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Dosimetric comparisons for determining optimal arc geometry in multi target thoracic VMAT SBRT treatment plans for patients with locally advanced in operable NSCLC

Introduction

In 2024, following the findings of the PACIFIC trial, the NRG oncology group began enrolling patients in a national trial, LU-008, which is designed to test the addition of high dose, targeted radiation to the standard treatment for unresectable LA-NSCLC. Patients are enrolled into 2 arms, one with standard fractionation to all sites of disease and the 2nd arm with SBRT to primary tumor and standard fractionation to nodal involvement.

The NRG LU008 trial provides planning strategies, target coverage criteria and OAR risk objectives. Although, within the literature, only general recommendations were found for optimal plan design aspects such as beam geometry.

The purpose of this research is to determine if advanced treatment planning techniques for patients enrolled in arm 2 of the trial: FFF, muti-iso non-coplanar SBRT VMAT arcs provide a clinically significant dose sparing to OARs without sacrificing plan quality or target coverage.

Methods

The sample population used for this study was 10 anonymized patient data sets selected from the NSCLC-Radiomics collection found in The Cancer Imaging Archive (TCIA). The type of lung cancer was first used to determine the sample population of the study within TCIA, anonymized patient data was provided by TCIA. This information included histology and staging for each data set.

Each patient had a total of 4 plans created: Coplanar 60Gy_30Fx (Plan A), Coplanar SBRT 50Gy_5fx (Plan B), Non-coplanar SBRT 50Gy_5fx (Plan C), and Noncoplanar 60Gy_30fx (Plan D). An EQD2 (A/B=3) dose composite and DVH was analyzed for Plan AB, Plan AC and Plan CD to compare OAR dose changes when adding noncoplanar beam arrangements. The plan quality metrics we considered referenced the clinical trial metrics from arm 2 LU008.

Patient Criteria

Each data set was analyzed individually using eligibility criteria found in the NRG LU008 trial guidelines. 10 of the 20 anonymized data sets were selected using the following inclusion factors:

- Primary tumor size ≤ 7cm
- Subjects with no pleural effusion
- Mediastinal involvement in nodal region

Exclusion factors included:

- Lack of identifiable lymph node involvement
- Primary tumor for SBRT target <2cm from nodal target
- Centrally located SBRT target

Results

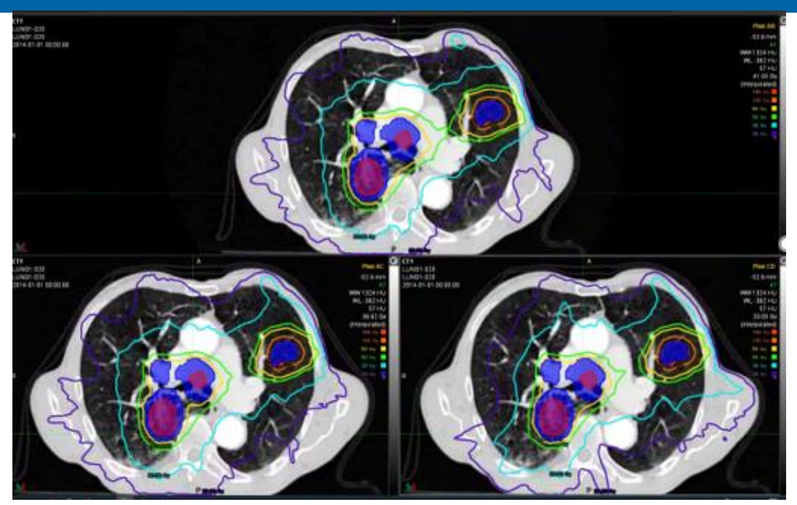

Fig. 1. There was limited improvements in IDL distribution with plan AC, utilizing noncoplanar beams in the SBRT plan only. More improvements were shown by using non-coplanar beams in both plans as shown in Plan CD.

