parenchyma or (C) tumor hemorrhage.

[1] Haacke EM *et al.* Magn Reson Med 2004;52:612–18.

[2] Haacke EM *et al.* Magn Reson Imaging 2005;23:1–25.