Purpose:
To evaluate the use of a non-rigid registration method for improved intra-operative target definition in 125-I permanent prostate implants.

Methods:
The validation dataset was created from 10 MRI-guided prostate biopsy patients with both diagnostic (with endorectal coil) and intra-procedural (without endorectal coil) 3 Tesla MRI scans under an IRB approved protocol. A biomechanical-based probabilistic non-rigid registration method was adapted to register diagnostic to intra-procedural images by matching the contoured prostate boundaries. The probabilistic framework provides a collection of prostate configurations under deformation, or a marginal probability map for a given location to be identified as inside the prostate by the registration. The marginal probability map was compared to the intra-procedural prostate contour. 125-I treatment plans were generated for the intra-procedural scans.

Results:
In two cases we find that ~5% of the prostate volume within the 50th percentile of the marginal deformed probability is not included in the intra-procedural contour, and 3-4% of the intra-procedural prostate volume is not included in any of the deformed configurations. Different regions of the prostate have varying uncertainties; preliminary results show margins of 1-2 mm near mid-gland and 3-4 mm around the apex. We present geometric uncertainties and the resulting variation of dosimetric quantities in the base, mid-gland, apex and peripheral zone of the prostate.

Conclusions:
We study the feasibility of using a probabilistic non-rigid registration method for supplementing intra-procedural images with diagnostic MR images. The method is evaluated geometrically and dosimetrically, which quantifies the method's ability to provide intra-procedural estimation of the accuracy of the deformed configurations. This method will be applied to registration of diagnostic MR with intra-procedural transrectal ultrasound images to improve visualization of the prostate apex and substructure, which could provide improved prostate boundary definitions with uncertainty margins to guide the development of intra-operative brachytherapy treatment plans.

Funding Support, Disclosures, and Conflict of Interest:

This work was supported by NIH grants 1U41RR019703-01A2, 1R01CA111288-01A1, P01-CA67165, and U01CA151261.