

Title:**Clinical Implications of CT Image Quality Variation in Low Dose Lung Cancer Screening Scans****Authors:**

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Purpose:

To assess variation of low dose CT lung cancer screening scan image quality in a wide range of current day CT scanners and the impact this has on lung nodule volume change measurements.

Materials and Methods:

International lung cancer CT screening sites scanned a commonly available reference object (3 rolls of $\frac{3}{4}$ inch x 1000 inch 3M scotch™ tape) with low dose protocols as part of the CT Lung Cancer Screening Protocol Challenge. Fully automated processing of site submitted DICOM data produced fundamental image quality properties and the distance from scanner iso-center for each reference object. Analysis included 3D resolution expressed as the ellipsoidal volume of estimated Point Spread Function (PSF) sigmas specified in mm^3 (lower is better) as well as the mean CT number and standard deviation (SD) of the tape material in Hounsfield Units (HU). Ellipsoidal nodule models of varying sizes were then used within a first order CT scan simulator to estimate 95% confidence intervals (CI) on lung nodule volume change measurement error for a 6mm solid nodule. Variation in 3D resolution, mean tape HU, SD for tape material, and nodule volumetric change error bounds were calculated in three iso-center distance ranges (0-74, 75-149, and ≥ 150).

Results:

A total of 27 international sites submitted data from 54 CT scanners using low dose lung cancer screening protocols. Analysis of all $\leq 1.25\text{mm}$ slice thickness data resulted in a mean and SD of 3D PSF resolution values for the following three iso-center distance ranges in order: (0.42, 0.26), (0.46, 0.36), and (0.63, 0.46). Corresponding values for mean tape HU were (112.5, 10.1), (110.4, 11.7), and (103.5, 18.9) and for image noise represented as Tape HU SD were (19.6, 11.3), (26.8, 21.3), and (35.8, 34.2). The mean and standard deviation of the estimated 6mm solid nodule volume change error CI % was (49.4, 20.4), (51.6, 20.9), and (67.0, 22.9).

Conclusions:

Image quality characteristics in low dose CT scans degrades as a function of distance from iso-center leading to high levels of volume change measurement error. Increased volume measurement error must be taken into account when calculating and using volumetric nodule size change measurements in the periphery.