AbstractID: 3290 Title: Multistage Treatment Planning Optimization for Managing Organ Motion in Radiotherapy Planning

Purpose: The management of breathing-registered IMRT treatment planning is explored by incorporating the motion pattern of breathing directly into the treatment planning process. The movement of the voxels from one CT timeframe to another is ``tracked'' and modeled. A timestamp for each voxel specifies its position throughout the breathing cycle. The treatment models incorporate planning constraints throughout multiple time periods. Robustness of the algorithm, plan quality, and potential clinical significance are evaluated.

Method-and-Materials: 4D-CT scans of lung cancer patients were acquired with different breathing phases(phases 0-9, 0:full-inhale, 5:full-exhale), Three treatment planning strategies are performed and compared. 1)Standard planning with a static PTV based on a single selected phase(control). 2)The Internal Target Volume(ITV) approach, where ITV is defined as the union of CTVs in all breathing phases. 3)Multi-stage optimization and planning, where movements of voxels from one CT-timeframe to another are "tracked" and modeled, and planning constraints are incorporated throughout the multiple-phase period. Sophisticated computational optimization techniques are used to solve these models.

Results: Applied to a lung case, the static-PTV plan results in unacceptable PTV-underdose. Multistage-plans offer as good coverage as the ITV-plans, comparable minimum PTV dose while simultaneously reducing the mean-dose to left lung normal tissue(20%), heart(20%), and esophagus.

Conclusion: Multistage treatment planning optimization can provide good PTV-coverage plans, improve PTV-underdose, and significantly reduce dose to organs-at-risk, especially those organs in the proximity of the tumor. Evidence of morbidity reduction to organs-at-risk are observed. The challenge involves the ability to solve a large-scale treatment planning problem. With sophisticated mathematical optimization modeling and computational strategies, such planning is possible and can be made available for clinical use. Further investigation of ITV will be conducted to understand if improved plan quality can be achieved via improved construction of this structure. Clinical studies are needed to validate the importance of our approach to treatment outcome.