Imaging of the prostate with vibro-elastography: preliminary patient results

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1 Introduction

Prostate brachytherapy is a minimally invasive procedure for treating localized prostate cancer. Transrectal ultrasound (TRUS) is the primary imaging modality providing the guidance for brachytherapy. However, imaging and detection of the prostate with conventional B-mode TRUS still remains a challenging task because of the poor contrast between the prostate and surrounding tissues. As prostate is a firm organ with respect to its surrounding tissues, ultrasound elastography would be a potential candidate. This abstract extends [1] and presents further patient results from imaging of the prostate using a dynamic ultrasound elastography method called vibro-elastography (VE) [2].

2 Materials and Methods

A TRUS VE imaging system has been constructed. The system utilizes a Sonix RP ultrasound machine with a biplane endorectal TRUS probe. Both B-mode images and digitized radio-frequency (RF) signals can be acquired simultaneously from the machine. The TRUS probe is mounted on a shaker, which is used to apply compression waves to the rectal wall, typically band-pass filtered white noise. The probe and shaker are mounted on a stepper. With the stepper, they can be rotated about the longitudinal axis of the probe at different angles.

For VE, RF signals are used. Every RF data frame consists of many scan lines. Each RF scan line is divided into a series of short segments with equal length and overlap at different depths. Tissue motion due to the probe compression and relaxation is determined by the time domain cross-correlation with prior estimates (TDPE) method [3]. With the time sequences of tissue motion estimates, transfer functions (TFs) between different spatial locations in tissue are estimated using Welch's periodogram method with accumulative windows [1]. The average magnitude of the TF over the frequency range of the excitation is determined and is equivalent to a "displacement" image of tissue. Tissue strain is obtained by the least squares estimation of the gradient of the "displacement" field. Alternatively, the L_2 norm of the differences between TFs at different locations is computed to approximate tissue compliance [1].

3 Results

There are 12 patients imaged by the TRUS VE system in the British Columbia Cancer Agency, Vancouver Centre, including the 3 cases done in [1]. Fig. 1 shows the prostate VE and B-mode images in the sagittal scan planes containing the longitudinal axis of the probe, when the probe was manually rotated. The VE images obtained show good delineation of the prostate by comparison to B-mode images. One can also see the urethra in the middle VE image in Fig. 1.

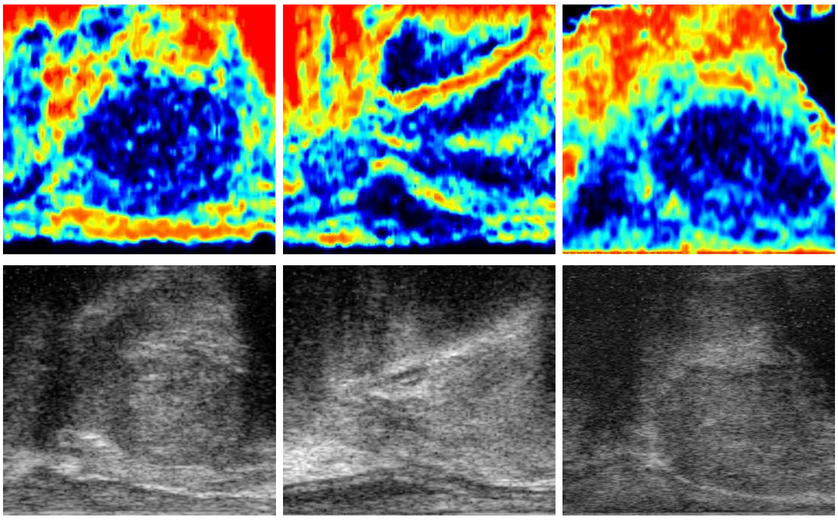

Fig. 1. Prostate VE images (top row) and B-mode images (bottom row) in the sagittal scan planes, when the probe was manually rotated.

4 Conclusions

We presented the preliminary patient results of imaging of the prostate using VE. This approach provides the ability to visualize the stiffness difference between the prostate and surrounding tissues. While only a few patients have been imaged so far, the results are encouraging. Further research is required to determine the potential usefulness and accuracy of the VE method for prostate segmentation.

References

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