Quantitative transrectal shear wave elastography undergoing salvage extraperitoneal laparoscopic radical prostatectomy following failed radiotherapy

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Abstract

To evaluate pre-surgical quantitative transrectal shear wave elastography (SWE) in the detection and characterisation of radioresistant prostate cancer. 12 men with recurrent prostate cancer following external beam radiotherapy were selected from a prospective protocol driven study. All underwent MR imaging and quantitative shear wave elastographic assessment of recurrent disease prior to salvage laparoscopic radical prostatectomy procedures. Images were used to construct 3-D mold printing and histopathological processing of surgical specimen. Statistical analyses including ROC were generated using 3D reconstruction software programmes. There were 48 cancer foci identified on final histopathology using patient specific mold based approach in 12 patients. Mean number of lesion was 3.4 (range 2 to 4). Quantitative transrectal SWE showed a sensitivity and specificity 0.77 (95% CI 0.627 - 0.880) and 0.82 (95% CI 0.642 - 0.942) respectively. The diagnostic accuracy increased with increasing size of the lesions with overall AUC of 0.89. In our series quantitative transrectal SWE showed a good diagnostic accuracy in the detection and characterisation of recurrent prostate cancer following failed radiotherapy treatment. These findings may help in targeting biopsies or future focal treatment options.

Introduction

Salvage treatment options vary for radical radiotherapy (external beam or brachytherapy) failure in men with continued organ confined prostate cancer disease on clinical imaging. Shear wave elastography (SWE) is an ultrasound technique which is not dependant on compression/release technique of strain elastography method and hence elastography produced is an improved reflection of tissue stiffness. The present study was designed as a feasibility phase to assess diagnosis accuracy of transrectal SWE in the detection and characterisation of clinically localised radioresistant prostate cancer.

