Do Weight-Based Pediatric CT Abdomen Protocols Provide Similar Size-Specific Dose Estimates for Similar Patient Effective Diameters?

The preferred pediatric patient size metric to use in adjusting technique parameters for abdomen and pelvis studies according to the Image Gently coalition is patient diameter. Additionally, Boone et al. suggested the use of patient diameter to adjust technique parameters to maintain Contrast to Noise Ratio (CNR) across pediatric body habitus as early as 2003\textsuperscript{1}. However, academic literature continues to cite weight-based pediatric abdominal protocols as a method of “right-sizing” the dose\textsuperscript{2} and many institutions and manufacturers generate and use weight-based technique charts.

In this study, we examined the relationship between pediatric patient effective diameter and Size-Specific Dose Estimates (SSDE) when using weight-based CT acquisition technique parameters. The purpose of the study was to examine how the use weight-based technique charts affects estimated patient dose.

A total of 36 pediatric abdomen and pelvis studies completed over a 5 month period in a single health system were examined. The studies were acquired on 3 Philips Brilliance 64 units and 2 GE Lightspeed VCTs. Patient weight was obtained either verbally or from the patient’s medical record by the CT operator and the institution’s weight-based technique chart was used to select the exposure settings. The technique chart is broken down into 11 weight bins for each scanner with CTDI\textsubscript{vol} values and corresponding parameter settings ranging from 4 to 11 mGy.

The mid-scan image was chosen as the representative location for patient effective diameter calculation, which for these studies was approximately the mid-abdomen. Effective diameter was calculated by Radimetric Inc.’s eXposure\textsuperscript{TM} software as were the dose normalization coefficients for each calculated effective diameter based on the tables in AAPM Report 204\textsuperscript{3}. The scanner reported CTDI\textsubscript{vol} was then scaled by the dose normalization factor to determine the estimate of that patient’s absorbed dose, or SSDE.

A plot of the calculated SSDE vs. the effective diameter is included below as chart 1. A weak correlation, with a slight downward trend of SSDE at large effective diameters is observed. However, there are wide variations in SSDE for similar effective diameters. The large differences in SSDE for similar diameters is due to the significant variation in scanner output due to the selection of different techniques based on patient reported weight. Chart 2 plots the scanner CTDI\textsubscript{vol} against effective diameter and factors of 2 differences in scanner output are observed for similar diameters.

The large variability in the height of the pediatric population is the most likely cause for the variability in SSDE for similar effective diameters. Two patients may weigh the same but vary in height by a half a foot or more, which would significantly alter body shape and hence effective
diameter. This work indicates that weight-based protocols do not effectively match estimates of patient radiation dose for similarly sized scan regions.

References:

2. S. Singh et al., “Dose Reduction and Compliance with Pediatric CT Protocols Adapted to Patient Size, Clinical Indication, and Number of Prior Studies,” Radiology, 252(1).