ABSTRACT

Longitudinal measurements of diffuse reflectance were obtained in vivo from head and neck cancers (HNC) using head-based spectroscopy in mice and human tumors that were undergoing curative radiotherapy. These spectra were quantified using an inverse Monte Carlo model to estimate fractional changes in tissue optical properties, vascular oxygenation (SO2) and hemoglobin content, and total hemoglobin concentration (THb). The optical properties and oxygenation values across subjects was higher than within subjects and that exposure to radiation caused decreases in both non-invasive methods and non-invasive methods for all non-responders. In both mice and humans, prolonged disease-free survival (of the primary treated site) showed sustained increases of SO2 per subject, relative to baseline, across time.

INTRODUCTION AND BACKGROUND

The growth rate, metastatic potential and response to radiation therapy of HNC has been shown to be dependent on changes in tumor oxygenation levels [1]. Clinical tools to sense tissue oxygenation include both invasive (such as the pO2 electrode and immunohistochemical analysis of biopsied tissue) and non-invasive methods such as MRI or radio-labeled imaging and spectroscopy. The clinically invasive methods cannot be used routinely, especially, expensive, or time-consuming for daily use. However, there were no differences in oxygenation between the PR and CR groups before then.

CLINICAL MANAGEMENT OF HNC

- Pre- and post-treatment measurements of tumor hypoxia using pO2 electrodes and/or PET and MRI to show that improved oxygenation related to better outcomes [2,3].
- In order to personalize and individualize cancer treatment, it will be necessary to evaluate tumor physiology repeatedly during treatment.
- Diffuse correlation and reflectance spectroscopy has been used to monitor changes in blood flow and oxygenation in sub-regions of HNC patients but did not highlight differences between responders and partial responders [4].
- Here, we use optical spectroscopy at the primary site to investigate changes in oxygenation during radiation therapy in both animal and human studies.

MOBILIZATION AND HYPOTHESIS

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INSTRUMENTATION AND METHODS

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ANIMAL EXPERIMENTS

Study design:

- 42 nude mice inoculated with FaDu cells in flank
- Treatment started when tumor volume ~ 100-400 mm
- Retarded Carlo model to extract optical endpoints of vascular oxygenation (SO2) and hemoglobin
- Longitudinal optical measurements obtained on HNC lesions during radiation therapy were quantified to extract vascular oxygenation and blood volume in mice and human subjects. The temporal trends for changes in SO2 relative to pre-treatment levels indicated markedly different patterns for subjects that respond to therapy vs. those that did not. Monitoring vascular oxygenation in solid HNSCC undergoing treatments could provide a non-invasive method to monitor treatment response in individual patients.

SUMMARY AND CONCLUSIONS

- Longitudinal optical measurements obtained on HNC lesions during radiation therapy were quantified to extract vascular oxygenation and blood volume in mice and human subjects. The temporal trends for changes in SO2 relative to pre-treatment levels indicated markedly different patterns for subjects that respond to therapy vs. those that did not. Monitoring vascular oxygenation in solid HNSCC undergoing treatments could provide a non-invasive method to monitor treatment response in individual patients.

HUMAN STUDIES

- 8 Patients with confirmed HNSCC lesions that were accessible via the oral cavity were consented
- CT based treatment was planned in customized immobilization devices with N-contrast
- Unframed Target Volume (PTV) dose for each lesion was 70Gy (delivered in 2Gy daily fractions)
- Optical probe guided to lesion surface by the oncologist and was held in place by patient
- 1-3 locations were scanned to obtain diffuse reflectance from different sites at each time point.

REFERENCES: