Purpose: To develop a new method for accurate measurement of dynamic respiratory tidal volume, we investigate the feasibility of measuring torso volume change using optical surface imaging (OSI).

Methods: Based on a validated volume conservation theory, the tidal volume is equal to the volume change of the torso during quiet respiration (Li et al, PMB, 54:1693, 2009). A clinical OSI system was employed to acquire surface images of seven geometric phantoms and two 'deformable' torso phantoms. The mesh surface images were converted into contours for volume calculation using a treatment planning system. For geometric phantoms, their volumes under the incomplete surface images were calculated with aid of their symmetry. The results were compared with theoretical calculation and water containment experiments. For deformable torso phantoms, we created volume-controlled deformation stages by placing deformable PlayDoh (DPD) materials on top of rigid Rando/Thorax phantoms, mimicking respiration-induced torso surface elevation and volume change. The volume difference under the surfaces with and without the DPD padding was calculated with aid of a common posterior line to enclose the region of interest. Three different volumes of DPD padding (<500cc) were mounted on the torso phantoms and CT scanned for volume measurements.

Results: For geometric phantoms, the OSI measured volume had accuracy (±1s) of 0.0%±1.6% (vs. geometric volume calculation) and 0.6%±3.8% (vs. water containment experiment). For deformable torso phantoms, the volume change was measured using OSI with an accuracy of 1.5%±2.5% against the measured volume using CT imaging. Linear regression showed a one-to-one relationship between the OSI volumes and CT volumes with a slope of 1.003 ($r^2$=0.999).

Conclusions: The optical surface imaging system can accurately measure the volume of geometric phantoms and the volume change of deformable torso phantoms. The accuracy is about 3% against standard volume measurement methods. Further study on human subjects is under investigation.

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