Analyses Of Interfractional Variations In Pancreatic Position Based On Four-dimensional Computed Tomography

T. Shiinoki¹, Y. Narita², M. Nakamura², K. Shibuya², Y. Matsuo², M. Nakata³, A. Sawada², T. Mizowaki², A. Itho¹, M. Hiraoka²

¹Department of Nuclear Engineering, Graduate School of Engineering, Kyoto University, sakyo-ku, Japan,
²Department of Radiation Oncology and Image-applied Therapy, Graduate School of Medicine, Kyoto University, sakyo-ku, Japan,
³Clinical Radiology Service Division, Kyoto University Hospital, sakyo-ku, Japan

Purpose/Objective(s): Pancreatic movement with respiration is one of the most critical limitations for the treatment of pancreatic cancer with radiation therapy. We hypothesized that interfractional stabilities in the position of pancreas at the end-exhalation were higher than those at end-inhalation. The purpose of this study was to evaluate the interfractional stabilities of pancreas during the course of radiation therapy, based on four-dimensional computed tomography (4DCT).

Materials/Methods: Ten patients with pancreatic tumors were enrolled in this study. For each patient, 4 times 4DCT at CT simulation (CTS) and during 6 weeks treatment course were acquired under free breathing in the supine position with his arms raised fixed in customized vacuum pillow. Subsequently, the rigid image registration between 4DCT datasets and the reference 4DCT (CTS) was performed based on the bony anatomy on a treatment planning system (Eclipse; Varian, Palo, CA). Intrapancreatic bile ducts were manually delineated as surrogate of pancreas head position on the 4DCT set by one medical physicist and one radiation oncologist. Centroids of bile ducts were computed at 0% (end-inhalation) and 50% (end-exhalation) of the respiration phases. Then intrafraction and interfraction variations in position of the centroids were evaluated in the superior-inferior (SI), anterior-posterior (AP), and left-right (LR) directions, respectively.

Results: The mean and standard deviation (S.D.) of intrafractional variations in position were 1.3±1.2 mm, 1.3±0.9 mm, 4.7±2.8 mm in LR, AP and SI directions, respectively. Variations were significantly large in the SI direction (p < 0.05). The mean and S.D. of interfractional variations in position at the end-inhalation were 3.6±2.5 mm, 2.9±2.2 mm and 4.7±3.3 mm in LR, AP and SI directions, respectively. On the other hand, those at the end-exhalation were 3.3±2.2 mm, 2.3±2.4 mm and 3.2±2.8 mm, respectively. Interfractional variations in SI direction were significantly smaller (P<0.05) at end-exhalation than end-inhalation, although no significant differences were observed in both LR and AP directions.

Conclusions: The largest variations of pancreatic tumor motion are along SI direction. Interfractional stabilities in position at the end-exhalation in SI direction are significantly higher than those at end-inhalation. It indicates that breath-holding at the end-exhalation might bring higher positional reproducibility, which makes it possible to accomplish dose escalated radiation therapy with more accuracy and reduce toxicities with minimum margin size around pancreatic tumor.

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