Conclusion: The experimentally determined RSP of the liquid fiducial marker was in good agreement (within 1%) of the theoretical calculation. The investigated liquid fiducial marker introduced smaller dose perturbation than the solid fiducial markers. The liquid fiducial marker shows promise for use in image-guided proton therapy of locally advanced lung cancer, as the risk of altering the clinical dose distribution is minimal.

PO-0947
VMAT-based grid for spatially fractionated radiation therapy
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Purpose or Objective: The purpose of this study is to investigate about feasibility of using volumetric modulated arc therapy (VMAT) technique to provide a Grid dose distribution with the therapeutic ratio (TR) advantage similar to the block-based Grid.

Material and Methods: A series of cylinders with hole diameters of 1.3 cm and 1 cm height was created in a phantom as the boost volume within a larger volume target. The Monaco® 5 treatment planning system was used to plan the phantom. Four arcs, with collimator angles at 00 and 1800 were used. The cost functions were defined to deliver 17 Gy dose to the boost volume and 6 Gy dose to the target volume. A dose profile from treatment plan was utilized to calculate TR for the VMAT-based Grid. In addition, for an available Grid block in our department the TR value was calculated from dose profile using EBT Gafchromic film. The Hug–Kellerer (H-K) radiobiological model (Equation 1) which is more appropriate at doses higher than 12 Gy was used to calculate survival fraction of cell lines under a single hole of the both Grids. The values of α/β ratios for tumor cells and normal cells were considered to be 10 Gy and 2.5 Gy, respectively.

Equation 1:
\[ 2F = \sum V_i \left( -k_2 D_i + k_3 \left( 1 - \exp(-k_2 D_i) \right) \right) \]
where \( \alpha = k_1 - k_2 - k_3 \) and \( \beta = k_2 k_3 \left( \ln(2) - 1/2 \right) \left( \ln(2) \right)^2 \) represents the relative cell numbers receiving the same dose ranging from \( D_i \) and \( D_{i+1} \). The therapeutic advantage of the Grid irradiation was considered in terms of the normal tissue cell survival ratio (Grid/open field ratio) for the same tumor cell survival. The therapeutic ratio (TR) was calculated for both VMAT-based and block-based Grids.

Results: Figure 1 shows a 2D dose distribution of VMAT-based and block-based Grids at the center of the phantom. The VMAT plan generated a highly spatially modulated dose distribution in the volumes. D95% and D50% for the cylinders and the target in Gy were 16.5, 17 and 6, 10 respectively. The valley to peak ratio of the VMAT-based and block-based Grid was 19% and 22% respectively. The Therapeutic ratio for VMAT-based and block-based Grid was obtained 1.25 and 1.38 respectively.

Conclusion: The theoretically calculated RSP of the liquid fiducial marker was in good agreement (within 1%) of the theoretical calculation. The investigated liquid fiducial marker introduced smaller dose perturbation than the solid fiducial markers. The liquid fiducial marker shows promise for use in image-guided proton therapy of locally advanced lung cancer, as the risk of altering the clinical dose distribution is minimal. The liquid fiducial marker shows promise for use in image-guided proton therapy of locally advanced lung cancer, as the risk of altering the clinical dose distribution is minimal. The liquid fiducial marker in good agreement (within 1%) of the theoretical calculation.