Title: Comparison of abdominal CT protocols: a multi-center study on image quality and radiation dose levels.

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Introduction: (1) To highlight the spread of patient exposure and image quality performances for various abdominal protocols. (2) To ensure that radiation dose reductions in abdominal CT protocols do not impair the detection of low-contrast structures.

Methods: An anthropomorphic abdominal phantom (QRM, Moehrendorf, Germany) with two optional rings (2.5 cm and 5 cm), representing the attenuation of an adult abdomen of 50 kg (small phantom), 75 kg (medium phantom) and 100 kg (large phantom), was scanned on 70 CT machines in the Western part of Switzerland. The phantom contains in the axial plane four spheres of 5, 6 and 8 mm in diameter with a contrast of 20 HU relative to the background at 120 kV. For statistical reasons, each phantom size was systematically scanned 10 times using local clinical settings of the portal phase for the detection of focal liver lesions (FLL); 40 regions of interest (ROIs) including the target and 150 ROIs with background noise only were extracted. Low contrast detectability (LCD) was objectively assessed using a Channelized Hotelling mathematical model Observer (CHO) with ten dense differences of Gaussian channels for the calculation of a receiver operating characteristic (ROC) curve. For each lesion size, the area under the ROC curve (AUC) was used as a figure of merit (FOM). A new image quality metric, called the weighted AUC (AUC), was proposed to combine the AUC results of all 3 different lesion sizes in a single metric. The displayed $CTDI_{vol}$ was used as a radiation dose metric.

Results: The median dose used for acquisitions is equal to 5.8 mGy, 10.5 mGy and 16.3 mGy, respectively for the small, medium and large phantoms. For the small phantom, the median image quality is equal to 0.977 with an interquartile range (IQR) equal to 0.027. For the medium phantom the dispersion increased and the median image quality decreased (AUC_w = 0.926 and IQR = 0.05). For the large phantom, despite a large range of $CTDI_{vol}$, the median image quality also decreased (AUC_w = 0.89 and IQR = 0.068) and six centers appeared as outliers with relatively limited AUC_w scores (AUC_w inferior to 0.75), due to very low $CTDI_{vol}$ values.

Conclusions: The use of a CHO model showed that the majority of institutions performed reasonably well when searching FLL. However, for some outliers, the $CTDI_{vol}$ values were so small that image quality outcomes were clearly not adequate for the intended task. Moreover, the spread of image quality levels was associated with a large $CTDI_{vol}$ distribution, showing that the concept of diagnostic reference levels should be revisited to take into account the image quality aspect. This would ensure comparable diagnostic performance image information content whatever the type of CT unit.