Validation of Real time Virtual Sonography (RVS) for targeted MR-ultrasound guided transrectal prostate biopsies against transperineal template saturation biopsies for service development

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Target audience

This work is of interest to clinical staff working in urology, radiologists reporting prostate MRI, MR physicists working in a clinical setting, and, more broadly, those with an interest in applications of MR and ultrasound image fusion.

Purpose

Ultrasound guided needle biopsy is the definitive method of diagnosis of prostate cancer but standard. Soft tissue contrast in B-mode ultrasound is poor. As such, transrectal ultrasound (TRUS) biopsies, which coarsely sample the gland, give a false negative rate of 30% and undergrade disease in a further 30%. Transperineal template saturation biopsies help to overcome this limitation with systematic sampling throughout the gland, but these require general anaesthesia and can give rise to complications for the patient. In addition, the resources required to collect and process samples are significant. A number of systems now exist which offer fusion of real-time B-mode with previously acquired MRI data[1,2]. Using multiparametric MR (mpMRI) images, it is possible to visualise potential targets for transrectal biopsies, creating a sensitive yet minimally invasive procedure for detecting high grade disease.

This study explores the experiences of using a Real time Virtual Sonography (RVS) system with mpMRI protocol to establish a targeted fusion biopsy service, using transperineal template biopsy for validation. To the authors' knowledge, this is the first study to compare fusion guided biopsies against such detailed systematic template biopsies.

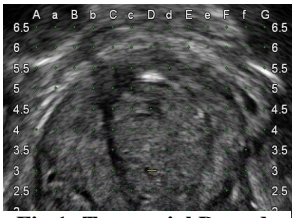

Fig.1: Transaxial B-mode image of prostate with biopsy template

Methods

Twenty-seven consecutive patients were selected. The indications for biopsy were patients under active surveillance for known Gleason 6 prostate cancer with visible abnormality on mpMRI (n=11) or patients with an elevated PSA but at least one negative previous standard TRUS biopsy (n=16). All had received a standard diagnostic mpMRI scan (T1w, T2w, diffusion-weighted (DW) and dynamic contrast enhanced (DCE) images). Targeted lesions were suspicious for high grade prostate cancer on at least 2 sequences. Two patients were also imaged using a 3D T2w sequence to optimise the image fusion process. Axial T2w images (or 3D where available) and/or ADC maps (calculated using b=0 and b=1000 DW images) were used to identify targets, depending on their visibility as reported by an experienced uroradiologist. Sagittal and axial T2w images (or 3D where available) were registered and fused with live B-mode data.

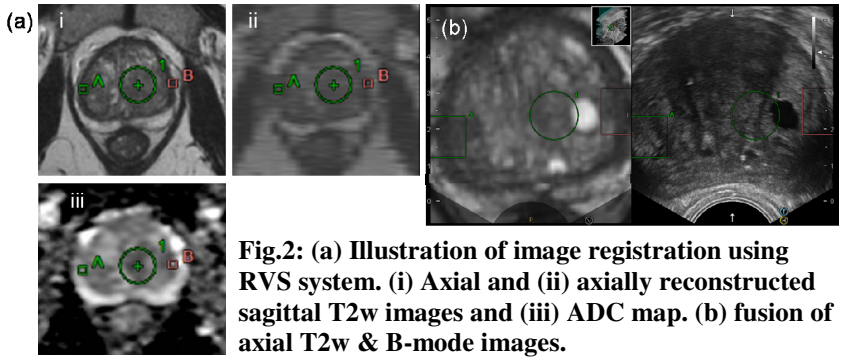

Fig.2: (a) Illustration of image registration using RVS system. (i) Axial and (ii) axially reconstructed sagittal T2w images and (iii) ADC map. (b) fusion of axial T2w & B-mode images.

Patients were consented to undergo a TRUS targeted fusion biopsy using RVS (Hitachi Preirus with CC531 biplane transducer) followed by a transperineal template biopsy (Hitachi Preirus U533 biplane transducer & stepper arm, DK Technologies, Barum, Germany) covering the gland with cores every 0.5 mm (fig.1). Procedures were performed by a consultant urological surgeon assisted by an MR and ultrasound physicist performing the image registration (fig.2a) and fusion (fig.2b) iteratively with feedback from the surgeon. Results from the two biopsy techniques were compared, relating template cores back to the B-mode and MR images used for guidance, as demonstrated by the schematic and sample data in fig.3.

Results & Discussion

The initial learning curve involved in setting up the fusion biopsy service was significant, initially ~30 minutes per patient to the theatre session. With experience, image registration and fusion using 2D T2w images took approximately 15 minutes. This was reduced to <10 minutes using 3D T2w images.

Eight of 27 patients tested negative with both biopsy techniques. Template biopsies were positive in the remainder (19), and fusion biopsies identified 11/19 positive results. The main reason for false negative results was incorrect identification of a target on MRI (6/8). The remaining 2/8 cases had far lateral disease, which is difficult to target transrectally. The template biopsies of patients with false negative fusion biopsy mostly revealed Gleason 6 disease, which would not be clearly visible on MRI.

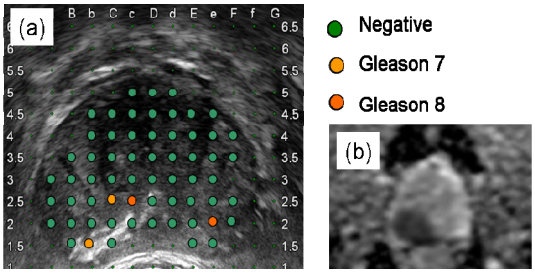

Fig.3: (a) Template with B-mode image showing cores taken and histological findings. (b) ADC map of prostate showing suspicious region of restricted diffusion

Conclusions

Preliminary data show that targeted fusion biopsies using the RVS system have been successful for patients with suspected high grade prostate cancer and suspicious MRI. The process required efficient communication between urologists and radiologists, as well as an additional trained member of support staff to perform the image registration and fusion.

Overall, if fusion biopsies were implemented as part of the patient pathway, 30% of the patients presented would have avoided a template biopsy. Although conducted under general anaesthesia in this study, fusion biopsies could be performed with local anaesthesia, reducing the potential complications as well as the burden on resources.

References

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[2]Sonn GA, Natarajan S, Margolis JA et al. Targeted Biopsy in the Detection of Prostate Cancer Using an Office Based Magnetic Resonance Ultrasound Fusion Device. J Urol. 2013;189:86-92.