Author Disclosure: J. Kemp: None. M.J. Price: None. K.A. Gifford: None. B.C. Parker: None. B. Mason: None. L. Rechner: None. D. Neck: None. K. Ferachi: None. J. Gibbons: None. K. Matthews: None.

3725

FDG-Cerenkov Imaging: A Molecular Approach to Real-time Treatment Guidance

C. Carpenter, H. Liu, C. Sun, G. Pratx, Z. Chang, and L. Xing; *Stanford University, Stanford, CA*

Purpose/Objective(s): Real-time feedback, identifying both tumor location and radiation dose, would be beneficial during interventional procedures such as glioma brain tumor resection. We investigated the feasibility of using a fiber-based Cerenkov imaging system to detect tumor margins in the surgical resection cavity in vivo. The potential benefit of a Cerenkov imaging is its ability to image tumor cells by their preferential uptake of radiotracers such as FDG, and the additional ability to visualize radiation treatment in real-time. We investigated the performance of Cerenkov imaging for these goals both in phantoms and in vivo in a tumor mouse model.

Materials/Methods: Experiments were performed in a dark chamber through an optical fiber bundle and imaged by a charge-coupled device (CCD) camera or an optical detector. Cerenkov luminescence was recorded from 5 mice bearing subcutaneous C6 glioma cells with intravenous injection of 18F-FDG. The tumor tissues were exposed and CLI was performed on the mouse before and after surgical removal of the tumor using the fiber-based imaging system and compared to a commercial optical imaging system. Separately, phantoms were irradiated with a linear accelerator with 9MeV electrons.

Results: Tumor tissues showed significant preferential uptake of FDG vs. normal tissues, with nearly a 20% increase. After tumor removal, Cerenkov signal from the surgical cavity dropped to the noise level. In addition, the Cerenkov signal arising from the phantom indicated irradiation.

Conclusion: This proof-of-concept study explored the feasibility of using fiber-based CLE for the detection of tumor tissue in vivo for guided treatment. With further improvements of imaging sensitivity and spatial resolution of the current system, CLE may have a significant application in the clinical setting in the near future.

Author Disclosure: C. Carpenter: Q. Leadership; NovoMed. H. Liu: None. C. Sun: None. G. Pratx: None. Z. Chang: None. L. Xing: None.

3726

Iterative Determination of Clinical Beam Phase Space From Dose Measurements

E. Herranz,[1] J.L. Herraiz,[1] P. Guerra,[2] J. Cal-Gonzalez,[1] M. Perez-Liva,[1] R. Rodriguez,[3] C. Illana,[3] M. Ledesma,[2] J. Calama,[4] and J.M. Udias[1]; *[1]Grupo de Física Nuclear, Dpto. Física Atómica, Molecular Nuclear, UCM, CEI Moncloa, Madrid, Spain, Madrid, Spain, [2]Department of Electronic Engineering, ETSIT, Universidad Politécnica de Madrid, Madrid E-28040 Spain, Madrid, Spain, [3]GMV, Tres Cantos, Madrid E-28760, Spain, Madrid, Spain, [4]Clinica La Luz. C/ General Rodrigo 8. 28003. Madrid, Madrid, Spain*

Purpose/Objective(s): Monte Carlo (MC) method can accurately compute the dose produced by medical linear accelerators. However, these calculations require a reliable description of the electron and/or photon beams delivering the dose, the phase space (PHSP), which is not usually available. A method to derive a phase space model from reference measurements that does not heavily rely on a detailed model of the accelerator head is presented. The iterative optimization process extracts the characteristics of the particle beams which best explains the reference dose measurements in water and air, given a set of constrains.

