Detection of Radiation Therapy Induced Cerebral Microbleeds in Gliomas: Does High Field Mean High Yield?

Wei Bian1,2, Christopher Hess1, Susan Chang1, Sarah Nelson1,2, and Janine Lupo1
1Radiology and Biomedical Imaging, University of California San Francisco, San Francisco, CA, United States, 2Joint Graduate Program in Bioengineering, University of California San Francisco & Berkeley, San Francisco, CA, United States, 3Neurological Surgery, University of California San Francisco

Introduction: Although radiation therapy is a mainstay in the treatment of patients with gliomas, it is estimated that approximately 60% of tissue within the high dose treatment field is normal brain tissue. Over time, this results in the formation of cerebral microbleeds (CMBs), focal perivascular collections of hemosiderin deposits, in normal brain tissue that persist for years after receiving radiation therapy. At lower fields strengths, it has been shown that the detection of CMBs is enhanced with Susceptibility-weighted imaging (SWI) compared to T2*-weighted magnitude images, but there has been recent debate as to whether SWI is necessary at 7T where there is already heightened susceptibility in magnitude images. In addition, although studies have shown improved sensitivity to microbleeds on magnitude images at 3T and 7T compared to 1.5 T, it is not clear how much sensitivity is gained with 7T over 3T for CMB detection. The goal of this study, therefore, was to compare CMB detection between 3T and 7T field strengths and magnitude and SWI reconstructions in glioma patients with radiation-induced microbleeds.

Methods and Subjects: Ten patients with gliomas who had received radiation therapy between 2 and 15 years prior to the date of imaging, were scanned at both 3T and 7T GE scanners on the same day. High resolution T2*-weighted imaging using a 3D flow compensated SPGR sequence was performed at both field strengths with an 8-channel phased array receive coil. The TE/TR was 28/56ms at 3T and 16/50ms at 7T. A GRAPPA-based parallel imaging acquisition was implemented with either a 2-fold (3T) or 3-fold (7T) acceleration factor to keep total acquisition time within 6 minutes. Other parameters were the same for both scanners with flip angle 20°, 24cm FOV, and an in-plane resolution of 0.5 x 0.5mm, and 2mm slice thickness. The imaged volumes were carefully prescribed to ensure that the same coverage was obtained for both 3T and 7T scans. Standard SWI post-processing was performed on the reconstructed k-space data for each coil, and then combined and intensity corrected. Minimum intensity projection images through 8 mm-thick slabs were generated from both magnitude and SWI images and used for microbleeds identification. Microbleeds were identified as small hypointense foci that did not correspond to vessels on consecutive slices, and counted in normal-appearing tissue outside the tumor region. A Wilcoxon signed rank test was performed to test whether there was a significant difference in CMB detection between groups.

Conclusions: Although the sensitivity of CMB identification increases with field strength, the heightened susceptibility artifacts present at higher field strengths can limit their detection. In order to achieve the highest detection rate of CMBs for these patients, tumor location should be considered in conjunction with field strength. Even with the heightened sensitivity obtained at 7T, SWI is still beneficial in identifying microbleeds over conventional magnitude T2*-weighted GRE imaging.


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