

Purpose:

Proton radiography (PR) was investigated for daily set up prior to proton radiation treatment, which would provide improved imaging capabilities along with reduced radiation dose to pediatric, lung and T-spine tumors. Pediatric patients are more susceptible to radiation induced malignancies and toxicities from therapeutic and diagnostic radiation. While, in the case of T-spine and lung tumors, motion and lung heterogeneities can significantly reduce the benefit of using proton beam therapy.

Methods:

A group of 5 pediatric patients with 1) neuroblastoma, 2) spinal malignancy, or 3) thoracic tumor were used to evaluate proton radiography. In addition, 7 lung/T-spine tumors were also used to evaluate the ability of proton radiography to allow real-time tumor tracking, while the tumor is moving within the lung with the patient respiration. Proton radiographic images were generated using a Monte Carlo imaging tool, PR-Imaging, developed at MGH.

Results:

Radiographic images of the lung tumors were generated with simulated PR-Imaging using a scanned proton pencil beam (PBS) at 230MeV, 330MeV and 490MeV, and compared to diagnostic X-ray digitally reconstructed radiographs (DRR). In addition, whole body PR-Images of pediatrics was compared to conventional X-ray radiographs. PR images with high resolution comparable to that of a diagnostic x-ray were generated. The X-ray portal images and the X-ray radiographs present better edge detection, while lung tissue to soft tissue boundaries of the tumor were better distinguished in PR images. The PR-imaging allows the oncologist and radiologist to change windowing level and tumor contrast level relative to soft tissue background.

Conclusions:

PR-Imaging prior to therapy allows for high quality images that can provide information on range degradation of the proton therapy beam. PR-Imaging during therapy allows for daily quality assurance and tumor tracking during radiation to guarantee that it has been appropriately treated with radiation.