resulted in the lowest GI vs. HA-VMAT & MDCA (p<0.05). For targets>1cm, HA-VMAT gave superior CIs vs. MDCA & GK (p<0.001). GK again had the lowest GI, but not significantly different from HA-VMAT (p=0.13). V12Gy-TV was lowest for HA-VMAT for all targets, but all means were within 2ccs of each other. All plans achieved clinically acceptable and similar OAR doses. Beam-on times were hours longer for GK, but were comparable between MDCA & HA-VMAT.

Conclusion: This study revealed that HA-VMAT is capable of achieving similar out-of-target normal brain dose as GK, while maintaining excellent conformity and significantly reducing treatment time for patients seeking treatment of multiple metastases. HA-VMAT provides a competitive SRS treatment solution, particularly for patients with multiple large and irregularly-shaped metastases.


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Approaches of Sparring Lung in SBRT for Treating Tumors in Lungs with Volumetric Arc Therapy

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Purpose/Objective(s): Sparing lung in Stereotactic Body Radiotherapy (SBRT) for treating tumors in lungs is critical to reduce the radiation induced toxicities, such as radiation pneumonitis and late fibrosis. A retrospective study was performed with a new combination of approaches to improve lung sparing in SBRT plans with VMAT and Monte-Carlo dose calculation algorithm.

Materials/Methods: Twenty two SBRT lung plans were optimized using traditional LINAC MLC based approaches: an uniform dose distribution in the target with an average P-IDL (prescription isodose line) of (88.8±1.9)% (The error bar of all the data is the 95% confidence interval (CI)) and clinically delivered. The plans were re-optimized using a new combination of approaches with variation of P-IDL and evaluated with: 1. R_{50iso}, the ratio of 50% prescription isodose volume to the plan target volume (PTV); 2. V20, the volume of lung within 20Gy; 3. PCI, the Paddick conformity index; 4. D2cm, the maximum dose at 2 cm from PTV in any direction; 5. Dmean, the mean dose in total lung volume. 

Results: It was found that the optimal P-IDL was in the range of 75%~80%. With the new optimization strategies and the optimal P-IDL, the average PCI was increased by (10.3±2.1)%; the average R_{50iso}, V20, D2cm and Dmean were decreased by (30.2±4.1)%; (27±5.4)%; (13±4.3)% and (16.6±2.3)% respectively; the dose distributions in the targets also were changed from concave to convex.

Conclusion: The new set of optimization approaches can significantly improve the lung sparing in SBRT VMAT plans with Monte-Carlo dose calculation algorithm for treating tumors in lungs while increasing the dose to the target. The new plans were more conformal in both high and intermediate dose regions. The optimal P-IDL was found in the range of 75-80%.


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Consequence of Patient Motion during Lung SBRT While Treating with Flattening-Filter Free (FFF) Beams or Flattened Beams (FB)

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Purpose/Objective(s): SBRT technique is widely used for treating small early-stage lung lesions for the preferable high GTV dose and sharp dose falloff beyond the PTV. However, the small target size increases the potential of misalignment and consequently treatment failure. This study investigates the robustness of lung SBRTs planned with flattening-filter free beams (FFFBB) and flattened beams (FB).

Materials/Methods: This retrospective study focused on lung SBRT patients treated for lesions in the left upper or middle lobes. Five patients (PTV 25-35cc) treated at our institution between 2018 and December were randomly selected. Each patient had a clinical treatment plan with two FFF 6MV arcs (10Gy x 5 fractions, or 12.5Gy x 4 fractions). A set of comparison plans was created with 6MV FB and optimized to comparable PTV coverages. To simulate setup error and motion induced tumor misalignment while maximize the dose effect to the heart, beam isocenters were moved by 3mm, 3mm, and 5mm in the anterior-posterior, medial-lateral and superior-inferior directions, respectively. The shifted dose distributions were recalculated and compared against the initial plans (plans without motion), and then between the FFF and FB plans. Dose coverages to the GTV, PTV, heart, spinal cord and normal lung (total lung - GTV), as well as the conformity index and homogeneity index were analyzed.

Results: The volumes of GTVs averaged 6.7±1.7cc and the PTVs averaged 29.7±2.8cc for these patients. The GTV and PTV D99 differences between the FFFBB plans and FB plans were 1.3% and -0.8%, respectively. The mean heart dose and normal lung dose were higher in the FB plans than in the FFFBB plans by 24.3cGy and 20.4cGy. In the simulated misalignment, the FFFBB plans lost 26.8% PTV D99 coverage while the mean heart dose increased by 31.1cGy. The FB plans lost 23.2% PTV D99 coverage while the mean heart dose increased by 287.6cGy. Comparing two shifted plans, the FB plans maintained slightly higher PTV and GTV coverage, while the mean OARs doses increased only marginally.

Conclusion: Accurate patient positioning is critical for safe and accurate delivery of SBRT. Although the dosimetric effects of the misalignment is similar between the FFFBB and FB plans, the FB plan preserves the target coverage better. Future study with larger patient number having tumors at different locations in lungs would be invaluable.