A System for Prostate Intervention in a 1.5 T MRI Scanner in the Supine Position

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Introduction: Prostate cancer is the most likely cancer to develop in a Canadian male with a prevalence of 1 in 7.1 cases in 2005 [1]. In the United States 230,000 new cases of prostate cancer have been projected for 2005 [2]. Despite improvements in the delivery and reduction in associated toxicity of external beam radiotherapy, local persistence or recurrence of disease remains prevalent in 25-51% of patients [3,4]. A careful and thorough investigation of the spatial distribution of cancer within the prostate gland is paramount to meaningful progress in effective prospective management and therapy. Magnetic Resonance Imaging (MRI) provides the ability to deliver excellent soft tissue contrast and resolution of the anatomy. It also provides an opportunity to spatially characterize pathology and biology through dynamic contrast-enhanced (DCE) imaging, MR spectroscopic imaging of tissue metabolites, and diffusion-weighted (DWI) imaging. Previous systems have been developed for prostate interventions in a standard 1.5 T MRI scanner with excellent biopsy-needle targeting accuracy, but have required the patient to be placed in the prone or left lateral decubitus position [3], thereby compromising stability, patient comfort, and safety. A number of recent studies have shown that prostate motion is greatly reduced when patients are placed in the supine position due to greater patient comfort and reduced respiratory motion [4-6]. In this work, the feasibility of creating adequate perineal exposure for prostate interventions in the supine position using dedicated table architecture is investigated.

Figure 1: Picture of the custom imaging table for patient positioning in the supine position docked to GE 1.5 T MRI scanner.

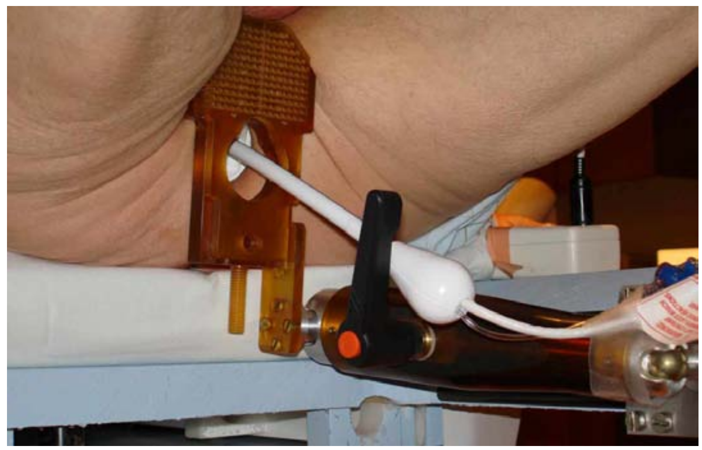

Figure 2: Image showing the accessibility of the perineum and accommodation of stereotactic perineal template and coil.

Materials/Methods: To permit the patient to be positioned supine and allow access to the perineum, a dedicated prostate interventional table (Figure 1) was designed in collaboration with Sentinelle Medical Inc. (Toronto, Canada). The table is a modification of Sentinelle Medical's Vanguard System which is used in breast imaging and intervention. The table has been revised to provide boot supports for hip and knee flexion and immobilization, pelvic immobilization, imaging coil integration, and ample room for perineal exposure and operative space (Figure 2). The table has also been designed to accommodate both the "access to prostate tissue under MRI guidance" (APT-MRI) device [7,8] as well as a stereotactic perineal template and coil system [3]. The interventional table provides ease of mobility between the MRI suite and adjacent rooms. Patients can then be set-up on the table prior to it being docked to the MRI scanner, thus freeing the unit for standard clinical workflow. An REB/HSRBB approved protocol is currently enrolling patients to develop the revised interventional techniques and measure organ motion and patient comfort in the new system. Prostate motion was measured using a 2D FIESTA with fat saturation (TE/TR – 1.9/6.2ms; matrix 320x224, FOV 26 cm, 8mm slice thickness) and temporal resolution 2sec, and analyzed with manual POI tracking using MIPAV software (Medical Image Processing Analysis and Visualization – NIH).

Results: On an initial trial, the patient was placed on the table and imaged for a period of 60 minutes with the endorectal coil in place. There was no report of discomfort from the patient, and perineal exposure was excellent (Figure 2). Respiratory and peristaltic motion observed during the 2D FIESTA sequence caused negligible movement of the prostate gland. Maximum displacement of the prostate gland was 0.51mm and 1.02mm, associated with a mean displacement of 0.00 +/-0.31mm and 0.00 +/-0.46mm in the AP and SI directions, respectively, over 2 minutes of imaging time.

Conclusions: This system for prostate intervention provides a means by which MRI data can be used to accurately guide and provide feedback to validate new imaging techniques with the patient placed in the supine position, thereby minimizing patient discomfort and prostate motion.

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