AbstractID: 4628 Title: Patient Breathing Motion Synchronized IMAT: A New Technique for Compensating Intra-fraction Organ Motions

Purpose:
To develop an image-guided radiotherapy technique for compensating intra-fraction organ motions by taking full advantage of 4-D CT and motion tracking.

Methods and Material:
We have developed a new image-guided radiotherapy technique called patient breathing motion-synchronized intensity-modulated arc therapy (IMAT) based on the following observations.
(1) If the LINAC gantry rotates x degrees in one breathing cycle during an IMAT arc delivery, then the beam source "sees" the same breathing phase at beam angles spaced x degrees apart.
(2) If each breathing cycle is divided into k breathing phases, then we can partition all discrete beam angles used for planning an IMAT treatment into k groups, with each group "seeing" a particular breathing phase.
If one can first calculate an intensity map for each group of beam angles using their corresponding snapshot in the 4D CT image set as a gantry-fixed IMRT plan, then the resulting k groups of intensity maps can be combined and converted into a final set of IMAT treatment arcs.
As long as the patient can reproduce his/her own pre-recorded breathing patterns, the IMAT plan can be delivered and is optimal in 4-D.
(3) To ensure that the patient's breathing is always at the correct breathing phase at the start of the irradiation of each IMAT arc,
the beam is not turned on after pressing the "Beam-On" button until the breathing pattern reaches the predetermined phase through motion tracking.

Results:
We applied the motion-synchronized IMAT technique to the dynamic phantom from CIRS Inc., which can simulate patient breathing motions.
Our experimental study indicated that this technique can deliver optimal treatments under motions.

Conclusion:
We have developed a new image-guided radiotherapy technique called patient breathing motion-synchronized IMAT.
Our prototype study has demonstrated the feasibility and advantage of this novel method that warrants further investigation.