Mean (SD) cc, % or Gy	3DCT (IMRT)	4DCT (IMRT)	3D vs. 4DCT (IMRT)	4DCT (VMAT)	IMRT vs. VMAT (4DCT)
PTV volume	618 (333)	518 (296)	p<0.01		
PTV V95%	95.2 (3.4)	97.1 (2.7)	p<0.01	97.1 (2.1)	p=0.83
PTV V107%	0.5 (0.5)	0.1 (0.1)	p<0.01	0.2 (0.3)	p=0.06
Lungs-GTV V20Gy	25.6 (5.4)	24.3 (5.5)	p<0.01	22.8 (4.7)	p<0.01
Lungs-PTV4D V20Gy	21.8 (5.3)	20.5 (5.3)	p<0.01		p<0.01
Oesophagus Dmean	21.6 (8.0)	20.9 (8.2)	p=0.02	19.8 (8)	p=0.04
Heart V35Gy	11.8 (10.7)	11.1 (10.2)	p<0.01	8.6 (8.6)	p<0.01

All treatment plans were met the clinically acceptable goals. The 4D-IMRT showed a statistically significant improvement ($p<0.05$) compared to 3D-IMRT in all relevant parameters. The 4D-VMAT plans further reduced all OAR parameters significantly ($p<0.05$), while maintaining identical target coverage. Phantom measurements confirmed that both techniques (IMRT and VMAT) can be safely administered.

Conclusion: By using the 4D-CT acquisition and mid-ventilation target delineation approach, significant PTV volume reduction was obtained. This method is improving PTV coverage and OAR doses using the same technique (IMRT). VMAT technique might further gain additional dosimetric benefits for patients with NSCLC.

PO-0845

Evaluating dosimetric indices in lung SBRT for establishing treatment plan quality guidelines

R. Yaparpalvi[1], M. Garg[1], J. Shen[1], W. Bodner[1], D. Mynamapati[1], H.C. Kuo[1], P.G. Scripes[1], A. Basavatia[1], N. Ohri[1], W.A. Tome[1], S. Kalnicki[1]
[1]*Montefiore Medical Center, Radiation Oncology, Bronx- New York, USA*

Purpose or Objective: We applied a variety of published conventional and stereotactic plan quality dosimetric indices to describe and discern clinically achieved target dose distributions in Lung SBRT.

Material and Methods: Treatment plans of 100 Lung SBRT patients treated were retrospectively reviewed. The targets (n=102) were evenly distributed – right lung (53) and left lung (49). Patients were prescribed to a total dose of 50-60 Gy in 3-5 fractions. Dose optimizations were accomplished with 6 MV using either 2-5 arcs VMAT (90); 8-14 IMRT fields (6) or 10-16 static fields (6). Dose calculations were performed using AAA algorithm with heterogeneity correction. A literature review on dosimetric indices recommended for qualitative analyses of conventional and stereotactic dose distributions in target coverage, homogeneity, conformity and gradient categories was performed. From each patient treatment plan, the necessary parameters for calculating various indices were quantified.

Results: For the study, the mean (±SD) values for indices were: coverage (96.4 (±2.4) %); homogeneity (1.27 (±0.07)); Conformity (1.04 (±0.08)) and Gradient 1.27(±0.30) cm). Geometric conformity (g) strongly correlated with the conformity index (defined by van't Riet /Paddick)($p<0.0001$). All Gradient measures strongly correlated with PTV ($p<0.0001$). Evaluating High Dose Spillage, the average cumulative volume of all tissue outside the PTV receiving a dose of > 105% of prescription dose was 0.94 (± 1.64) %. Considering Low Dose Spillage, the maximum % of prescription dose to any point at 2 cm distance in any direction from PTV was 56.0 (± 11.4) %. The lung volume (total lung volume – GTV) receiving doses of 20 Gy and 5 Gy (V20 and V5) were mean 4.9 % (± 3.1) and 16.9 % (± 9.0). The RTOG lung SBRT protocol advocated conformity guidelines for prescribed dose in all dosimetric evaluation categories were met in ≥94% of cases.

Conclusion: The high-rate of adherence to RTOG protocol dose conformancy guidelines in our study validates that indices derived from our SBRT lung plan dose distributions are a tool for establishing plan metrics in clinical trials, for scoring competing plans and as well as for comparing inter-institutional lung SBRT plan dosimetric data. However, these indices should only be used as an additional tool to grade plan quality once a satisfactory treatment plan has been achieved judged on the basis of clinical expertise, acceptable dose distributions and dose gradients, while respecting critical organ and normal structure doses.

PO-0846

The impact of anatomical changes on the accumulated carbon ion dose in pancreatic cancer patients

A.C. Houweling[1], K. Fukata[2], Y. Kubota[2], H. Shimada[2], C.R.N. Rasch[1], T. Ohno[2], A. Bel[1], A. Van der Horst[1]
[1]*Academic Medical Center, Department of Radiation Oncology, Amsterdam, The Netherlands*
[2]*Gunma University, Gunma University Heavy Ion Medical Center, Maebashi, Japan*

Purpose or Objective: Improvements in overall survival of pancreatic cancer patients after carbon ion radiotherapy have been reported from Japanese clinical trials. Due to the sharp distal dose fall-off, a high dose can be delivered to the tumor, while sparing the nearby healthy organs. However, changes in gastrointestinal gas volumes can greatly influence the carbon ion range.
We evaluated the robustness of carbon ion therapy for pancreatic cancer patients by investigating the impact of interfractional anatomical changes on the accumulated dose when using bony anatomy- and fiducial marker-based position verification.

Material and Methods: Nine pancreatic cancer patients, treated with photon radiotherapy in free breathing, were included in this retrospective planning study. The internal gross tumor volume (iGTV), internal clinical target volume (iCTV), duodenum, stomach, liver, spinal cord and kidneys were delineated on the (average) 4D-CT scan. Intratumoral gold fiducial markers were implanted in all patients to enable position verification using cone beam CT (CBCT).
Treatment plans were created using a 4-beam passive scattering technique. A smearing technique was used to account for patient setup errors; a safety margin of 3 mm was applied to compensate for range uncertainties. Plans were generated to deliver at least 95% of the prescribed dose (36GyE in 12 fractions) to 99% of the iCTV.
To enable dose calculations on the daily CBCTs, the planning CT was deformably registered to each CBCT. The gastrointestinal gas volume visible on each CBCT was copied to the deformed CTs. Next, fraction doses were calculated by aligning the treatment plan according to a bony anatomy- and a fiducial marker-based registration. For both registration methods the resulting fraction doses were rigidly summed to acquire the accumulated dose.
We compared both accumulated doses to the planned dose using dose-volume histograms (DVHs) and calculated DVH parameters for the iGTV and iCTV (Dmean, D2%, D98%) and organs at risk (Dmean, D2cc).

Results: The D98% of the target volumes showed the largest differences (Figure). For the bony anatomy-based registration, D98% reduced significantly from 99.6% ± 0.2% (iGTV; mean ± standard deviation) and 98.6% ± 0.5% (iCTV) as planned to 92.3% ± 3.8% and 81.9% ± 7.7% for the accumulated dose, respectively. For the marker-based registration, this was slightly improved to 95.1% ± 4.0% (iGTV) and 88.6% ± 4.0% (iCTV), which was still significantly different from planned.
For the duodenum, severe deviations were observed in the DVHs between the planned and accumulated dose. Both the direction and magnitude of the deviations differed considerably between patients. The other organs showed minor changes.