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Contrast-detail measurements in CT - A new image quality evaluation methodology

Rationale: The essential principle of maintaining lower radiation dose and optimum image quality is to understand the effects of exposure factors on image quality. The evaluation method of low contrast detail (LCD) detectability performance—particularly the automated approach—is a good choice for deep understanding the influences of exposure parameters on image quality. However, this method requires a certain specification of an LCD phantom and dedicated software that are not commercially available. The study aimed to develop a new methodology of evaluation and optimisation of computed tomography (CT) image quality based on LCD detectability performance.

Methodology: A new phantom was designed to obtain CT images of LCD. The specifications of the phantom design were optimised to satisfy the requirement of the new evaluation methodology of LCD detectability performance and based on evaluation of the limitations of available phantoms and the standard recommendations of phantom manufacturing. The phantom was manufactured with the cooperation of Artinis Medical Systems (Zetten, The Netherlands). A dedicated software was developed with the cooperation of Artinis Medical Systems to objectively evaluate the obtained CT images of the new phantom. The LCD detectability performance of CT images were measured by calculating the CT inverse image quality figure (CT IQFinv). The new methodology was validated by determining the influences of exposure factors of kVp and mAs, slice thicknesses and objects location within the phantom on the image quality in terms of CT IQFinv measurements. The validation was based on software and radiographers' scoring results.

Results: A new method of calculating the IQFinv values for CT images, CT IQFinv, was developed based on the method of calculating the IQFinv in digital radiography (Equation 1). A further requirement was the linear interpolation of the Hounsfield Units of the phantom's objects to account for both positive and negative contrast values.

$$IQFinv = 100 / (\sum_{i=0}^8 \sum_{l_i} D_{i,th}) \quad \text{Equation 1}$$

Where $L_{i,th}$ is threshold of the linear interpolation contrast values, and $D_{i,th}$ is threshold of detail sizes

CT IQFinv values were obtained objectively by the software and subjectively from radiographers' assessment. The results from radiographers and software showed that the new methodology of CT image quality assessment was sensitive to changing kVp, mAs and slice thicknesses.

Conclusion: The developed automated assessment methodology of LCD detectability performance in CT has the potential to effectively evaluate the effects of protocol parameters on image quality of different CT scanners and systems. The new phantom needs further improvement and the software should be also improved to increase the sensitivity and accuracy of their performance. Wider range of different kVp, mAs, slice thicknesses and other protocol parameters and different CT scanners should be also examined in future studies to ensure that the results conform to theory in a wider range of variables.

Biography

Rob Davidson, PhD (SydneyUni), MAppSc(MI) (CSU), BBus (UniSA), FIR, is the Professor in Medical Imaging at Canberra University, Australia. Rob's current research focus is on dose / image quality in planar radiography and CT and digital image processing in medical imaging. He currently has over 50 peer review publications / referred proceedings; has an adjunct professorial appointment at RMIT University.

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