Methods and materials

The feasibility phase of this study is a part of a large Shear Prostate Study aimed at diagnostic accuracy of Transrectal SWE in the detection and characterisation of prostate cancer. The study design is shown Figure 1 below:
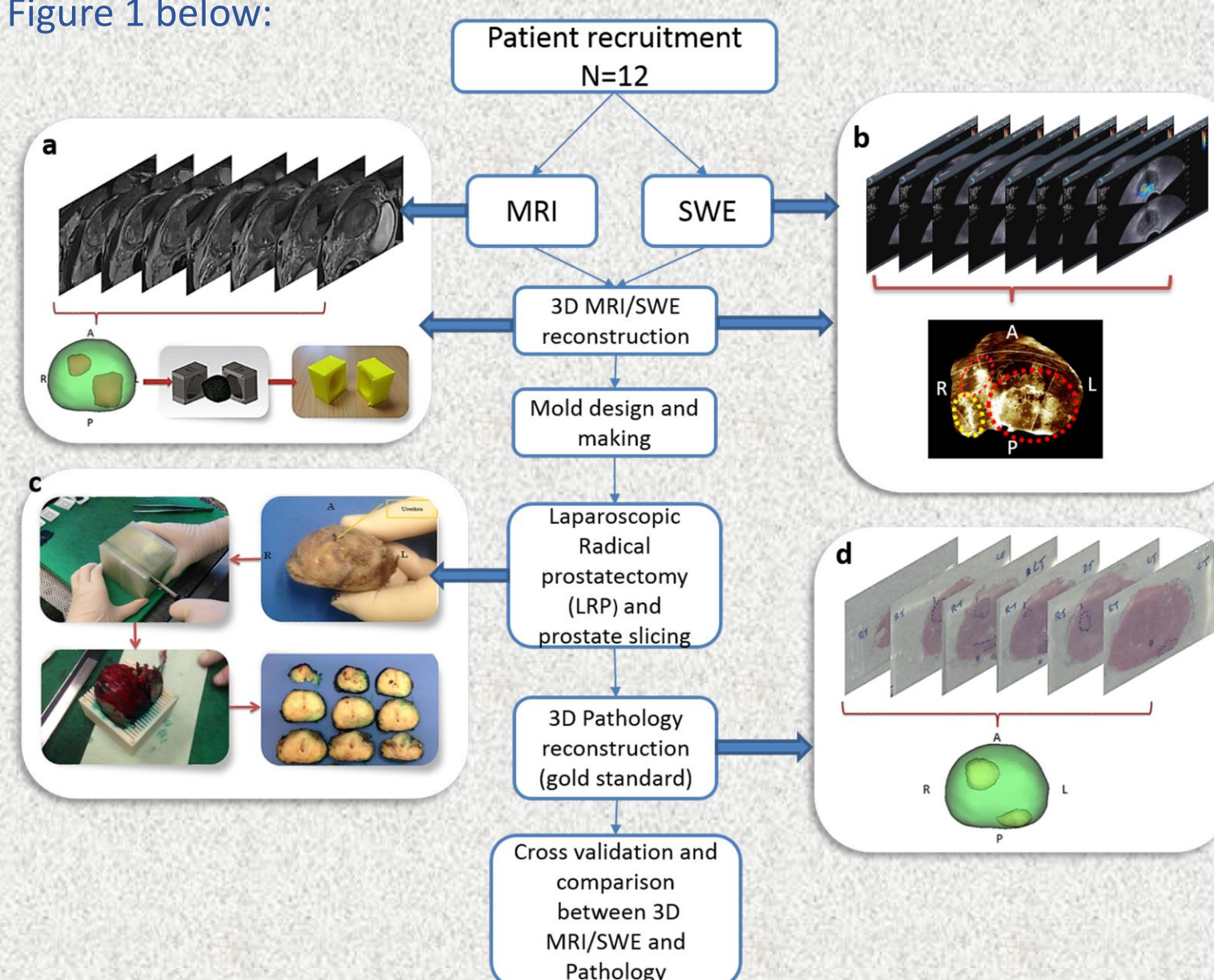
After careful segmentation and photographing from both B-mode and SWE data, each suspicious cancerous area was manually marked on each slide and fused into a 3D model (Figure 2-a). Lesions were distinguished from normal tissue of prostate gland in pseudo-colour image with different quantitative data (Figure 2-b). The advantages of this technique were to provide a better visualised and comprehensive analysis for the characterisation of prostate cancer.
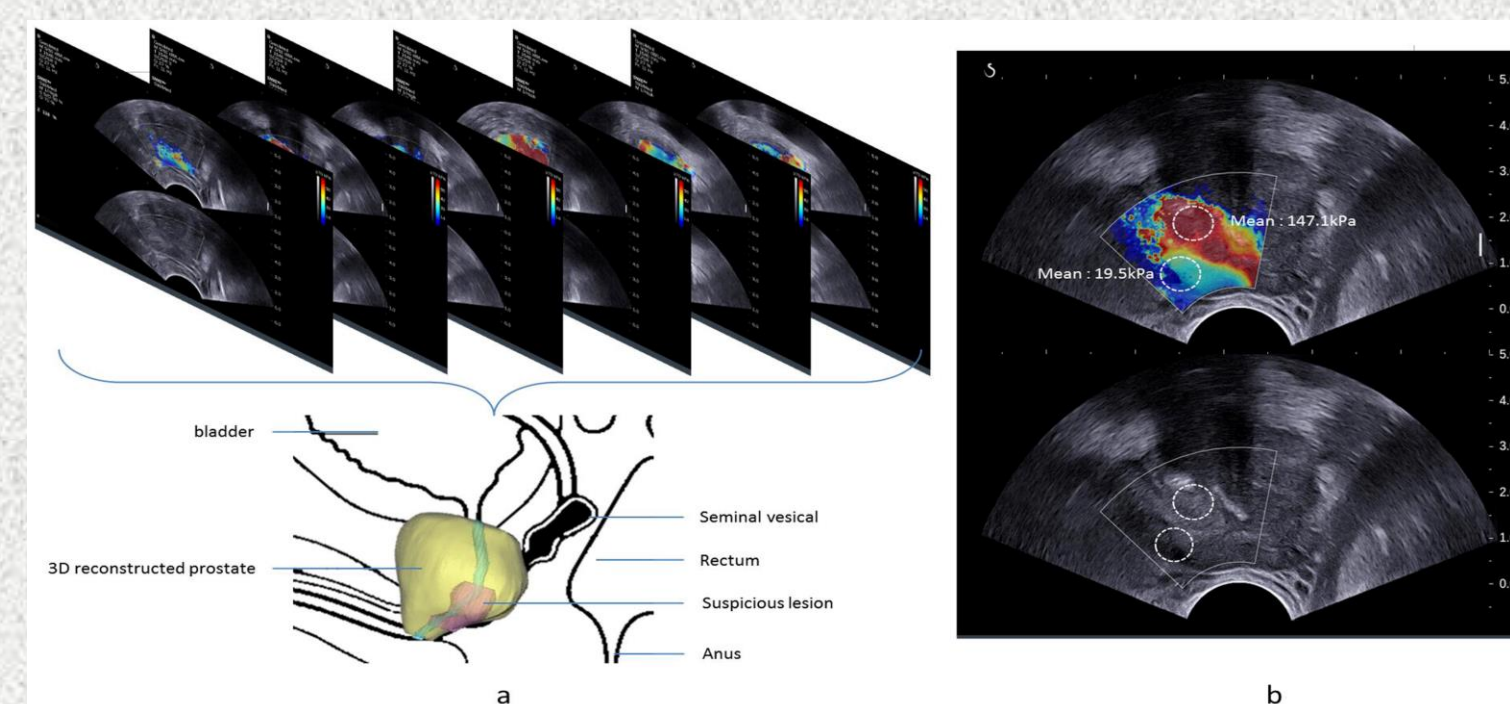
Results

