Purpose: To assess the effect of audio instruction on tracking accuracy for MHI-TM2000 (VERO).

Methods: Anterior-posterior abdominal skin surface displacements for ten patients with a lung tumor were measured by a respiratory monitoring system with and without audio instruction. Based on the obtained twenty respiratory patterns, a three-dimensional movable phantom with a steel ball target of 9.5 mm in diameter was driven along the superior-inferior direction. The target position was measured in real time by the laser displacement gauge and the orthogonal kV x-ray imaging subsystem. Simultaneously, the kV x-ray imaging subsystem predicted the future target position, and then the system controller calculated the corresponding rotation angles. Thereafter, the gimbaled x-ray head tracked the target based on the command. Total tracking system error (ET) was computed by both target prediction errors and mechanical response errors of the gimbaled x-ray head, and then compared between with and without audio instruction.

Results: By applying audio instruction, the reproducibility of respiratory pattern was significantly improved ($p < 0.01$), although motion amplitude was increased by a factor of 2.1 on average. The root mean squares of the ET (RMSET) were up to 1.18 mm without audio instruction and 1.26 mm with audio instruction, respectively. There was no significant difference between free breathing and audio instruction in the RMSET ($p = 0.26$). The correlation between the RMSET and the 90th percentile of respiratory speed (v) was stronger under the conditions of audio instruction ($R2 = 0.77$) than under the conditions of free breathing ($R2 = 0.29$).

Conclusions: Audio instruction improved reproducibility of respiratory pattern but increased to the v that negatively affected the tracking accuracy. The tracking errors can be deduced from the v for regular respiratory pattern, suggesting upper limit of the v to achieve high tracking accuracy.

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