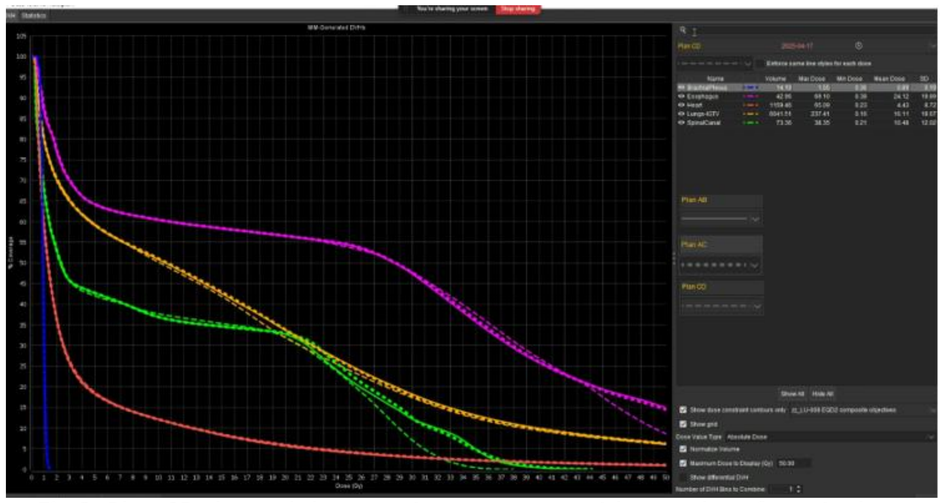

Fig 2. Plan CD showed the most improvement with max dose for spinal canal and esophagus. The OARs analyzed were referenced from clinical trial metrics from arm 2 of the LU008 trial.

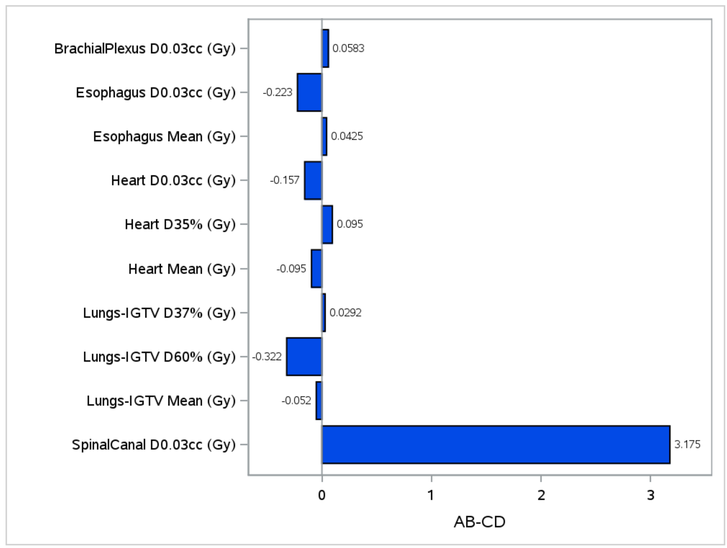

Fig 3. On Average, max dose to spinal canal showed the greatest improvement when comparing coplanar beam arrangements to non-coplanar beam arrangements for both plans.

Conclusion

The statistics of this research does not show significant dose sparing differences between the coplanar and non-coplanar plans, however, we did find a noticeable difference with some patients. On average, we were unable to find an optimal beam technique that would benefit all patient anatomy. It was found that the advance treatment planning techniques can improve some OAR dose metrics without sacrificing target coverage. Though there are some benefits, there are clinical tradeoffs when considering these advanced treatment techniques. Such as, the simplicity of patient setup, Complexity of plan design and the time commitment of dosimetry planning.

Limitations

The most challenging aspect of this research was the use of virtual data sets to standardize dosimetry parameters across all patients in this study for the SBRT target. This does not capture clinical patient anatomy and target size variability.

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