

A COMPARISON BETWEEN AFFINE AND RIGID MR AND CT REGISTRATIONS FOR PROSTATE BRACHYTHERAPY DOSIMETRY

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PURPOSE

Brachytherapy dosimetry requires locating implant seeds with respect to the prostate and neighboring tissues. While MR images define pelvic anatomy, existing MR techniques image seeds unreliably. Conversely, CT images do not define soft tissues, but reliably resolve seeds. Post-implant MR and CT registration promises seed localization. Clinicians have relied on rigid registrations based on a few corresponding seeds. The goal of this research is to improve post-implant MR and CT registration by using more seeds and an affine (deformable) instead of rigid model.

METHOD AND MATERIALS

Six weeks after brachytherapy implantation we acquired MR and CT images from five patients. MR (GE Signa with body coil; FOV 200mm, 2mm-thick slices, matrix size 256) images were acquired using SPGR sequences to optimize seed visualization. Patients lay supine for both MR and CT (GE LightSpeed; 320mm FOV, 1.25mm-thick slices, matrix size 512) imaging. Three seeds were manually selected in the MR and CT images each, and seed positions were measured. Seed pair correspondences were established manually. A rigid registration (3PR) was solved based on the positions of the three seed pairs. From 3PR registered images, 27 new corresponding seed pairs were manually selected. A many-point-rigid (MPR) and an affine transformation were solved, both by minimizing sum-squared distance between the 27 seed pairs. Errors were computed on distances between registered seeds.

RESULTS

Root-mean-squared distance (mm; mean, stdv) between seed was (4.12,1.18), (2.80,0.51), (2.14,0.25) in the 3PR, MPR and affine registrations, respectively. MPR alignment reduced 3PR RMS error ($p < 0.12$). Affine alignment significantly reduced rigid RMS error ($p < 0.04$). Maximum distance (mm; mean, stdv) was (7.44,1.50), (5.40,0.96), (4.00,0.79), respectively. MPR significantly reduced 3PR max-distance ($p < 0.03$). Affine significantly reduced rigid max-distance ($p < 0.04$).

CONCLUSIONS

Using many seeds, MPR reduced errors produced by the popular 3PR method, indicating improved alignment. Affine registration further reduced errors. This improvement may enable more accurate dosimetry. Our results also suggest the utility of seed-based verification of registration methods.