Cone beam computed tomography number errors and consequences for radiotherapy planning: an investigation of correction methods.

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Abstract

PURPOSE: The potential of keV cone beam computed tomography (CBCT) for guiding adaptive replanning is well-known. There are impediments to this, one being CBCT number accuracy. The purpose of this study was to investigate CBCT number correction methods and the affect of residual inaccuracies on dose deposition. Four different correction strategies were applied to the same patient data to compare performance and the sophistication of correction-method needed for acceptable dose errors.

METHODS AND MATERIALS: Planning CT and CBCT reconstructions were used for 12 patients (6 brain, 3 prostate, and 3 bladder cancer patients). All patients were treated using Elekta linear accelerators and XVI imaging systems. Two of the CBCT number correction methods investigated were based on an algorithm previously proposed by the authors but only previously applied to phantoms. Two further methods, based on an approach previously suggested in the research literature, were also examined. Dose calculations were performed using scans of a "worst" subset of patients using the Pinnacle³ version 9.0 treatment planning system and the patients' clinical plans.

RESULTS: All mean errors in CBCT number were <50 HU, and all correction methods performed well or adequately in dose calculations. The worst single dose discrepancy identified for any of the examined methods or patients was 3.0%. Mean errors in the doses to treatment volumes or organs at risk were negatively correlated with the mean error in CT number. That is, a mean CT number that was too large, averaged over the entire CBCT volume, implied an underdosing in a volume-of-interest and vice versa.

CONCLUSIONS: Results suggest that (1) the correction of CBCT numbers to within a mean error of 50 HU in the scan volume provides acceptable discrepancies in dose (<3%) and (2) this is achievable with even quite unsophisticated correction methods.

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