AbstractID: 11459 Title: Preliminary feasibility study: Modeling 3D deformations of the prostate from whole-mount histology to in vivo MRI

Purpose: To investigate the accuracy of a 3D biomechanical model-based deformation algorithm (MORFEUS) in modeling the prostate deformation that occurs between *in vivo* magnetic resonance imaging (MRI) and identification of the tumor on whole-mount histology.

Method and Materials: Three image sets were acquired for 10 patients: 1) i*n vivo* T2-weighted MR images acquired prior to prostatectomy, 2) e*x vivo* T2-weighted MR images, and 3) digital images of the histological slices, rigidly registered to construct a 3D volumetric image. All three images sets were imported into the radiation treatment planning system for contouring. The entire prostate gland, the peripheral zone and central gland were contoured. The prostate was converted into a finite element model, where each zone was assigned the appropriate material property. Naturally occurring structural and morphological features (*e.g.* urethra) were identified as verification points in the *in vivo*, *ex vivo*, and histological images, for quantification of the accuracy of the deformable registration. MORFEUS was used to model the deformations that occur due to excision and fixation either directly, deforming histology to *in vivo* MRI, or using a two-step process, histology to *in vivo* MRI via an intermediate step, using *ex vivo* MRI.

Results: Initial analysis has been completed for a subset of the patients. Uncertainties following rigid registration alone exceeded 8.0mm. No significant improvements were observed when including the intermediate deformation step. The average absolute error following deformable registration, based on the verification points, was 1.3, 1.2, and 1.9mm in the left/right, anterior/posterior, and superior/inferior directions, respectively. This error is smaller than the 3 mm image slice thickness.

Conclusions: Substantial deformation confounds the ability to compare histology with *in vivo* imaging. Deformable registration using MORFEUS can be used to resolve the deformation, enabling quantitative evaluation of *in vivo* imaging based on histology as a gold standard for tumor definition.