Investigation of Clinical Performance of Two 4DRT Techniques — RPM and Bellows System

Purpose

The objective of this study was to systematically evaluate the clinical performance of two 4DRT techniques, RPM and Bellows system.

Materials and Methods

An RPM system was mounted at the distal end of a Philips CT simulator couch. A marker block was positioned on the sternum of a newly released commercial lung phantom. A Bellows sensor was tied around the thorax of the phantom next to the marker block to ensure equal breathing amplitudes. The air pressure generated by an air pump inflated and deflated the lung phantom periodically. It also drove a spherical target in a translational fashion with an 8° rotation at the end of the motion. The performance of the two systems was investigated by applying different motion depths, 0.3, 0.5, 0.75, and 1.0, and motion patterns, $\sin^2(x)$, $\sin^4(x)$, and $\sin^6(x)$, to the lung phantom. The pressure wave was detected by the Bellows sensor and fed into the CT scanner for 4DCT reconstruction.

Results

The motion wave forms detected by RPM and Bellows system were almost identical in cases of $\sin^2(x)$, $\sin^4(x)$, and $\sin^6(x)$ with a motion depth of 1. At large depths, both systems provided equal sensitivity in detecting breathing signals. At shallow breathing depths, the wave forms detected by RPM were degraded and the peaks were somewhat flattened, while the Bellows system preserved a relatively good wave form. At extremely shallow depths, RPM failed to track the breathing motion while the Bellows system continued to perform normally, providing a superior sensitivity over the RPM.

Conclusions

RPM failed to detect the breathing signal when the motion amplitude became very small. Bellows System was able to track the respiratory motion continuously even when it is extremely weak.