The REDUCTION Protocol Generates Three-Dimensional Reconstructed Images Comparable to Conventional CT

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Purpose: At our academic medical center, we have developed a Reduced Effective Dose Using Computed Tomography In Orthopaedic iNjury (REDUCTION) protocol that minimizes effective radiation dose while providing high-fidelity two-dimensional advanced imaging. We sought to evaluate the ability of this technology to generate advanced three-dimensional CT (3D-CT) imaging using this ultra low-dose CT protocol for assessment of various fracture types.

Methods: Using a 64-slice CT scanner (SOMATOM Sensation, Siemens), radiation dose was lowered from the standard radiation dose by altering multiple parameters: tube current (milliamperes, mA), tube potential (kilovolts, kV), detector collimation (mm), slice thickness (mm), reconstruction interval (mm), pitch, and gantry rotation time. Reconstructed 3D-CT images utilizing REDUCTION protocol for 4 different fracture locations (pelvis / acetabulum, tibial plateau, tibia / fibula, and elbow) were matched to reconstructed 3D-CT images utilizing conventional CT (C-CT). All images were de-identified prior to evaluation, and images were matched by fracture location, characterization, gender, and age. Three independent fellowship-trained orthopaedic traumatologists evaluated corresponding sets of REDUCTION protocol and conventional CT images. Evaluators were queried as to whether paired REDUCTION protocol and C-CT 3D-reconstructed images were equivalent in quality, and as to whether each scan afforded an equivalent amount of diagnostic information. Inter-rater reliability (kappa [κ] statistics) was calculated to assess for differences among respondents.

Results: The REDUCTION protocol utilized parameters as follows: tube current (15 mA), tube potential (80 kV) detector collimation (0.625), slice thickness (3 mm), reconstruction interval (3 mm), pitch (.516-1), and gantry rotation time (0.5). 3D-reconstructed CT images using REDUCTION protocol were rendered with an estimated effective dose (ED) of 0.08 mSv as compared to 0.8 mSv for 3D-CT images rendered using C-CT. Inter-rater reliability for equivalence in quality between REDUCTION protocol and C-CT rendered 3D images was near perfect ($\kappa = 0.87$). Inter-rater reliability as to equivalence of diagnostic information between REDUCTION protocol and C-CT rendered 3D images was near perfect ($\kappa = 0.94$).

Conclusion: The use of the REDUCTION protocol for diagnostic assessment of specific fractures of the extremities affords the ability to create high-resolution reconstructed 3D-CT images comparable to that rendered utilizing conventional CT. With approximately a tenfold reduction in irradiation to patients, this adapted modality may ultimately be able to redress optimal diagnostic imaging in appropriately selected patients.

See pages 47 - 108 for financial disclosure information.

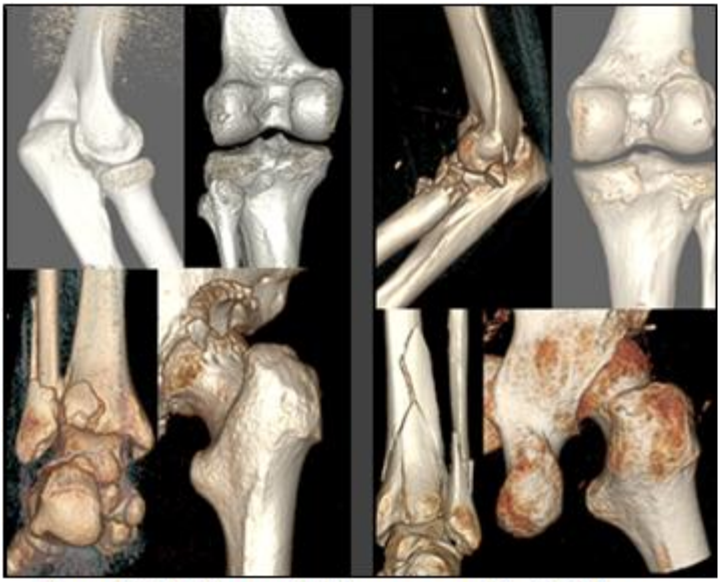

Figure 1. ULD-CT images (left) vs. corresponding C-CT images (right). Nearly indistinguishable resolution with ULD-CT and with a 10x decrease in effective radiation dose (equivalent to 1 chest radiograph).