Purpose: To quantify the impact of dose reduction on image quality and observer performance in chest CT and to determine the minimum dose for which current levels of lung nodule detectability is maintained.
Methods: A chest phantom was constructed to investigate nodule detectability in chest CT. The phantom incorporates lung-equivalent plastic modules featuring simulated nodules of varying size (1 - 10 mm), contrast (-600 - +50 HU), and shape. The phantom was imaged on a multi-row CT scanner across a range of energy (80-140 kVp), current (10-200 mA), and slice thickness (1 - 5 mm), encompassing 2 orders of magnitude in dose. Nodule detectability was quantified by measurement of human observer SNR in two-alternative forced-choice (2AFC) tests, yielding quantitation of area under the ROC curve, Az. A variety of imaging tasks were considered, including solid nodule and nodule-unknown detection. Performance was assessed in 5 observers by measuring Az as a function of imaging dose.
Results: Examination of Az versus dose indicates that observer performance exhibited at current clinical dose levels was maintained down to one-fourth the dose for all imaging tasks. For simple tasks (solid nodule detection) and with prior information, performance was preserved down to one-tenth the current clinical dose. At the lowest dose levels, image quality was degraded by artifact rather than quantum noise.
Conclusion: This work indicates the potential for significant dose reduction in chest CT. Observer performance in all imaging tasks was uncompromised at doses reduced by a factor of 4 or more from current clinical techniques. With prior information, e.g., follow-up of suspicious nodules, even greater dose reduction is possible. The imaging phantom and 2AFC methodology will be used in future investigation of more complex imaging tasks (e.g., size estimation) under conditions of varying quantum noise, spatial resolution, and image artifact.