Abstract

A significant obstacle to clinical acceptance of CT-based dose-planning of intracavitary brachytherapy (ICT) for gynecological malignancies is lack of practical and accurate methods for localizing intracavitary applicators from volumetric CT studies. A related problem is the inability of most commercially-available treatment-planning systems to model internal colpostat shielding and inter-applicator attenuation effects. To address these issues, we present a novel method of localizing the ICT applicator components (colpostats and tandem) in the spiral CT frame of reference requiring only the transverse CT images. The method consists of finding the transformation that maximizes the coincidence between the known 3D shapes of each applicator component with the corresponding volume defined by point-by-point contours of the corresponding surface on each CT slice. We have used this technique to localize Fletcher-Suit CT-compatible applicators for three cervix cancer patients using post-implant CT examinations (3 mm slice thickness and separation). Dose distributions in 1-to-1 registration with the underlying CT anatomy were then derived from 3D Monte Carlo photon-transport simulations incorporating each applicator’s internal geometry (source encapsulation, high-density shields, and applicator body) oriented in relation to the dose matrix according to the previously-measured transformations. By applying our localization technique to CT studies of a precision-machined phantom, the absolute accuracy of the method was found to be ±0.2 mm in plane, and ±0.3 mm in the axial direction while its precision was ±0.2 mm in plane, and ±0.2 mm axially. Supported in part by NIH grant RO1 CA 75371.