Development of Real-Time Couch-Based Tracking System (CBTS) For Image Guided Radiotherapy: A Feasibility Study

K. Chang\(^1,2\), S. Lee\(^1\), C. Lee\(^3\), J. Shim\(^1\), Y. Cao\(^1\), S. Lee\(^4\), W. Yoon\(^1\), Y. Park\(^1\), D. Yang\(^1\), C. Kim\(^1\), \(^1\)Department of Radiation Oncology, Seoul, Korea, Republic of, \(^2\)Department of Biomedical Engineering, college of Medicine, Korea University, Seoul, Korea, Republic of, \(^3\)Department of Information and Communication, Gyeonggi-Do, Korea, Republic of, \(^4\)Cheil General Hospital & Women's Healthcare Center, Kwandong University College of Medicine, Kangwon, Korea, Republic of

Purpose/Objective(s): Intra-fraction motions due to respiration in the thoracic and abdominal regions have been observed. Respiration-induced tumor motion can result in radiation-induced toxicity in the healthy tissue. The aim of this study is to evaluate the mechanical accuracy of couch-based tracking system (CBTS) according to the respiration data with measurement the accuracy and delay time of CBTS for clinical application.

Materials/Methods: Position data of the 3 axes using AlignRT (Vision RT, UK) were obtained. The surface position data of the patient is transferred to the serial port in MCU through the RS-232C communication system. MCU generated an optimized control signal and produced the motor control signals in real time using a PID algorithm. And CBTS tracks the surface position data of three directions using three motors. Current couch position information according to the 3 axes was fed back to tracking program using the linear encoder and linear strip. The regular respiratory motion data is a sine wave representing artificial respiration with a constant cycle. The respiration data was recorded at a sampling period of 10 ms for 60 s. We evaluated the mechanical movement of CBTS according to the sine wave and volunteer data. The CBTS has a mechanical delay time between the respiration data and tracking data, and an inherent processing time that the respiration data is transferred to the serial port within micro controller unit (MCU). We can calculate the processing time using the data transfer rate of RS-232C. The overall delay time of CBTS was calculated as the sum of two delay time. The test was repeated at intervals of 60 seconds for 3 minutes. Then we calculated root mean square (rms) error, average error, and standard deviation error of accuracy in 3 directions (X, Y and Z directions) based on the phase difference between the respiration data and tracking data.

Results: The result of analyzing the acquisition-correction data shows that the root mean square error and standard deviation of measurement in 3 axes (X, Y, and Z directions) is 2.94 ± 1.67 mm, 2.99 ± 1.69 mm, 5.05 ± 3.02 mm, respectively. Overall delay time of CBTS is calculated about \(2.34 \times 10^{-4}\) sec as the sum of the inherent processing time and the average mechanical delay time of CBTS.

Conclusions: This novel CBTS has the potential for clinical application for tumor tracking in radiation therapy. The effect of the delay time needs to be further evaluated from the view-point of dosimetric impact and plan degradation. Further studies are necessary to reduce the delay time, to investigate the novel tumor motion prediction algorithm for real-tracking radiotherapy.

Acknowledgment: This work was supported by the Korea University Grant.