Purpose: To perform the quality assurance for the dynamic tumor-tracking (DTT) irradiation with Vero4DRT (MHI-TM2000).

Methods: Vero4DRT swings its gimbaled 6-MV C-band x-ray head along the pan and tilt direction to track a moving tumor. Surrogate signal-based DTT system implemented in Vero4DRT was used. Before DTT irradiation, the correlation model (4D-model) between motion of the IR markers on the abdominal wall and the tumor position was created with synchronously monitoring by the IR camera and orthogonal kV x-ray imaging subsystem. During beam delivery, the 4D-model predicted the future tumor position from the displacement of the IR markers in real-time, and then contentiously transferred the corresponding tracking orientation to the gimbaled x-ray head.

Water-equivalent phantoms were set on a 1D motor-driven base with IR markers. A film placed at a depth of 10 cm in the phantom was irradiated under the following conditions: stationary state, and tracking and non-tracking state for sinusoidal patterns. In addition, the geometric accuracy was evaluated using a 3D moving phantom and Polaris Spectra for the previously-acquired patient's respiratory pattern.

Results: Compared to the stationary conditions, reductions in lateral distance between 95% doses of the dose profile were 1.2 mm for tracking and 29.6 mm for non-tracking state for (amplitude \([A]\), period \([T]\)) = (20 mm, 2 s); and 0.2 mm and 29.4 mm for \((A, T) = (20 \text{ mm, } 4 \text{ s})\); and 0.0 mm and 11.2 mm for \((A, T) = (10 \text{ mm, } 2 \text{ s})\), respectively. In the geometric accuracy testing, 95th percentile of the tracking error was 0.5 mm in left-right, 1.0 mm in superior-inferior, and 0.5 mm in anterior-posterior direction.

Conclusions: We demonstrated that Vero4DRT substantially reduced the blurring effects on dose distribution with high tracking accuracy, and confirmed the safety of the DTT irradiation for a clinical application.

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