AbstractID: 13227 Title: A new approach to model-based dose calculations for kilovoltage beams

Purpose: The additional radiation dose delivered to radiotherapy patients from repeated image guidance procedures is a growing concern. This study presents a new approach to model-based dose calculation that overcomes the deficiencies of currently available model-based algorithms in the kilovoltage regime.

Method and Materials: Monte Carlo techniques were used to calculate the dose to patients resulting from kV-CBCT scans for multiple scan sites including the head-and-neck, chest, and pelvis. Both dose-to-medium and dose-to-water were calculated using realistic simulated kV-CBCT beams to find a correlation between the effective thickness of bone (d_{EB}) traversed by an x-ray beam to reach a voxel and the correction factor needed to correct the model-based dose calculation. A program was written to facilitate the calculation of d_{EB} in which the incident beam profiles and isocenter relative to a scanned patient were taken into account.

Results: A strong correlation between dose correction factor and d_{EB} was observed. A unique correction factor calibration curve as a function of d_{EB} was derived and used to predict patient dose. Compared to gold standard Monte Carlo calculated dose distributions, the resulting mean dose error for each patient was less than 3% for bone and 2% for soft-tissue. This was in contrast to model-based calculations, which resulted in mean errors of up to -103% for bone and 8% for soft-tissue.

Conclusion: The derived correction factor as a function of effective bone thickness is capable of accurately calculating the dose to bone and soft-tissue by making use of patient CT data and the incident kV-CBCT beam information. The accuracy of this new approach is patient and scan site independent because it takes into account the spectral changes of the x-ray beam. With the addition of a commissioned kV-CBCT beam this new approach can facilitate inclusion of imaging dose in radiotherapy treatment planning.