Circumferential or Sectored Beam Arrangement for SBRT Impact on Target & Normal-structure Dose-Volume Metrics

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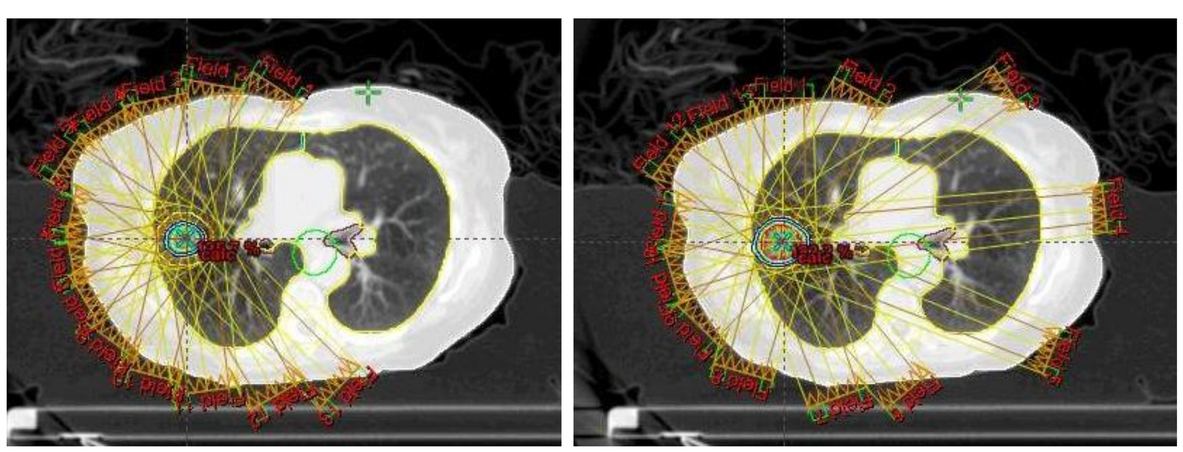
Background

High-precision four-dimensional computed tomography (4DCT) tumor imaging and online image-guided positional verification considerably reduce and individualize radiation target volumes while improving targeting precision of stereotactic body radiation therapy (SBRT) compared to three-dimensional CT-based conformal radiotherapy. This enables considerable escalation of fraction doses and reduces the overall treatment time, with consequential improvement in local control ratesfor non-small-cell lung cancer (NSCLC). The Radiation Therapy Oncology Group (RTOG) and the European Organization for Research and Treatment of Cancer (EORTC) Radiation Oncology and Lung Cancer Groups have provided recommendations to assist in the implementation of high-precision radiotherapy and SBRT into routine clinical practice. In principle, planning and delivery of SBRT generally utilizes multiple coplanar or non-coplanar beams or arc techniques directed at the radiation target to achieve clinically acceptable conformal target dose distributions and steep normal tissue dose gradients. Nonetheless, beam arrangements for SBRT follow personal or institutional preferences. While some groups avoid beam entry over the contralateral lung, others favor a more evenly spaced circumferential approach. The purpose of this study is to compare two beam arrangement concepts: sectored (beam entry over ipsilateralhemithorax) and circumferential (beam entry over both ipsilateral and contralateral lungs), for static-gantry intensity-modulated radiation therapy (IMRT) and intensity-modulated arc therapy (IMAT) delivery techniques with respect to dose gradient and exposure of normal organs-at-risk for patients treated by SBRT for primary NSCLC.

Methods

Data from 60 patients treated by SBRT for primary NSCLC formed the basis of this study. Four treatment plans were generated per dataset: IMRT/IMAT plans using sectored (-s; image on the left) and circumferential (-c; image on the right) beam configurations. The prescribed dose (PD) was 60 Gy in 5



fractions to 95% of the PTV with a maximum PTV dose of ~150% of PD for a 6 MV photon beam. Plan conformality, target dose heterogeneity, R_{50} (ratio of volume circumscribed by the 50% and the PTV) were evaluated. For lungs, mean doses (MLD) was evaluated.

Results

Dose conformality and target dose heterogenety were comparable between sectored and circumferential techniques. Dose gradient , on the other hand

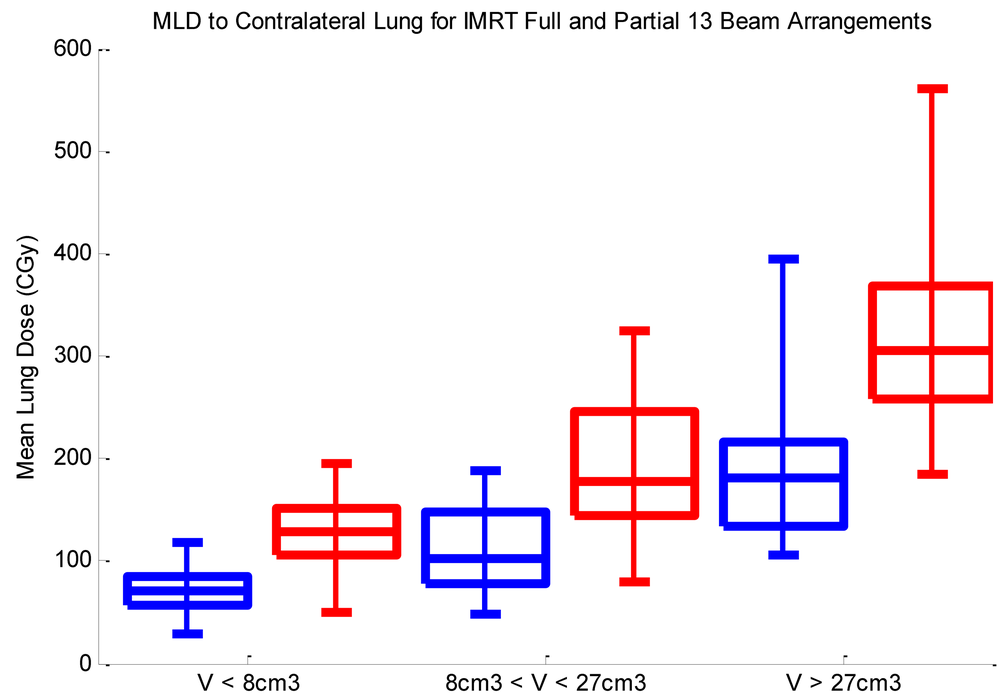
Conformity Index	Circumferential Arrangement	Sectored Arrangement	Percent Difference	Pvalue*
IMRT	1.14 ± 0.06	1.14 ± 0.05	**0.3%**	0.079
IMAT	1.13 ± 0.17	1.13 ± 0.05	**0.1%**	0.780

Heterogeneity Index	Circumferential Arrangement	Sectored Arrangement	Percent Difference	Pvalue*
IMRT	1.42 ± 0.07	1.42 ± 0.06	**0.2%**	0.627
IMAT	1.41 ± 0.07	1.41 ± 0.06	**0.2%**	0.669

was unequivocal.

Gradient (R_{50})	Circumferential Arrangement	Sectored Arrangement	Percent Difference	Pvalue*
IMRT	4.48 ± 0.71	4.28 ± 0.58	**4.7%**	<0.001
IMAT	4.10 ± 0.77	4.08 ± 0.51	**0.3%**	0.273

Sectored SBRT planning resulted in a significant decrease in contralateral MLD when compared to circumferential planning (p<0.001).



Conclusion

As expected, sectored beam arrangements showed dosimetric advantages over circumferential beam arrangements in terms of contralateral lung sparing.