AbstractID: 7355 Title: The effect of mid-scan changes of breathing frequency and amplitude on 4D CT quality

Purpose: Commercial 4D CT systems attempt to correlate imaging with the respiratory cycle of the patient. Though it is known that irregular breathing introduces artifacts, this has not been systematically explored. The purpose of this study is to quantitatively investigate the effect of changing the amplitude and frequency of the breathing pattern mid-scan on image quality.

Materials and Methods: The Washington University 4D phantom holding a 2 cm lung tumor object encased in solid water was scanned with the Philips Brilliance 64 slice CT scanner in retrospective helical mode using the "bellows" respiratory surrogate. The breathing cycle was obtained from a lung cancer patient, and the motion during the first half of the scan was produced at a baseline trajectory with a consistent frequency and amplitude. The two parameters were then varied mid-scan to new frequency and amplitude values, throughout a range of 7.5 to 22.5 breaths/minute and 5 to 15 mm, respectively. Four phases were reconstructed using the commercial scanner software. Image quality was then evaluated by assessing volumetric, centroid, and geometric changes.

Results: Changes in amplitude of more than 25%, regardless of change in frequency, caused measurable volumetric and geometric image artifacts. Conversely, changes in frequency alone did not cause a notable change in the presence of artifacts. The largest amount of volume change was present at the 0% phase (peak inhalation) where the change in amplitude was greatest, while the least amount of volume change was present at the 50% phase.

Conclusions: These basic breathing statistics of the patient's respiratory wave would be useful in quickly assessing the quality of a helical 4D CT scan prior to image reconstruction. More work is necessary to generalize these results with other scan acquisition techniques and respiratory tagging algorithms.

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