AbstractID: 6110 Title: Liquid Scintillation-Based Proton Residual Range Measurement Using a Dynamic Biological Lung Phantom

Purpose:

To test and apply a scintillation-based method to directly observe proton residual range and range variation in a dynamic biological lung phantom.

Method and Materials:

The dynamic biological lung phantom using a preserved swine lung has previously been compared to human lung and evaluated as an experimental platform for IGRT studies. Fiducial markers and a 5 cc artificial tumor were placed in the lung, and the phantom was imaged on a GE Lightspeed CT in 4D mode before and after seed and "tumor" implantation. The resulting 10-phase DICOM datasets were evaluated in terms of anterior-posterior (AP) water-equivalent path length (WEL) variation throughout the ventilatory cycle. The preserved swine lung was irradiated in the AP direction with a 170 MeV proton beam through a 1 cm x 10 cm slit aperture. Proton residual range and range variation were directly observed using a custom-built lucite chamber filled with scintillating fluid, monitored during irradiation by a video camera. Images were then analyzed using ImageJ to determine residual proton range.

Results:

WEL analysis on the imaged lung suggests a range of lung WEL values between 8 and 25 mm (average ~16 mm). Peak calculated WEL difference at the tumor margin after implantation during ventilatory motion was approximately 5mm. Irradiation of the phantom demonstrated regional range variation across the lung on the order of 13 mm, with total WEL values equivalent to calculated values. Residual range variation due to ventilatory motion was less significant, at some points on the order of ±2.4 mm.

Conclusion:

The dynamic biological lung phantom in conjunction with the scintillation chamber has been shown to be a simple, inexpensive, and effective tool for the measurement of proton residual range and significant residual range variation in a complex biological system.