Purpose:

To assess plan quality and treatment efficiency of 4D-VMAT and gated-VMAT in the treatment of non-small cell lung cancer using SBRT.

Methods:

Treatment planning software was developed in Matlab to simulate both 4D-VMAT and gated-VMAT on patients with stage I lung cancer and at least 1 cm of tumour motion. Gated-VMAT delivers radiation to the tumour during only a portion of the respiratory cycle and hence requires frequent start and stop motions of the gantry. In the 4D-VMAT algorithm, target and organ motion from the entire respiratory cycle is incorporated during optimization. Gantry moves continuously but delivery of each MLC aperture is synchronized to specific phases of target motion.

All 4D-CT scan consisted of 10 phases and were acquired with the patients breathing freely. The SBRT fractionation scheme was 48 Gy in 4 fractions with at least 95% of the PTV receiving 100% of the prescription dose. For gated-VMAT, the PTV was derived from the ITV of the relevant respiratory phases plus a 5mm margin. In the 4D VMAT algorithm, the GTV was defined on a single phase and the PTV created with a 5mm margin. PTVs for the other respiratory phases were determined through 4D-image registration and deformation using a bspline transformation model. For both treatment deliveries, dose was accumulated on the maximum exhale phase and DVHs generated.

Results:

Findings show gated-VMAT and 4D-VMAT deliveries resulted in maximum doses to most OARs far below SBRT protocol constraints. The 4D-VMAT beam on time is on average 8 min. Gated-VMAT will have similar beam on time but treatment time can more than double after accounting for 25 to 35 beam interruptions per arc.

Conclusions:

Gated-VMAT and 4D-VMAT were able to produce dosimetrically acceptable lung SBRT plans. The advantage of 4D-VMAT is the greater efficiency in treatment delivery.