AbstractID: 3690 Title: Free Breathing Synchronized 4D Radiotherapy: imaging, treatment planning, and delivery

Purpose: Develop four-dimensional (4D) radiotherapy to incorporate breathing motion in thorax, covering PTV adequately and reducing mean lung dose and V20 for lung. Analyze tumor and thoracic structures motion using the 4D-CT images.

Method: Motion of tumor and thoracic structures of twenty lung cancer patients are studies, using a retrospective respiratory gating 4D-CT and external respiratory signal generator system. Breathing was synchronized with cine image acquisition, and retrospectively correlated based on respiratory phases. For 4D-delivery, MLCs were synchronized with respiratory motion and followed tumor with a safe margin selected based on reliability of patient breathing ranging from 100% largest static field to 0% the smallest dynamic field.

Results: 4D-CT provides tumor motion in different phases of breathing cycle. The GTV/CTV delineated on helical CT without incorporating breathing motion underestimates GTV/CTV by 25-50% compare to the 4D-GTV/CTV delineated on 4D-CT image sets. The 4D radiotherapy reduces the mean lung dose by 16-32% (average 23%) and V20 reduction for ipsi lung by16-26% (average 21%) compare to the standard protocol. The volume changes of apex, mid and inferior regions of the lung during breathing are 11%, 24%, and 65%. The motion of tumors varies with the location. Tumors located in the apex move by 3-5mm, 2-4mm, and 2-3.5mm in superior/inferior, anterior/posterior, and right/left directions. Those located in mid lobe move by 6.5-9mm, 3.5-5mm, and 4-5mm, and those in lower lobe move by 7.5-12mm, 4-8mm, and 3.5-6.5mm. The superior/inferior motions of diaphragm, rib and carina range from 7-25mm, 2-7mm, and 3.5-13mm. On 4D delivery, we tested MLC synchronization with breathing motion on phantom. Lung volume coverage is minimized by a 20% safe margin.

Conclusions: 4D-CT provides tumor motion in different phases of breathing cycle. 4D delivery synchronized with respiration-induced motion reduces mean lung dose and were synchronized with respiratory motion V20 for lung.