Purpose:: To improve the robustness and duty cycle of treating a moving tumor, the minimum intensity projection (min-IP) is used as the basis of planning target volume (PTV). Variable dose rates synchronized to the respiratory signal are adapted to overcome the dose heterogeneity resulted from the non-uniform probability density function (PDF).

Methods:4DCT of a lung cancer patient with gross tumor volume of 43 cm3 is used to compute both maximum intensity projection (MIP) and min-IP. Two RapidArc plans were generated based on MIP and min-IP based PTVs. The tumor dose is the prescription dose in the case of MIP plan. For the min-IP based plan, 3 PDFs, including a linear, a sinusoidal and an actual patient PDF were included in computing the tumor dose. In order to achieve prescription, which is 60 Gy to 95% of the tumor, the dose of the min-IP plan is first renormalized. In the second method, variable dose rate synchronized to the respiratory signal is assumed. The dose rate is inversely proportional to the dwell time or PDF.

Results:Compared with the plan based on MIP, significantly less lung volume is treated by the primary beam with the min-IP plan, resulting in 62% lower mean lung dose without renormalization. However, with uniform renormalization, the change in mean lung dose is -33%, -8% and 3% respectively for the 3 different PDFs. More significant gains at 28.3% and 25.2% for the sinusoidal and actual patient PDFs in the mean lung dose were observed when variable dose rates were used.

Conclusions:Instead of chasing the tumor using a moving aperture, we tested a novel approach to instead let the tumor pass through a smaller static aperture. Variable dose rates synchronized to the respiratory signal substantially improved lung sparing without compromising tumor dose.

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