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Delineation and Registration of Neurovascular Bundles Using Pre- and Post-Magnetic Resonance-guided Brachytherapy Images

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Abstract:

Purpose: To evaluate the accuracy of an image segmentation and registration method used to segment specific image items - neurovascular bundles (NVBs) - in MR images obtained before and after magnetic resonance guided brachytherapy (MRBT). Information on the location of NVBs in post-brachytherapy images can then be used for calculation of the radiation dose to NVBs.

Methods and Materials: The images used in this study were of 19 patients diagnosed with localized prostate cancer between November 1997 and January 2000. All patients underwent MRBT at Brigham and Women's Hospital. The sequences used were: pre-brachytherapy endorectal coil (erMR) T1 and T2-weighted fast spin echo (T2 FSE), 5000/105 TR/ETE, 10 cm FOV, 3mm contiguous axial, and post-brachytherapy phased array T2 FSE, 4000/105 TR/ETE, 14 cm FOV, 4 mm thick, 1mm spaced axial. Pre-brachytherapy T1 images were used for a manual delineation of total gland (TG) and NVBs using 3D-Slicer. T2 images were used to guide contouring of the TG, which is not well visualized in T1 images. Post-brachytherapy axial T2 weighted images were used for manual segmentation of TG. Pre and post-brachytherapy images were then co-registered using a deformable modeling technique based on finite elements in combination with thin-plate splines. The effectiveness of the registration method was evaluated by calculating prostate gland volumes before and after image registration. Radiologist assessed the accuracy of location of NVBs on post-brachytherapy images.

Results: The average difference between the pre-brachytherapy prostate volume and the volume of the registered post-brachytherapy prostate was 4%. In 16 of 19 (84%) of cases, the location of the registered NVBs was in agreement with known anatomic location according to a trained radiologist.

Conclusion: The registration algorithm is sufficiently accurate to assess the location of NVBs on post-brachytherapy MR images. The presented registration method provides a basis for the assessment of radiation dose to NVBs and could also be used for dose planning when using imaging methods in which the NVBs are not visible (e.g. CT). (This work was supported by NIH grant R01-AG-19513.)