

AbstractID: 12953 Title: Does KV-MV dual-energy computed tomography have an advantage in measuring proton stopping power ratio in patients?

Purpose: To evaluate different combinations of x-ray energies when using Dual-Energy CT (DECT) method for calculating proton stopping power ratio (SPR) in the presence of random noise and beam hardening effects.

Method and Materials: We selected three representing x-ray energy pairs: 100kVp and 140kVp for KV-KV, 100kVp and 1MV for KV-MV, and two 1MV x-rays with and without external filtration for MV-MV DECT imaging. Small perturbations in CT numbers and x-ray spectrum used for the DECT calculation were introduced to simulate effects of random noise and beam hardening. The CT dose to generate a fixed amount of random noise was determined by Monte Carlo method in simulated CT images of a water phantom. The SPRs of 34 human tissues listed in *ICRP 23* and *ICRU 44* were calculated using the DECT method with all three x-ray energy combinations. We also performed error propagation to study the sensitivity to CT number uncertainties for each of the DECT x-ray pairs.

Results: The relative sensitivity of the derived SPR to random noise in CT number was 6.59, 1.27 and 3.34 for KV-KV, KV-MV, MV-MV DECT techniques, respectively. Under the same condition, the root-mean-square errors in SPRs derived using the KV-MV DECT technique were at least 50% smaller than those using the KV-KV or MV-MV combinations. Additionally, we found CT number uncertainties for the high energy beam within the dual-energy pair had a bigger impact to SPR accuracy than the low energy beam, suggesting it is more important to emphasize the accuracy of the high energy CT imaging than the low-energy one in DECT applications.

Conclusion: The KV-MV combination makes the DECT method more robust in calculating proton SPRs or resolving effective atomic number for tissue composition in the presence of CT number uncertainties.

Conflict of Interest: Research partially sponsored by Varian Medical Systems.