AbstractID: 12739 Title: A lifelike breathing phantom and model tumor for IGRT and 4D dose calculation applications

Purpose: To evaluate an anatomical breathing phantom and model lung tumor for IGRT and 4D applications.
Method and Materials: The shape of a tumor was extracted from a patient's CT image, and a replica tumor created in a flexible resin using rapid-prototyping techniques. A 5mm grid of fine holes was included in the model tumor to allow insertion of up to 30 micro-mosfets. The physical characteristics of this tumor were compared with those of real patient tumors. This tumor was inserted into a commercial anatomic breathing phantom (RSD Inc.). This phantom includes spine, and a flexible ribcage. The tumor and phantom's chest motion were programmed using real patient traces. CT images (4D and free breathing), kilo-voltage setup images (including fluoroscopy), and mega-voltage portal images were compared with those from real patients. Twenty mosfets were inserted into the model tumor, and the phantom was irradiated using a step-and-shoot IMRT plan. The expected dose distribution was calculated using a previously validated 4D Monte Carlo technique.
Results: The appearance of the phantom/tumor in kV and MV images was very similar to real patient images. The average CT number of the model tumor was 76 (at 120kVp), compared with 30 for the real patient (an effective difference in electron density of 2%). Its physical density and hardness was 1.3g cm^{-3} and 27durometers (range for real tumors: 0-60), respectively. The CT numbers of the bone and soft tissue regions of the breathing phantom were in the range found for real patients. The CT number of the lung material was the same as air. Agreement between the 4D Monte Carlo and experimental DVH was better than 3%.
Conclusion: Rapidprototyping techniques can be used to produce realistic low cost model tumors that, in combination with an anatomical breathing phantom, can be used for IGRT and 4D applications.