Diffusion abnormality index provides potential imaging biomarker to indicate brain tumor response to radiation therapy

Orlando, Fla., February 8, 2013 – Diffusion abnormality index (DAI) shows promise as an imaging biomarker to measure brain tumor response to radiation therapy, according to research being presented at the 2013 Cancer Imaging and Radiation Therapy Symposium. This Symposium is sponsored by the American Society for Radiation Oncology (ASTRO) and the Radiological Society of North American (RSNA).

The study included 20 patients who had brain metastases and were treated with whole brain radiotherapy. The total of 45 lesions among the patients was further categorized as 16 responsive, 18 stable and 11 progressive lesions. Diffusion measurements were taken prior to radiation treatment, two weeks after the start of treatment and one month after treatment completion. For each patient, a normal tissue apparent diffusion coefficient (ADC) histogram was used to divide the tumor ADC histogram into three regions: low (high cellularity), normal and high (edema and necrosis) diffusion. Analyzing the complex behavior in ADC of brain metastases from pre-radiation therapy to two weeks after starting treatment, investigators developed a new diffusion index, the DAI, which included both low and high ADC contributions, for prediction of post-treatment tumor response.

Sensitivity and specificity of the change in DAI from pre- to the end of therapy were evaluated and compared with the changes in gross tumor volume from pre-treatment to the end of therapy. The changes were valuable in predicting non-responsive lesions post-treatment. Early prediction of brain tumor response to radiation therapy is vital in providing the most appropriate radiation doses to each lesion.
“While this review included a small number of patients, the data demonstrate that DAI may be a good biomarker to predict brain tumor response,” said lead study author Reza Farjam, a PhD candidate in biomedical engineering focused on cancer functional imaging at the University of Michigan in Ann Arbor, Mich. “Further study of this method is needed to improve early prediction of tumor response to radiation therapy and to help us provide brain cancer patients with more accurate information about their treatment progress.”

The abstract, “Diffusion Abnormality Index: A New Imaging Biomarker for Early Assessment of Tumor Response to Therapy,” will be presented in detail during a scientific session titled “The Role of Biologic Imaging for Evaluating Post-treatment Response” at 10:30 a.m. Eastern time on Saturday, February 9, 2013. To speak with Reza Farjam, PhD, call Michelle Kirkwood on February 8-9, 2013, in the Press Office at the Hilton Orlando Lake Buena Vista in the Walt Disney World Resort at 407-560-2314 or email michellek@astro.org.

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2013 Cancer Imaging and Radiation Therapy Symposium
Abstracts of Interest News Briefing, Saturday, February 9, 2013, 7:00 a.m. – 7:45 a.m. ET

Oral Presentation: Saturday, February 9, 10:30 a.m. Eastern time

12 Diffusion Abnormality Index: A New Imaging Biomarker For Early Assessment Of Tumor Response To Therapy

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Abstract Body:
Purpose/Objectives: Diffusion heterogeneity in a brain tumor presents a challenge to use a diffusion change as an indicator for therapy response. Hence, we developed a diffusion abnormality index (DAI) for early perdition of brain tumor response to radiotherapy.

Materials/Method: For each patient, a normal tissue ADC histogram (HNT,ADC) is obtained in a normal brain volume of 3-4cc and normalized to have a peak intensity equal to 1. A tumor ADC histogram is generated in the tumor volume defined on post-Gd T1 weighted images. The tumor ADC histogram usually spreads beyond the normal tissue ADC histogram, and the latter divides the first into three categories: low (high cellularity), normal, and high (edema and necrosis) diffusion. Thus, an abnormal diffusion probability function (ADPF) of the tumor is defined by 1-HNT,ADC and band-pass filtered to reduce noise influence at the two tails. Considering that an increase in the low-ADCs of the high tumor cellularity region could predominantly determine response compared to a change in the high ADCs, a weighting factor (α) is used to weight the low ADCs related to the high ADCs in the ADPF. Finally, a DAI of a tumor is defined as an integral of the ADPF-weighted ADC histogram of the tumor. The DAI was evaluated for predicating post-RT radiographic response in 20 patients who had brain metastases and were treated by whole brain radiotherapy (WBRT). Of a total of 45 lesions, 16 were responsive, 18 stable and 11 progressive. The group differences in the changes of the DAIs from pre-RT to 2 weeks (2W) after start of RT were tested (Mann Whitney U test). The performance of DAI for predicting non-responsive lesions was evaluated by Receiver Operating Characteristic (ROC) analysis and compared with the changes in gross tumor volumes (GTVs) observed within the same time interval.

Results: The percentage decrease in DAI from pre-RT to 2W was significantly greater in responsive tumors than in stable and progressive ones (p < 0.0009). The ROC analysis revealed that a change in the DAI (AUC = 0.90) from pre-RT to 2W was a significantly better predictor than a change in the GTV (AUC = 0.68) for post-RT response (p < 0.01), suggesting that physiological change occurs before the volumetric change.

Conclusions: The diffusion abnormality index, accounting for both low and high diffusion caused by high cellularity and edema, respectively, could be a better diffusion-imaging biomarker for early assessment of tumor response to therapy. Support by NIH RO1 NS064973 and R21 CA113699

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