Purpose: Conformal SBRT plans for Lung cancer with static gantry angles are ideal candidates for applying motion tracking because of: (1) better dosimetric conformity with reduced target margin and (2) easier and more faithful target tracking without intensity modulation. This work is to demonstrate that by delivering the target tracking during gantry rotation, we can significantly improve delivery efficiency without negatively affecting plan quality.

Methods: A lung SBRT plan with static beams was created using CT images of the reference breathing phase. It is converted to an arc plan with variable dose rate followed by the conversion to a 4D plan with the segment aperture morphing (SAM) method (Gui 2010) with considerations of both target location and shape changes as depicted by the 4D CT. Gantry angle ranges were determined from the clinical monitor units, with the 22.2 MU/degree, which is chosen to maximize the dose rate. All segments of the dynamic 4D plan were merged into a single arc with variable dose rate. Each segment occupying 1/10 of the breathing period delivers 6.6 MUs at a dose rate of 1000 MU/min. Delivery time was measured and compared to the planned.

Results: The dose distributions of the single phase 3D plan and the arc 4D plan showed little difference. The delivered time for the 4D arc plan agreed with the calculated time, and is almost the same as delivering the 3D plan without target tracking. A 12 Gy treatment takes less than 2.5 min.

Conclusions: The feasibility of a novel 4D delivery method where a 3D SBRT plan is converted into 4D arc delivery has been demonstrated. In addition to realizing the conventional target tracking benefits, our method further improves delivery efficiency, which is important for maintaining the geometric relationship between the target motion and the breathing surrogate during treatment.

Funding Support, Disclosures, and Conflict of Interest:

This study is supported by NIH_Grant_1R01CA133539-01A2.