Purpose: The aim of this study was to clarify the impacts of acquisition parameters on artifacts in four-dimensional computed tomography (4D CT) images, such as the partial volume effect (PVE), partial projection effect (PPE), and mis-matching of initial motion phases between adjacent beds (MMimph) in cine mode scanning.

Methods: A thoracic phantom and two cylindrical phantoms (2 cm diameter and heights of 0.5 cm for No.1 and 10 cm for No.2) were scanned using 4D CT. For the thoracic phantom, acquisition was started automatically in the first scan with 5 sec and 8 sec of gantry rotation, thereby allowing a different phase at the initial projection of each bed. In the second scan, the initial projection at each bed was manually synchronized with the inhalation phase to minimize the MMimph. The third scan was intentionally unsynchronized with the inhalation phase. In the cylindrical phantom scan, one bed (2 cm) and three beds (6 cm) were used for 2 and 6 sec motion periods. Measured target volume to true volume ratios (MsTrueV) were computed. The relationships among MMimph, MsTrueV, and velocity were investigated.

Results: In the thoracic phantom, shorter gantry rotation provided more precise volume and was highly correlated with velocity when MMimph was minimal. MMimph reduced the correlation. For moving cylinder No. 1, MsTrueV was correlated with velocity, but the larger MMimph for 2 sec of motion removed the correlation. The volume of No. 2 was similar to the static volume due to the small PVE, PPE, and MMimph.

Conclusions: Smaller target velocity and faster gantry rotation resulted in a more accurate volume description. The MMimph was the main parameter weakening the correlation between MsTrueV and velocity. Without reducing the MMimph, controlling target velocity and gantry rotation will not guarantee accurate image presentation given current 4D CT technology.