Enhancement of Signal-to-Noise Ratio and Low Contrast Detectability in Low-dose CT Images Using Non-linear Post-processing

Shreter R¹, Shreiber R¹, Fisher D¹, Engel A¹

Purpose: It has been postulated that image reconstruction algorithms that increase the Signal-to-Noise Ratio (SNR) of low-dose CT images will reduce Low Contrast Detectability (LCD). This research evaluates a novel image reconstruction algorithm, showing improved LCD in low-dose SNR-enhanced images.

Method and Materials: Two CT performance phantoms (the American College of Radiology (ACR) CT accreditation and Catphan 600), containing 2.0-15.0 mm (diameter) low-contrast targets at 0.3-1.0% contrast levels, were scanned on the 64-slice GE Discovery 690 and Philips Brilliance 64 CT scanners, respectively. 32 thin-slice datasets were acquired in axial or helical scanning modes at dose levels of 8-50 mGy, with parameter combinations simulating typical acquisitions. An additional 32 corresponding datasets were generated by applying 3D non-linear post-processing (SafeCT from Medic Vision Imaging Solutions) to the original datasets, using default abdomen processing parameters. All datasets were reformatted to slice thicknesses of 0.625-5.0 mm. 2 slices were extracted from each dataset for review. The 128 images were presented in random order to 5 experienced CT readers (3 radiologists and 2 physicists) who were requested to specify the smallest detectable low contrast targets.

Results: All processed images showed a decrease of at least 70% in image noise relative to their corresponding original images. The related-samples Wilcoxon signed rank test was performed, showing that LCD was significantly higher in the processed images (p <0.01 for the ACR and p <0.0001 for the Catphan phantoms) than in the original images. Highest LCD improvements were observed at low-dose levels (200%, p <0.0001 for 100 mAs) and at low-contrast levels (150%, p <0.0001 for 0.3% contrast level). In some cases, processed images showed higher LCD compared to the original images acquired at double the dose.

Conclusion: 3D non-linear post-processing may improve not only the SNR of the CT image, but also the LCD. This was confirmed over a wide range of CT parameters and conditions, suggesting significant potential for CT dose reduction.

Clinical Relevance/Application: Image quality and radiation dose are of prime concern in CT imaging today. This study demonstrates improved quality of low-dose images in terms of SNR and LCD using a novel post-processing algorithm.

¹ Rambam Medical Center, Haifa, Israel
Figure:

Contact: Roni Shreter
E-Mail: ronishreter@gmail.com
Institution: Rambam Medical Center

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Disclosures:
Roni Shreter - Consultant, Medic Vision Ltd.
Reuven Shreiber - Employee, Algotec Ltd.