Reproducibility of Automatic Lung Nodule Volumetry under Variation of Slice Thickness, Exposure, and Reconstruction Kernel in a Phantom Study: Comparison of Conventional and Partial Volume-Based Measurements

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Purpose:
Interscan reproducibility of nodule volumetry is a key issue in lung cancer screening and therapy monitoring. It is a well-known fact that currently available volumetry techniques require identical scanning and reconstruction parameters for all examinations in order to produce comparable results. For various reasons, this prerequisite is often not met in clinical practice. Aim of this study was to evaluate if performing an explicit partial volume analysis after segmentation can increase reproducibility with respect to variations of the most relevant scanning and reconstruction parameters.

Method and Materials:
The physical phantom used in this study contained 38 solid, spherical and non-spherical nodules representing different morphological situations (isolated, juxtapleural, vascularized) with diameters between 3 and 10 mm. The phantom was scanned with slice thicknesses of 0.6, 1, and 2mm, a dosage of 20mAs and 120mAs, and was reconstructed with a B46f, B50f, and B60f kernel using a Somatom Sensation 64 CT scanner (Siemens, Forchheim, Germany). For all 684 nodules, segmentation was obtained fully automatic based on fixed threshold separation from the parenchyma and morphological separation from simulated vasculature or chest wall. Reproducibility of conventional volume estimation (CONV, solely based on the segmentation mask) was compared to a novel segmentation-based partial volume analysis approach (SPVA) which combines information from segmentation mask and original CT densities for volumetry.

Results:
Variation of the reconstruction kernel between B46f and B60f (n = 228) resulted in a mean abs. volume difference of 3.7%±4.4% (SPVA) and 11.0%±17.1% (CONV), variation of slice thickness (n = 228) from 0.6mm to 1mm in 2.4%±5.5% (SPVA) and 6.5%±8.3% (CONV), from 0.6mm to 2mm in 4.3%±7.5% (SPVA) and 8.0%±11.4% (CONV), and variation in dosage between 20mAs and 120mAs (n = 342) in 3.0%±4.3% (SPVA) and 3.7%±6.0% (CONV).

Conclusions:
While changes in exposure posed no significant problem to either approach, SPVA performed substantially superior to conventional segmentation-based volumetry with respect to robustness to both slice thickness and reconstruction kernel variations.