

Purpose: To evaluate the effect of breathing motion on the delivery of linac-based intensity modulated total marrow irradiation (IM-TMI).

Methods: An IM-TMI treatment planning for an anthropomorphic Rando phantom was performed using the three isocenter technique that was previously reported by our group. The chest sub-plan that targets the ribs, sternum and spine while sparing the lungs, liver, and heart was used to evaluate the effect of breathing on the treatment delivery. The breathing motion was simulated using a motorized stage. IM-TMI dose measured in a stable phantom first and then in a phantom that was set on motion using three sinusoidal motions with peak-to-peak distances of 5 mm superior-inferior (SI), 10 mm SI, and 5 mm both SI and anterior-posterior (AP). A total of 46 thermoluminescent detectors (TLDs) were placed in five locations in the target bones and lungs. An additional 8 TLDs were used for dose calibration. The measured doses were corrected using the individual TLD sensitivities. The average TLD doses obtained with motion were compared to that of the stable delivery. In addition, a stereotactic photon diode was used to measure the dose in another target bone location.

Results: The ratio of the moving to stable delivery of mean dose were 1.04 (range: 1.01-1.06), 1.06 (1.04-1.07) and 1.03 (1.00-1.04) in target bones while the ratios were 1.00 (0.94-1.09), 1.01 (0.97-1.04) and 1.00 (0.97-1.04) in the lungs for the 5 mm SI, 10 mm SI, and 5 mm SI and AP motions respectively.

Conclusions: In this study, 16 out of 18 measurement points showed less than 6% difference with breathing motions in a single fraction. The delivered dose difference was as much as 7% high in bone and 9% low in lung with breathing motion.