Purpose:
Though the 4DRT techniques have been rapidly developed, the accuracies of these devices have not been generally discussed due to the limitation of the functions of the conventional moving phantoms. The purpose of this study is to evaluate several 4DRT devices such as respiration-detectors and 4DCT scanners by using the newly developed moving phantom with highly accurate position control in three directions.

Methods:
Three commercial respiration-detectors (AZ-733VTM, ANZAI Medical Co., Bellows SystemTM, Philips, Inc. and Real-time Position Management (RPM)TM, Varian Medical Systems, Inc.) were set on the 1D-axial unit of the moving phantom, which imitates the motion of the abdominal surface that was moved along the cos2n(x) curves (n=1,2,3) with different cycle times (3,5,7 seconds). Then the input and the measured motions were compared. For the verification of the 4DCT scanners, the acryl sphere with a diameter of 6 mm was moved in three directions. The 4DCT data sets were acquired by 16-detector row 4DCT scanners (AquilionTM, Toshiba Medical Systems, Co. and Brilliance CTTM, Philips, Inc.), and the positional errors were evaluated.

Results:
The averages of the positional errors of the respiration-detectors were 5.20 % for AZ-733VTM, 6.20 % for Bellows SystemTM and 0.96 % for RPMTM, suggesting that optical sensors could be more accurate than pressure-sensors. The positional errors of the target measured by 4DCT scanners tended to be larger when the cycle time was shorter. The ratios of the positional errors less than 5% to all the measured phases for cycle times of 3 and 7 seconds were 37 and 59 % in LR, 59 and 74% in AP and 52 and 78% in SI direction, respectively.

Conclusions:
The major respiration-detectors and 4DCT scanners were evaluated by using our novel moving phantom. This moving phantom can be used for evaluation of various 4DRT devices.