Overall sensitivity and specificity of SWE in the detection of prostate cancer for various sizes of the lesions was 0.77 (95% CI 0.627 - 0.880) and 0.82 (95% CI 0.642 - 0.942) respectively. The diagnostic accuracy increased with increasing size of the lesions with overall AUC of 0.89. There were 48 cancer foci identified on final histopathology using patient specific mold based approach (Table 1 below). Mean number of lesion was 3.4 (range 2 to 4).

Patient No. n=12		Gleason Grade				
		6 (3+3)	7(3+4)	7(4+3)	≥ 8	total
Cancer size (mm)	≤5	5	2	0	0	7
	5-10	4	8	1	2	15
	≥10	1	13	0	12	26
	Total	10	23	1	14	48

Table 2 shows comparison of performance of quantitative shear wave elastography and MRI (anatomical sequences and DWI) for different sizes of the lesions based histopathology of radical prostatectomy as reference standard. The performance of MRI and SWE was comparable and both were poor in smaller (<5mm). In three patients SWE correctly identified extracapsular extension of cancer and none of these were reported on MRI. There were not many lesions in the anterior zone of the prostate and hence performance of both imaging modalities in this area would need further study.

Performance of SWE was particularly promising for measuring periurethral stiffness in the apical region of the prostate. In seven men, SWE could reliably predict status of apical margin using mean periurethral stiffness as a marker of disease. It was false positive and false negative in two cases respectively. 3D reconstructed images (Figure 2-a) clearly showed disease in apical area and could be helpful in guiding surgical technique.

Imaging modality	Cancer size (mm)	Sensitivity	Specificity	P value
MRI	≤5	62.4%	93.4%	<0.01
	5-10	64.9%	93.5%	<0.01
	≥10	74.3%	91.5%	<0.01
SWE	≤5	42.4%	95.9%	<0.01
	5-10	72.1%	90.5%	<0.01
	≥10	87.5%	92.6%	<0.01

Discussion

Transrectal SWE is a novel imaging method and focus of our study. Grey-scale B modal ultrasound images based on brightness of image representing structural image of tissue had shown poor performance in the detection or characterisation of prostate cancer. There are several published reports showing benefits of SWE in the detection and characterisation of prostate cancer, however the technology has not been evaluated in radiation failure patients. This is particularly challenging area as fibrosis distorts the interpretation of images and quality of imaging modality is compromised. The performance of this imaging modality was particularly good in larger lesions and those situated close to apex of the prostate. Periurethral stiffness seen in the present could be a potential marker of risk of positive surgical margins and can guide surgery in this area in the future. The study is, however limited by small numbers but comparable to many reports of imaging modalities in radiation failure prostate cancer patients

Conclusions

Transrectal SWE imaging significantly improves detection and characterisation of radioresistant prostate cancer after radical external beam radiotherapy. The SWE technology can quantitatively assess the disease which may help in risk stratification to different salvage treatment options. A particular helpfully promising role of this technology is the assessment of the apical area is emerging to guide surgery with aim to reduce positive surgical margins, however this needs future studies with larger number of patients.

References

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