AbstractID: 10180 Title: In vivo Measurement of Proton Stopping Power Ratios in Patients Using Dual Energy Computed Tomography

Purpose: To introduce a new method based on dual-energy CT (DECT) for determining patient-specific proton stopping power ratios (SPRs) required for accurate computation of proton dose distributions. Accurate determination of SPRs requires atomic number information, which cannot be deduced from conventional CT scans.

Method and Materials: We have developed a two-parameter model to extract electron density ratios (EDRs) and effective atomic number (EANs) from two CT scans acquired at different energies. Based on an empirical relationship we discovered between the known SPRs and EANs of human biological tissues of standard density and elemental compositions published in *ICRU 44* and *ICRP 23*, we can estimate the SPR of any human biological tissue from its EDR and EAN values obtained from DECT scans. To validate this approach and compare it to existing practice, we introduced variations to the density and compositions of standard biological tissues to simulate unknown biological tissues. SPRs thus estimated using the DECT method are compared with their theoretical SPRs calculated using the Bethe-Bloch equation and a clinical procedure introduced by Schneider *et al*. at Paul Scherrer Institute (the PSI method).

Results: The accuracy of SPRs of standard human biological tissues estimated using the DECT method are substantially improved compared to those estimated using the PSI method: the maximum absolute (MAX) error and the root-mean-square (RMS) error are reduced from 3.19% and 0.89% to 1.10% and 0.29%, respectively. The DECT method is even more effective in SPR calculation when small perturbations were introduced in the standard tissue density and compositions: the MAX and RMS errors were reduced from 8.70% and 3.31% to 1.65% and 0.53%, respectively.

Conclusion: The DECT approach is an effective method for accurate determination of voxel-by-voxel effective atomic numbers and SPRs of biological tissues.

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