Positioning Accuracy and Reproducibility of a Passive Infrared Marker System

We have assessed the accuracy of a novel system for positioning targets at the isocenter of the linear accelerator. With two infrared cameras, the system determines the 3D coordinates of IR reflective markers through stereophotogrammetry. Locating a target relative to the markers, the system positions it at the isocenter of the linear accelerator. Displacement of the target from the intersection of the lasers determines positioning accuracy and reproducibility. For stationary markers attached to a torso phantom, the system consistently repositions the target within 0.5 mm with no dependence on either number or location of markers. Additional errors from CT localization of the markers and target increase this displacement to 1.0 mm. The 3D coordinates of the stationary markers do fluctuate slightly; shifting the markers on the surface of the phantom by an even larger amount increases mean displacement depending on both number and location of markers. For shifts of 2.5 mm, displacement ranges from 1.2 to 1.5 mm for any number of markers. For shifts of 5.0 mm, accuracy improves from a mean displacement of 3.5 mm with four markers to 1.8 mm with seven. Mean displacement also improves slightly with markers near the target. Collinear arrangements, however, significantly worsen accuracy. Shifts on graph paper produce similar results in positioning with number and location of markers. These results suggest that the system can consistently position the target within 2 mm of the isocenter even with marker shifts as large as 5 mm.