The validation of a dynamic adaptive radiotherapy system

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This work was designed to validate the feasibility of utilizing Eclipse treatment planning system and Trilogy Cone Beam Computed Tomography (CBCT) imaging system for online/offline dynamic adaptive radiotherapy (DART). We evaluated the importance of using CBCT image for patient localization in terms of tumor control and normal tissue avoidance. There would be significant tumor control loss (up to 14%) especially for obese patients if no image guidance was performed. Shifting or rotating prior to treatment may not be sufficient for correcting anatomy variations in their shape and size, thus adaptive radiotherapy is essential for accurate dose delivery. We also validated the accuracy of Analytical Anisotropic Algorithm (AAA) in Eclipse treatment planning system for accurate dose calculation. Overall, AAA provides accurate dose prediction (within 2%) for low energy photon beams (6MV). CBCT images are suffering the adverse effect from the photon scattering, which induces inaccuracy in HU numbers and instability in the HU-to-density calibration curve. Dose was calculated based on CBCT image sets using a site-specific calibration method and compared with the initial plan on the planning CT image. The dose comparisons between CT and CBCT image-based plans showed that using the site-specific HU-density calibration tables to calibrate CBCT images significantly improve the dose accuracy to ~2%. The DART system permits the application of the initial plan to the secondary image. It also allows image registration, accurate dose calculation even in tissue heterogeneity. CBCT images retain good image quality for online imaging system for dose recomputation. Overall, it is feasible to use the DART system for adaptive radiotherapy.