Dosimetric Comparisons between Pinnacle Auto-Plan and Manual VMAT for Lung Cancer

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Abstract

The purpose of this research is to examine the dosimetric differences between Pinnacle’s Auto-Plan versus manual plans for Volumetric Arc Therapy (VMAT) lung cancer treatment generated with minimal planner involvement. There have been only two studies on Auto-Plan with respect to lung cancer treatment, but only with Intensity-Modulated Radiation Therapy(IMRT); none with VMAT. Ten archived patient cases were selected for retrospective planning with the most common prescriptions: Two Sequential Integrated Boost (SIB) 66 Gray in 30 fractions, two SIB 60 Gray in 15 fractions, two Stereotactic Body Radiation Therapy (SBRT) 70 Gray in 10fractions, and four SBRT50 Gray in 4fractions. One Auto-Plan and one manual plan were created for each patient case. Dual partial arcs were used for all plans. Basic templates were implemented specific to each prescription and with slight differences between Auto-Plan and manual planning. Dosimetric comparisons were conducted with target volume coverage, prescription conformity, prescription homogeneity, Organ at Risk (OAR) sparing, Monitor Units (MUs), hot spot volume, low dose volume, and treatment planning time.

Introduction

Lung cancer is the second most common cancer in the U.S. Observation, surgery, chemotherapy, radiotherapy, or a combination thereof are the current methods used to treat lung cancer. For radiotherapy, the VMAT technique was clinically proven to offer significant OAR sparing. The inverse-planning techniques and optimizers of current Treatment Planning Systems (TPS) require a certain level of skill and experience to generate effective treatment plans. In an attempt to address the systemic planner bias issue, Philips introduced its Pinnacle Auto-Planning module in 2015 to generate high-quality plans with limited intervention. Since its release, there have not been any published studies comparing Auto-Plan to manual plans in VMAT lung cancer treatment.

Results

In all cases, equivalent target volume coverage was reached between Auto-Plan and manual plans, with no statistically significant differences in conformity or homogeneity indexes (tables 1 and 2).

![Conformity Index](image)

![Homogeneity Index](image)

In general, OAR sparing was statistically equivalent between Auto-Plan and manual plans across all prescriptions, however, Auto-Plan failed to meet OAR constraints on 4 of the 10 cases, typically failing spinal cord and lung constraints under SIB, and chest wall constraints under SBRT.

Auto-Plan had higher low dose volume in normal tissue for all but one case (table 6). Manual plans required 23.9% more MUs on average than Auto-Plan but it was not statistically significant (table 7).

![Spinal Cord Maximum Dose](image)

![Total Lung Mean Dose](image)

![Heart Maximum Dose](image)

![Normal Tissue Low Dose (L20%) Volume](image)

![Monitor Units](image)

Manual planning took 52% longer on average than Auto-Plan (table 8).

Discussions

The results were similar to the studies conducted by the University Hospital Zurich, Switzerland and the Cleveland Clinic in Ohio that examined Auto-Plan with IMRT. However, there were a number of limitations in this research. Biases were inherently incorporated to assist manual plans to achieve a treatableplantooffsettheadvanced algorithms built-in to Auto-Plan’s optimizer engine. Planning time could be adversely affected by heavy system resource utilization and network activity. The sample size was too small for statistical conclusiveness. Archived patient cases were carefully screened to exclude complex tumors, difficult to treat tumor locations, and close proximity to certain OARs to increase the probability of successfully achieving a treatable plan.

Conclusions

The dosimetric comparisons demonstrated that Auto-Plan and manual plans were able to produce optimal target coverage and equivalent OAR sparing. However, 4 out of the 10 Auto-Plan cases failed to meet OAR constraints and would require manual optimization.

There were several significant limitations in this study, such as small sample size, selective patient case criteria, and planning time variability, all of which requires further research between Auto-Plan and manual planning of VMAT lung cancer treatment.

References