

AbstractID: 6872 Title: Assessing Residual Motion for Gated Proton-Beam Radiotherapy

Purpose: To examine the influence of phase delays and baseline drifting on residual motion in gated radiotherapy.

Method and Materials: Four patients with hepatocellular carcinoma were studied within a phase I clinical trial for gated proton beam radiotherapy. Between 3 and 5 gold fiducial markers were implanted in or near the tumor site to serve as internal surrogates for the treatment target. The Varian Real-time Position Management (RPM) system was used as an external surrogate for respiration. The RPM was synchronized to an orthogonal bi-plane fluoroscopic imaging system, and simulation sessions were conducted under free breathing. The three-dimensional coordinates of each marker were tracked retrospectively, and compared with the synchronized RPM signal. The phase delay from internal position to external surrogate, and baseline drifting of the exhale position over the course of several minutes were measured, and their impact on gated treatment was assessed.

Results: Phase delays were found, ranging from -0.02 seconds to $+0.22$ seconds, indicating that motion inside the liver may not be seen immediately on the external surface. Phase delays varied from marker to marker, and also over time during the course of 4 to 6 minutes. Baseline drifting was also found in two of the four patients, indicating that the exhale position of the liver may not be stable within the first several minutes after lying on the treatment couch. The baseline drift was usually from inferior to superior, with values ranging from -1 mm to 6 mm. The worst-case residual motion of an amplitude-gated treatment was estimated to be 7.4 mm.

Conclusion: We observed phase delays of more than 100 ms in two of four patients, and baseline drifting of 5 mm or more in two of four patients. The utility of external surrogates for gating should be studied in more detail.