

AbstractID: 13591 Title: Comparison of Gold, Carbon, and Polymer Fiducial Markers Using Different Imaging Modalities to Determine Optimal Marker Material for Image Guided Radiotherapy

Purpose: To evaluate the visibility and artifact created by gold, carbon, and polymer fiducial markers across standard imaging modalities, including computed tomography (CT), kilovoltage (kV) and megavoltage (MV) linear accelerator imaging, Tomotherapy imaging, and ultrasound.

Method and Materials: A 30×31×15 cm phantom was constructed using Superflab bolus. Three of each type, gold (0.9×3 mm), carbon (1×3 mm), and polymer (1×5 mm) markers, were inserted into the center layer of bolus. The phantom was imaged with CT, linac based kilovoltage and megavoltage x-ray imaging systems, normal and fine Tomotherapy imaging, and ultrasound using various imaging parameters. The visibility and artifacts produced by each marker were assessed qualitatively and quantitatively; quantitative evaluations included analysis of contrast produced by each marker to assess visibility, and histograms and the standard deviation of the pixel values of a ring of increasing radius around each marker to evaluate artifacts.

Results: All tested markers could be seen clearly under CT, kV, and ultrasound imaging, with the gold markers demonstrating the highest contrast. Under CT imaging, gold produced significant artifacts, while no artifacts were observed around polymer markers. Only the gold markers were visible when using linac based MV and Tomotherapy imaging. For linac based kV images, the contrast increased with kV and mA values for all the markers with the gold being the most pronounced. On CT images, the contrast increased with kV for the gold markers while decreasing for the polymer and carbon marker. We observed that the contrast significantly increased with slice thickness for the gold markers while the impact on the carbon and polymer markers was minimal.

Conclusion: For kV based treatment verification, polymer and carbon markers are the preferred choice in CT simulation. For MV based treatment verification, gold markers should be used despite the artifacts they create on the simulation CT images.