Purpose:

The minimum dose to 2 cc of tissue receiving the highest dose (D2cc) has been suggested as a surrogate measurement for risk of developing toxicity in organs at risk (OARs) in patients receiving image-guided cervical intracavitary brachytherapy. Conventional D2cc is typically calculated by simple summation, assuming the locations of the hot spots do not vary substantially. This study explores the effect of deformable image registration in determining a more accurate D2cc of rectum, sigmoid colon, bladder and small bowel.

Methods:

Five patients, with 2 pelvic CT scans each performed at the time of brachytherapy planning, were evaluated. The first scan was performed with an empty bladder (an indwelling catheter was in place) and the second with a full bladder (with 180-cc sterile water). OARs were contoured on each scan. A symmetric demons algorithm with weighted sub-area approach was used to register images from different fractions. A pelvic prostate phantom was used to verify the method. After registration, the cumulated D2cc (ND2cc) was compared to the conventional D2cc (OD2cc) without deformable registration.

Results:

In all cases, the ND2cc was lower than the OD2cc. For full bladder scans, the average difference (range) for rectum, sigmoid colon, bladder and small bowel between ND2cc and OD2cc were 28.9 (1.6 - 56.6)%, 34.7 (5.7 -68.4)%, 12.1 (0.0 -27.7)%, 7.2 (1.1 -22) respectively. For empty bladder scans, the average differences (range) for the above organs between the ND2cc and the OD2cc were 30.7 (0.75-56.3%), 20.6 (6.3 -39.6)%, 7.5 (0.88-13.1)%, 12.2 (0.0 -22.2) respectively.

Conclusions:

A significant difference was observed between the ND2cc and the OD2cc with rectum and sigmoid being the most variable and bladder the least variable. While further studies are needed to evaluate which D2cc method is more useful in predicting late toxicity, we found the conventional method often overestimates dose to OARs.

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No conflict of interest.