AbstractID: 3441 Title: Investigation of the actually delivered patient dose in lung IMRT treatment based on deformable registration of 4D CT data and Monte Carlo simulations

Purpose: To accurately calculate the difference between prescribed and delivered dose caused by respiratory motion and artifacts in free breathing helical CT (fbCT) for lung IMRT treatments, and to estimate the impact of this difference in clinical outcome.
Method and Materials: Ten cases were studied. For all patients, fbCT and 4DCT reconstructed at 10 phases of the respiratory cycle were available. Patients were selected to have a wide range of tumor motion, size, and position. CORVUS was used to make two IMRT plans calculated on the fbCT for GTV (volume determined on fbCT) and ITV (volume determined by 4DCT) targets respectively. The prescribed dose was 60Gy. The fluence maps and beam setup parameters of the IMRT plans were used by the Monte Carlo dose calculation engine MCSIM for absolute dose calculation on free breathing and 4DCT data. CT deformable registration between the breathing phases was performed and the composite dose over the whole breathing cycle was calculated for the GTV, CTV and lungs. EUD and TCP/NTCP values were determined for the composite dose over the whole breathing cycle based on both plans.
Results: For a patient with 4 cm peak to peak tumor movement, a planned CTV EUD of 58 Gy was reduced to 54Gy and 33Gy respectively for the composite 4D dose distribution of ITV and GTV plans. 3-year control estimates for this patient, assuming that 3-year local control after 60Gy in the GTV is 30%, were reduced to 29% and 23% for the ITV and the free breathing plans respectively.
Conclusion: With the advent of 4DCT, CT data deformable registration and Monte Carlo dose calculations, it is feasible to accurately calculate in retrospect the actually delivered dose and compare it with what historically was assumed to be delivered.