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Robustness Quantification and Worst-case Robust Optimization in Intensity-Modulated Proton Therapy

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Lung cancer is the leading cause of cancer death and radiation is the standard therapy for patients with unresectable disease. Intensity-modulated proton therapy (IMPT), the next evolutionary step in radiotherapy, has the extraordinary capability to precisely deposit *maximum* cell killing energy in tumors and *minimum* exposure to surrounding normal tissues; therefore, IMPT will improve the therapeutic ratio, resulting in fewer adverse effects. However, use of IMPT for lung cancer is hindered by a serious limitation: it is highly sensitive to uncertainties caused by patient setup and range uncertainties, respiratory motion, anatomic changes due to tumor shrinkage and patient weight change. These uncertainties can cause under-treatment of tumors or over-exposure of surrounding normal tissue, resulting in unfavorable clinical consequences. Therefore, it is essential to implement robustness quantification (quantifying the sensitivity of IMPT plans to uncertainties) and robust optimization (delivering precise and predictable IMPT plans to ensure the highest clinical benefit). The root mean square dose volume histograms (RVH) can be used to measure the sensitivity of the dose to uncertainties and the areas under the RVH curve (AUCs) can be used to evaluate plan robustness. Robustly optimized plans have better target coverage, improved dose homogeneity, and lower or equivalent dose to organs at risk (OARs). Additionally, robust optimization provides significantly more robust dose distributions to targets and organs than conventional optimization. Planning directly based on CTV provides better or equivalent OAR sparing. Also 4D robust optimization mitigates the influence of interplay effect than 3D robust optimization in lung cancer.

Biography

Wei Liu obtained his PhD at Princeton University. Currently, he is an Associate Professor of Department of Radiation Oncology of Mayo Clinic College of Medicine. He authored 43 (23 are fist-authored) peer-reviewed journal publications, 4 US pending patients, and 1 book chapter. He has served as an Editor/reviewer for many top-ranked international journals. He was a recipient of National Institute of Health (NIH)/National Cancer Institute (NCI) Career Developmental Award (K25) and serve as a NIH/NCI Early Career Reviewer (ECR).

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