Purpose: To quantify the relative impact of respiratory motion on calculated dose in proton and photon treatment plans for advanced stage NSCLC.

Methods: In a randomized trial of passively scattered proton therapy (PSPT) vs. photon intensity modulated radiation therapy (IMRT), we have accrued 100+ stage II-III NSCLC patients with physician-approved photon and proton treatment plan pairs. This work copies all relevant beam parameters from the original dose calculation dataset (10-phase average CT) onto the ten individual phases of the four-dimensional CT (4DCT) dataset. The plan dose is then recalculated for each phase in both proton and photon modalities. We expect to identify 20+ patients with moderate to large respiratory motion (5+ mm) for this study. This work applies deformable image registration to compare 4D dose accumulation for the proton and photon plans over the planning 4DCT dataset.

Results: To date, 5 patient 4D dose recalculations are complete. Proton MLD was observed to vary by 4-25% when recalculated on the ten phases of the 4DCT. IMRT MLD varied by 0-4%. In the patient with the largest motion (18 mm), a 5% variation was observed from planned proton PTV D95. All other observed dose variations in other target and normal tissue structures (e.g. CTV, esophagus, heart, cord) were not significant.

Conclusions: This planning study demonstrates that PSPT can display a larger variation in lung dose as compared to IMRT. One factor may be the motion blurring of lung structure in the average 4DCT used in treatment planning, which may affect proton plans more. Because protons are not as robust as photons in the presence of respiratory motion, this study suggests that protons may benefit more from 4D treatment planning and respiratory motion management techniques such as respiratory gating or breath hold.

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None