

Truncation Effects on Effective Diameter Measurement for Size-specific Dose Estimation in Computed Tomography (CT) Imaging

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Abstract

The determination of size specific dose estimation (SSDE) has been proposed for accurate CT dose assessment. The SSDE introduction has prompted numerous manufacturers and researchers to develop various methodologies that have progressed from manual to automated methods in SSDE determination. Few studies reported on truncation effects with respect to specific size and SSDE determination and CT manufacturers are yet to incorporate truncation correction in their system ^[1,2].

This study aimed to evaluate the effects of truncation artifacts on the measurement of effective diameter (D_{eff}) and SSDE in CT imaging. A phantom study was performed using CTDI phantom of different diameters, 22 and 32 cm with Siemens SOMATOM Definition AS+ CT scanner. Phantom images of different truncation percentage (TP) of 5%, 10%, 15%, and 20% were simulated and acquired. The D_{eff} and SSDE were determined based on the displayed CTDI_{vol}, and the AAPM correction factor table was used to calculate the SSDE accurately ^[3]. The percentage error for each TP in comparison with non-truncated image (TP 0%) was computed.

Results showed the percentage error (PE) for both D_{eff} and SSDE increased as the TP increased. The PE was determined by comparing the D_{eff} and SSDE of each TP with non-truncated (TP 0%) image. Table 1 shows the values of PE of truncated images of different TP (5%, 10%, 15%, and 20%) for both D_{eff} and SSDE in phantom sizes of 22 and 32 cm. However, it can be observed that PE values for SSDE of 5% and 10% truncation were similar for both phantom sizes. This is because the correction factors for 5% and 10% were similar and had resulted in similar calculated SSDE. The highest recorded PE was observed in 20% truncation that determined the largest difference in D_{eff} and SSDE with non-truncated image.

Table 1: The percentage error on effective diameter, D_{eff} and SSDE based on truncation percentage, TP for two phantoms

TP	22 cm Phantom						32 cm Phantom					
	Measured diameters		D_{eff}	% Error D_{eff}	SSD E	% Error SSDE	Measured diameters		D_{eff}	% Error D_{eff}	SSD E	% Error SSDE
	AP	LAT					AP	LAT				
0%	21.88	21.88	21.88	0.00%	11.01	0.00%	31.82	31.86	31.84	0.00%	7.60	0.00%
5%	21.96	21.19	21.57	-1.42%	11.06	0.45%	31.86	30.91	31.38	-1.44%	7.94	4.47%
10%	21.86	21.16	21.51	-1.69%	11.06	0.45%	31.91	29.23	30.54	-4.08%	7.94	4.47%
15%	21.89	19.07	20.43	-6.63%	11.93	8.36%	31.90	27.70	29.73	-6.63%	8.20	7.89%
20%	21.83	17.90	19.77	-9.64%	11.87	7.81%	31.95	25.94	28.79	-9.58%	8.54	12.37%

This study demonstrates that there is a linear relationship between truncation percentage with measured D_{eff} and SSDE computation. It can be concluded that the percentage error in D_{eff} measurement and calculated SSDE will increase as TP increased. Therefore, the effects of truncation artefacts should be carefully considered in SSDE calculation for accurate estimation especially in development of automated calculation.

Keywords

Computed tomography, Effective diameter, Size-specific dose estimation, Truncation artefact

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