Distinguishing Brain Tumor Recurrence from Radiation injury utilizing 2D-CSI MR Spectroscopy

P. Weybright[1], P. C. Sundgren[1], M. Petrou[1], B. Nan[2], P. V. Maly[3]

[1]Radiology, University of Michigan, Ann Arbor, MI, United States, [2]School of Public Health, University of Michigan, Ann Arbor, MI, United States, [3]Radiology, University of Lund, Malmoe, Scania, Sweden

Purpose: To explore the ability of 2D-CSI MR spectroscopy in differentiating radiation injury versus tumor recurrence in patients previously treated for brain neoplasm who presents with new contrast enhancing lesion(s) at the site or vicinity of their primary tumor.

I**ntroduction**: Surgical resection and chemotherapy alone have proven to be insufficient in treatment of patients with primary and metastatic brain tumors. As a result, the various forms of radiotherapy, such as external-beam radiation, and radiosurgery have become important therapeutic adjuncts. The appearance of a new enhancing lesion after radiation treatment may represent tumor recurrence, radiation-induced demyelination, or radiation necrosis of the brain. Differentiation among these possibilities can be difficult with conventional MR imaging. Two-D MR spectroscopy has been reported to be helpful in distinguishing tumor recurrence and radiation injury using different metabolic ratios in the contrast enhancing lesion (1). Our study was designed to explore the ability of 2D-CSI spectroscopy in assessing new contrast enhancing lesions as tumor recurrence or radiation injury using the value of a given metabolite from the contralateral white matter as the denominator. In addition, we would like to obtain so called cut-off values for certain metabolic ratios that can be used alone or combined with those previous suggested that would help in the distinction between these to entities.

Methods: 2D-CSI MR Spectroscopy (PRESS, TE 144/TR 1000) was performed in 21 patients (11 male, 8 female aged 4-54, mean 33.4 years). Each patient had newly-found contrast enhancing lesions in the pons, posterior fossa, or supratentorial region at the site of a previously diagnosed and treated primary brain neoplasm. Histologic types included glioma, astrocytoma, ependymoma, and medulloblastoma. Patients were selected based on request by the referring clinician for spectroscopy to specifically evaluate for tumor recurrence versus radiation injury. Determination of tumor recurrence (11 patients) or necrosis (8 patients) was based on clinical course, subsequent imaging characteristics, and stereotactic biopsy/surgery. Within the VOI manually smaller voxels (1x1x1 cm) were placed in the contrast enhancing lesion and in normal appearing white matter on the contralateral hemisphere. Normalization was achieved by placing the contralateral white matter value for a given metabolite in the denominator, which led to the calculations of the following ratios; Cho/normal Cr(n) , Cr/Cr(n), NAA/Cr(n), Cho/Cho(n), NAA/NAA(n). In addition Cho/NAA and NAA/Cho ratios in the contrast enhancing lesion were calculated.

Results: The mean Cho/Cr(n) and Cho/Ch(n) ratios were significantly higher in patients with tumor recurrence compared to those with radiation injury (1.91 versus 1.12, p=0.002) (1.57 versus 0.99, p=0.005), respectively. The mean NAA/NAA(n) ratio was significantly lower in patients with tumor recurrence compared to those with radiation injury, 0.41 versus 0.6, p=0.07. No significant differences between the two groups were seen in the mean NAA/Cr(n) or LL/Cr(n) ratios. The mean Cho/NAA ratio was significantly higher in patients with tumor recurrence compared to those with radiation (3.92 versus 1.44, p=0.004) and the mean NAA/Cho ratio was significantly lower in patients with tumor recurrence compared to those with radiation injury (0.33 versus 0.78, p<0.0001).

Conclusion: The significant differences in the mean Cho/Cr(n), Cho/Cho(n), NAA/NAA(n), Cho/NAA and NAA/Cho ratios indicate the potential for spectroscopy to aid in differentiation of recurrent neoplasm from radiation injury in the evaluation of recurrent contrast enhancing lesions. While overlap between ratios does exist, part of the overlap may be due to histological heterogeneity and volume averaging within the voxel of normal and neoplastic tissue or of mixed neoplastic and radiation in juried tissue. Nonetheless, the significant differences in the trends of these ratios between the two groups in conjunction with conventional imaging may enable discrimination among recurrent neoplasm from radiation injury.

References:

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