

PRELIMINARY EXPERIENCE WITH VISUALIZATION OF SUSCEPTIBILITY SIGNALS TO DIFFERENTIATE RECURRENT TUMOR PROGRESSION OF BRAIN METASTASES AND RADIATION NECROSIS FOLLOWING GAMMA KINFE RADIOTHERAPY

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Introduction: Cerebral metastases are the second most common cerebral tumors in adults and occur in about 15%-25% of all cancer patients.

Gamma Knife is a relatively safe and effective method of localized radiation therapy for those tumors within functionally important brain regions. Accurate diagnosis of radiotherapy effect is of great significance to prevent overtreatment. Especially for those radiotherapy patients with heavy reaction, Both the diagnosis and the determination of the response to therapy have been entirely dependent on the MR imaging findings and the clinical presentations. MR T2 star weighted angiography (SWAN) is similar to SWI which is promising to be a sequence useful in the assessment of vascularity of brain tumors. It has been proved that SWI can delineate the inner structure and boundary of tumors and detect both the venous vasculature and hemorrhage within tumors. The aim of our study was to investigate the diagnostic value of susceptibility phase imaging in differentiation of tumor progression and radiation-induced effects after Gamma Knife for brain metastases.

Materials and Methods: An intraindividual follow-up study in twenty patients of solitary brain metastasis after Gamma Knife were performed. All images in the SWAN series were obtained using 16-channel phased array head coil on 3T clinical scanner (signa HDX machine, GE, Medical systems. Milwaukee, Wis, USA).the SWAN sequence parameters were: TR/TE=55.5/5.9 (ms), flip angle 20° bandwidth, 41.7 Khz, section thickness, 2mm, matrix size, 416x256. the 3D gradient echo acquisition time was 5min 38 sec with the use of ASSET factor-2. After post-processing 64 minIP slabs are generated and were performed along the Z direction. We evaluated recurrent metastasis and radiation necrosis in the following sequences: contrast enhanced T1weighted images and phase images follow up. Also CT scan was performed to exclude calcification and hemorrhage. Recurrent progression (P, n=8) or radiation necrosis (N, n=12) was confirmed from either histopathologic analysis or extensive clinical follow-up.

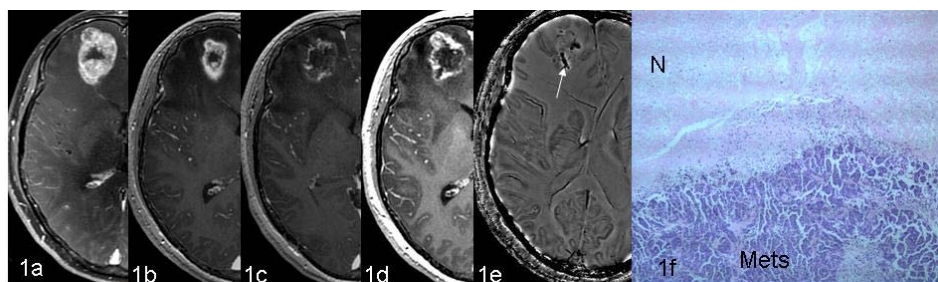


Fig1. A 47-year-old woman with a history of recurrent metastatic ovarian cancer. T1WI CE images before treatment(A), 2 months(B), 5 months(C) and 8 months(D,E) after gamma knife radiosurgery. Final phase map(E) showed increased susceptibility signal intensity(arrow) beyond the tumor margins suggesting the recurrent progression and was consist with pathologic changes. recurrent progression was around the tumor necrosis(F, HE $\times 100$. N: necrosis)

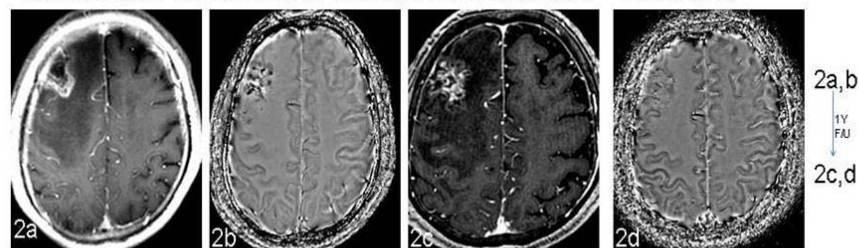


Fig 2. A 83-year-old man with a history of 20 years of lung cancer resection. Graphs illustrates frontal lobe metastasis on T1WI CE and ESWAN images of radiation necrosis. Phase map showed one month(B) and 12 months(D) after gamma knife radiosurgery. Noted at follow-up phase map radiation necrosis without susceptibility signal inside or surround the lesion. It is consist with the clinical symptoms improved.

Reference:

S. Mittal, Z. Wue, J. Neelavalli, et al. Susceptibility-Weighted Imaging: Technical Aspects and Clinical Applications, Part 2. AJNR February 200930: 232-252

Results: Increased susceptibility signal intensity inside and beyond the tumor margins showed a significant correlation with pathologic recurrent tumors. However, the areas of radiation necrosis showed iso-intensity or hyper-intensity without susceptibility signal changes in ESWAN sequences at follow-up images. Susceptibility signals at the edge of Metastasis in recurrent progression tumors were abundant, but sparse in radiation necrosis ($P < 0.01$).

Discussion: ESWAN showed a higher rate of angiogenesis of recurrent tumors than radiation necrosis. Observation of susceptibility signals reliably correlates with the increased tumor vascularity, particularly in recurrent tumors. In conclusion, the implemented techniques supply a qualitative method to permit prediction of tumor response. Abundant signals indicated tumor recurrence.