Abstract ID: 19143  Title: Dosimetric Changes Realized From Extended Bit-Depth and Metal Artifact Reduction in CT

Purpose: High-Z material in CT yields metal artifacts that degrade image quality and may cause substantial errors in dose calculation. This study couples a metal artifact reduction (MAR) algorithm with enhanced 16-bit depth (vs. standard 12-bit) to quantify potential dosimetric differences.

Methods: Extended CT to electron density (CT-ED) curves were derived from tissue characterization phantom with Titanium and Stainless Steel inserts scanned at 90-140 kVp for 12 and 16-bit reconstructions. MAR was applied to sinogram data (Brilliance BigBore CT scanner, Philips Healthcare, v.3.5). Single/double hip prostheses were simulated using Cerrobend rod(s) embedded in a pelvic phantom and two dosimetric verifications were performed to elucidate changes between 12 and 16-bit data: (1) BEAMnrc/Dosxyz Monte Carlo simulation (MC-SIM) (400,000,000 histories, 6X, 10X10 beam traversing Cerrobend rod) and (2) Gafchromic film analysis for plans calculated with Anisotropic Analytic Algorithm (AAA, Eclipse) and Monte Carlo (MC-BL, Brainlab). Five patients with metal implants were reconstructed using both bit depths, with plans calculated using AAA and derived CT-ED curves. Dose profiles and matrices were evaluated.

Results: For 12-bit images, Titanium and Stainless saturated at 3071 HU, while for 16-bits (120kVp), mean CT numbers were 8088+/-336 and 13,971+/-1460 HU for Titanium and Stainless, respectively. MC-SIM was well-matched between 12 and 16-bit images except downstream of metal, where 16-bit dose was ~6.4% greater than 12-bit. In treatment planning phantom cases, dose profiles were well-matched in the buildup region, but deviated in the shadow of metal where ~12% differences between AAA 16-bit and 12-bit doses were observed. Similar results were obtained in patient cases. The largest discrepancy was at a tissue-metal prosthetic interface, with 12-bit dose yielding 23.8% less dose than 16-bit.

Conclusions: Dosimetric differences revealed between 12- and 16-bit images were substantial. Further dosimetric verification is warranted. These results support implementing MAR-corrected, 16-bit images in treatment planning.

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