Size Specific Dose Esimates using Water-Equivalent Diameter from CT Radiograph Localizers in Automated Approach

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Background

The AAPM Report 220 introduced patient size-specific dose estimate (SSDE) calculated using water-equivalent diameter (WED). We propose a method that will predict WED from CT localizers for patients using a calibration method. Estimating WED from CT localizer radiographs would allow for WED to be included into data-driven clinical workflows such as size adaptive protocol selection like diagnostic reference ranges (DRRs) which provide a minimum estimated patient dose. Additional benefits include reduced data overhead if axial images are not stored and errors related to axial calculation. In this study we apply this method to patient data from 3 different CT scanners

Methods

For calibration and patient data, CT axial and CT localizer images were acquired from two Siemens SOMATOM Force scanners and one GE Optima 660. For calibration, images of CTDIvol phantoms of 1.0 (rod), 10, 16, and 32 cm diameters and the ACR phantom were acquired. Calibration curves were obtained for each scanner by plotting water-equivalent area per localizer-lateral dimension as a function of the mean pixel value (PV) from the CT localizer. A linear and quadratic calibration curve was used to convert PV to WED for CT localizers for abdomen and chest images. The CT localizer-based NDC was plotted as a function of the CT axial-based NDC.

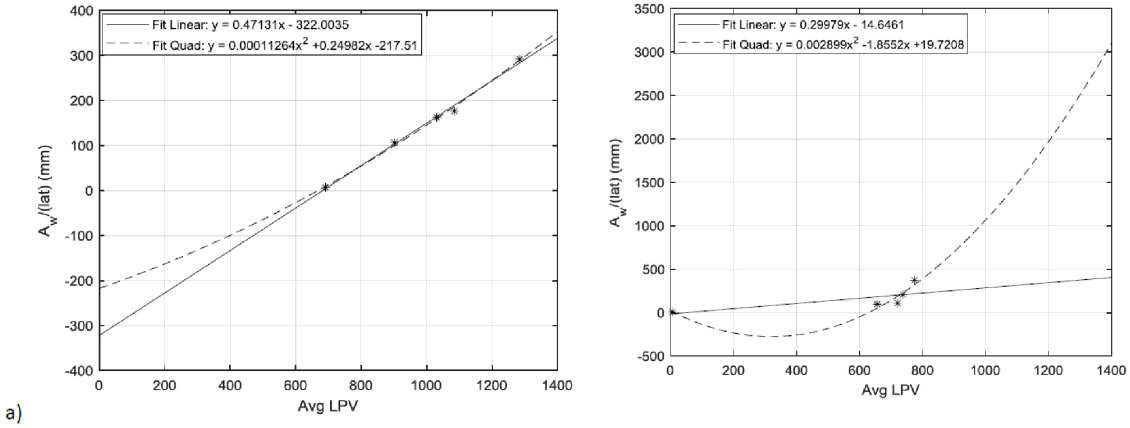

Figure 1. Linear and quadratic calibration curves for water-equivalent area for a) GE scanner (top) and b) Siemen's scanner (bottom), using CTDIvol phantoms with 10, 16, and 32 cm, a 1 cm PMMA rod and an ACR phantom.

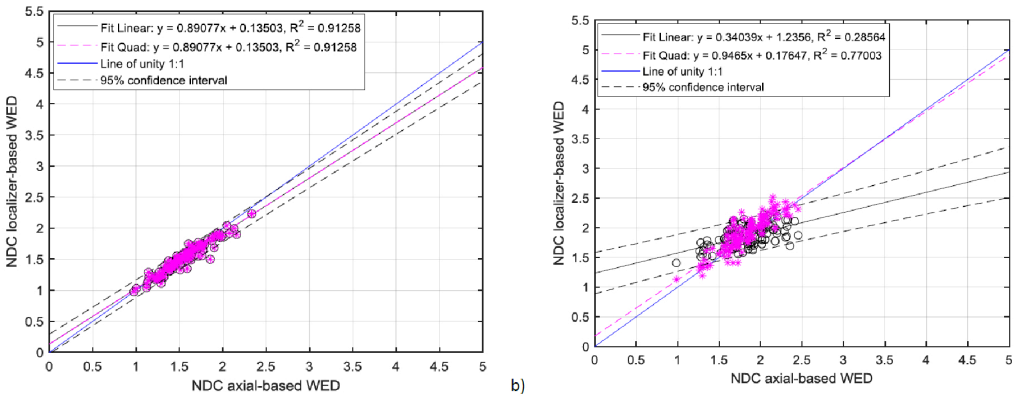

Figure 2. The CT localizer-based NDC as a function of CT axial-based for patient data on the a) GE scanner (top) and b) Siemen's scanner (bottom).

Results

The mean difference between localizer-based and axial-based for Siemens and GE scanners was 6.9 +/- 4.4 % (R^2=0.91) for linear and 6.3 +/- 4.5 % (R^2=0.91) for quadratic calibration, respectively, and for the quadratic fit calibration the mean differences were 2.4 +/- 23.8 % (R^2=0.29) for linear and 7.8 +/- 14.5 % (R^2=0.77) for quadratic calibration, respectively.

Conclusion

This work demonstrates an accepted method of calibrating CT localizers so that they may be used to estimate water-equivalent diameter. This method relies on CT acquisitions of reliable phantoms and requires the generation of a calibration curve. The calibration method is a non-cumbersome, automated approach that gives an accurate estimate of WED from CT localizers. This should be used to calculate SSDE prior to a CT scan.