This research is a treatment planning study for a bi-institutional “adaptively randomized” trial to compare the potential of passively scattered proton therapy (PSPT) vs. intensity modulated radiation therapy (IMRT) for patients with locally advanced (stage II-IIIb and selected stage IV) non-small cell lung cancer (LA NSCLC).

- PSPT and IMRT treatment plans have been designed by experienced practitioners at for each patient enrolled on in protocol using the normal tissue tolerances listed to the left.

- Cohort selected of protocol patients with moderate to large respiratory motion (5+ mm)

Axial slice of sample patient showing the proton (left) and photon (right) dose distributions as calculated on the average 4DCT dataset. The proton plans typically utilize 2-3 beams, while the photon beams typically use 5-12 beams.

The nominal clinical plan’s beam parameters are copied from the 4DCT average dataset onto the ten individual 4DCT phase datasets. The dose is then recalculated using the same parameters (e.g. same field modulation in IMRT, range modulator wheels and compensators in PSPT) as the original clinical plan.
• This method of phase-based recalculation will quantify the relative impact of respiratory motion on the nominally planned dose in proton and photon treatment plans.
• From the 10 phases of the 4DCT dataset, we get 10 unique DVH curves for each structure. On the left, are sample patients PTV and lung DVH curves. For simplicity we show the most extreme phases: T50 (exhale) and T0 (inhale). The original plan DVH is the solid line.
• The 9 mm motion patient (above left) has little variation in the DVHs except for the proton lung. Of interest is that the T0 lung DVH exceeded 40Gy, which was a violation of the normal tissue criteria in table above.
• The patient with large (18 mm) motion showed a large variation in the calculated proton dose in both the lung and PTV DVH curves. In both patients, little variation was observed in the IMRT DVH curves.
• This work will include deformable image registration to compute a 4D dose accumulation for each patient to provide a more accurate calculation of the dose delivered to each patient.

Preliminary Results

For five patient recalculations completed to date, the DVH criteria of the proton plans varies by more than the IMRT plans for each case.
• We expect to increase the number of patients to 20+ by time of publication.
• Using 4D dose accumulation methods, we hope to provide a quantifies measure of the effects of respiratory motion on the planned dose distribution for proton and photon therapy.

Preliminary Conclusions:
1. Protons display a larger variation in normal tissue dose as compared to IMRT.
2. One factor may be the blurring of moving structures when using average 4DCT datasets for dose computation.
3. This study suggests that protons may benefit more from 4D treatment planning and respiratory motion management techniques such as respiratory gating or breath hold.