Materials/Method: Beams with cylindrical symmetry, as the ones employed in intraoperative radiation therapy (IORT) are assumed. The particle type, energy, radial position of emission and angle with respect to the applicator axis are the only relevant variables of each particle trajectory. All these variables are considered during optimization, contrary to other approaches which optimize a reduced set of variables or even only the energy. The PHSP is discretized into 250000 bins whose individual contribution is estimated by an iterative expectation maximization of the maximum likelihood algorithm (EM-ML) comparing reference measurements to the dose produced by the PHSP. The absorbed dose distributions were simulated using a parallel version of the MC code Dose Planning Method (DPM), which allows for fast computation of doses, obtained as linear combinations of the dose produced by the elemental bin sources. Convergence of the algorithm for a set of data for a given energy is usually reached after 150 iterations, which takes less than two hours using 16 threads on a 8 physical cores computer (dual Intel E5620@2,4 GHz, 48 GB RAM). Full simulations of realistic accelerator heads provided reasonable constrains on the PHSP that the iterative algorithm should explore. The PHSP obtained have been incorporated in an IOERT dedicated treatment planning system.

Results: Phase space files have been derived for different energies and LINAC systems, both in electron and photon mode. Agreement with the reference data employed in the fit was very good. Once data in two different materials (water and air) are included in the fit, test challenges against known PHSP were successfully performed. Agreement with data not included in the optimization procedure is fair.

Conclusions: Reasonable PHSP can be obtained if enough computational resources and reference data on different materials are available. The method proposed is a new and powerful technique that potentially can be employed to obtain PHSP files for any accelerator for radiation therapy.

Author Disclosure: E. Herranz: None. J.L. Herraiz: None. P. Guerra: None. J. Cal-Gonzalez: None. M. Perez-Liva: None. R. Rodriguez: None. C. Illana: A. Employee; GMV. M. Ledesma: None. J. Calama: None. J.M. Udias: None.

3727

Novel Findings on 18F-FDG PET Uptake Distributions Within NSCLC Tumors

K. Wijesooriya,[1] P. Peng,[1] P.W. Read,[1] T. Pan,[2] A. Goode,[1] P. Judy,[1] S. Benedict,[1] and J.M. Larner[1]; *[1]University of Virginia, Charlottesville, VA, [2]MDACC, Houston, TX*

Purpose/Objective(s): Lung cancer is one of the most frequent lethal cancers, giving a 5 year survival rate of 20%. Local tumor failure following radiation is common. However, higher radiation doses (120 Gy) yield a higher local control rate (90%). Molecular imaging studies reveal tumor heterogeneity which may explain therapeutic resistance. Hence the use of ^{18}FFDG to dose paint lung tumors is a viable strategy . We hypothesize that a functional fit to the SUV uptake distribution represents the intrinsic heterogeneity of the tumor and this function could be used for dose painting. Alternatively, variations observed in the SUV uptake may not be due to the intrinsic heterogeneity of the tumor, but due to effects of PET position resolution (volume dependence) or tumor motion. The objective of this study is to derive a functional form of SUV uptake by eliminating resolution and motion effects.

Materials/Methods: We conducted a patient and a phantom study: I. Patient study: 25 peripheral NSCLC tumors with motion amplitudes less than 5mm, and tumor volumes of 5cc to 550cc. PET SUV uptake values for each tumor were fit with a Woods-Saxon model with 2 parameters: radius and skin depth. When the ratio of radius to skin depth becomes small, this simplifies to a Gaussian. II. Phantom study: spheres of homogeneous18F-FDG activity of motion amplitudes (0, 5, 10, 15, 20, 25, 30 mm) and volumes (internal diameter 10, 13, 17, 22, 28, 37 mm). Any variation observed in SUV uptake distribution with homogeneous activity spheres must be due to motion and volume effects. Therefore, we used this data to quantify uptake variations as a function of motion and volume.

Results: The patient study shows that for small tumors up to about 45cc, SUV uptakes can be described by a Gaussian distribution in all three dimensions, peaking at center and dropping as distance from center increases. For Intermediate tumor volumes (50 cc to 200 cc) SUV uptakes show a flat central region surrounded by a skin region over which activity drops. For large tumors, ($>$ 200 cc) SUV uptakes are low in the center of the tumor, and higher in the surrounding shell before dropping at the edge. Phantom study for stationary spheres shows that for volumes larger than 5 cc,