Early experience of micro-ultrasound prostate imaging

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Introduction

Prostate cancer is detected in approximately 1 in 8 men in the UK[1] and incidence is increasing[2]. Prostate biopsy is required to confirm diagnosis. The PROMIS trial[3] found using magnetic resonance imaging (MRI) to triage men may allow 27% of patients to avoid biopsy. As such, MRI is advocated as a diagnostic tool within the prostate pathway. However, there are limitations of MRI in terms of capacity, contraindications, and variability in reporting standards.[4]

Mirco-ultrasound (microUS) is an emerging technology that may be a viable alternative to pre-biopsy imaging of the prostate. Clinical trials have demonstrated that microUS is a useful addition to MRI in detecting clinically significant prostate cancer, with both modalities complementing each other.[5] Early evidence suggests that microUS will play an important role in assessing prostate disease, particularly in patients in whom MRI is contraindicated.[6] microUS uses frequencies in the range of 21 – 29MHz. This is enabled by the use of a higher ultrasound wave producing crystal density within the transducer head.[7] The higher crystal density compensates for increased attenuation associated with higher frequency sound waves, enabling deeper penetration than would be expected for frequencies in this range.

An microUS system (ExactVu™, Markham, ON, L3R 2N2, Canada) was installed into Hull Teaching Hospitals ultrasound department in September 2021. Following initial training, the system has been used to provide pre-biopsy assessment of the prostate. This study has evaluated the first cohort of patients assessed using this system who also underwent MRI and biopsy.

Study Aim

The aim of this study was to compare the findings of microUS assessment with that of pre biopsy MRI and histology outcomes in a cohort of patients with suspected prostate cancer.

Ethics

Ethics approval was sought through the Integrated Research Application System (IRAS) to allow for ethics review through the NHS Research Ethics Committee (REC). RECs safeguard the rights, safety, dignity and well-being of people participating in research in the NHS The project was approved and given a IRAS ID.

Methodology

104 patients were recruited into the study. All consented to imaging with the microUS system alongside the standard ultrasound guided transperineal biopsy procedure under local anaesthetic (LATP Bx). Demographics displayed in table 1.

The five point PI-RADS v2[8] MRI reporting system, and PRIMUS microUS reporting tool[9] were compared against clinical outcomes. Variation in MRI and microUS parameters limited direct comparison therefore, a 3-point risk stratification system was developed for imaging and histology outcomes (table 2). MRI, microUS, and histology outcomes were analysed and simple agreement rates of modalities produced.

Table 1: patient demographics

	Age years	PSA	Prostate Volume mL	PSAD
Range	47 - 84	0.82 – 50	16 - 167	0.04 – 0.93
Average	66.4	8.07	50	0.18
Median	67	6.4	42	0.14

Table 2 : Locally devised risk stratified scoring system

	Cat 1	Cat 1	Cat 2	Cat 3	Cat 3
Histology	Benign/ no cancer detected	Low grade PIN; ASAP	High grade PIN; Gleason 3+3 /3+4 & cancer core length < 6mm	Gleason 3+3 / 3+4 with cancer core length ≥ 6mm	Gleason ≥ 4+3
MRI PI-RADS v2	1	2	3	4	5
microUS PRIMUS	1; low risk anterior gland	2; low risk anterior gland	3	4, High risk anterior gland	5; High risk anterior gland

Results

Of the 104 patients recruited:

- 101 patients had MRI, microUS, and LATP Bx; 3 patients were unable to tolerate the microUS transducer and imaging could not be performed.
- 76% had fusion guided LATP Bx due to suspicion of prostate disease at MRI whilst 24% had a systematic non-targeted LATP Bx due to raised clinical concern only.
- Clinically significant cancer was detected in 48% of patients when utilising the PRECISION[10] criteria (Table 1 and 3).

Histology and MRI distribution (Graph 1)

- Good agreement between high risk cat 3 imaging and high risk histology is demonstrated. In 90% patients with cat 3 histology, a high risk cat 3 MRI was reported.
- There is poor agreement between low risk imaging and low risk histology. Only 32% of patients with low risk cat 1 histology had a low risk cat 1 MRI reported.

Histology and micro-US distribution (Graph 2)

- Reasonable agreement between high risk cat 3 microUS imaging and high risk histology. In 76% of patients with cat 3 histology, a high risk cat 3 microUS was reported.
- Reasonable agreement between low risk microUS imaging and low risk histology was found with 54% of cat 1 histology being reported at microUS.

Imaging modality comparison

Agreement rates of MRI and microUS modalities was made, assuming prostate MRI as the gold standard due to this being a well established technique.

- Of the 101 patients who had both MRI and microUS, there was agreement between imaging modalities in 56% of patients (table 4 shows distribution of agreement).
- Reasonable agreement between high risk cat 3 MRI and high risk cat 3 microUS with 63% concordance in reporting of the imaging modalities.
- Reasonable agreement between low risk MRI and low risk cat 1 microUS with 66% concordance between modalities noted.
- Highest agreements are seen within cat 3 high risk MRI and microUS, and also within cat 1 low risk imaging.
- Category 2 equivocal imaging results produce uncertainty due to the ambiguous appearances at MRI or microUS. Equivocal appearances can represent high or low risk disease. Including this category may affect agreement rates of imaging despite the fact that they are a real life conundrum. Further study needs to be undertaken to better understand how to evaluate category 2 outcomes.

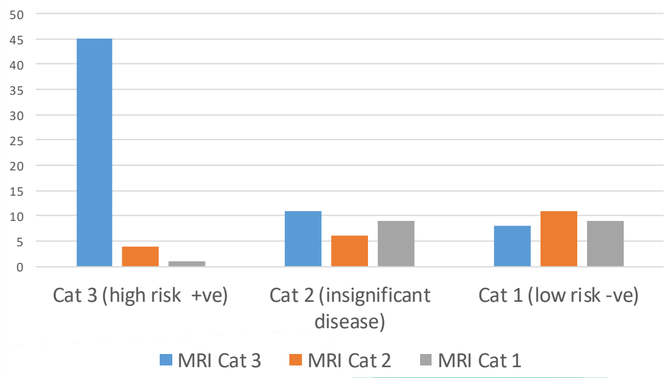
Table 3 Histological finding and relevant Gleason score of prostate disease

Histology	Count
Benign	23
Prostatitis	2
ASAP	1
Low grade PIN	1
High grade PIN	6
3+3 (max core length <6mm)	11
3+3 (max core length ≥6mm)	**2**
3+4 (max core length <6mm)	10
3+4 (max core length ≥6mm)	**10**
3+5	**1**
4+3	**15**
4+4	**5**
4+5	**15**
5+4	**2**
Total	104

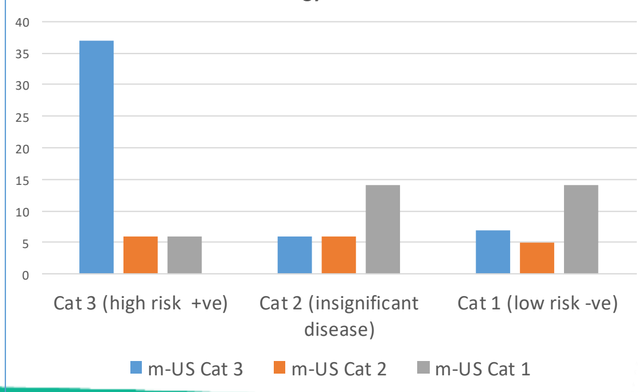
Table 4 Distribution of microUS and MRI scores and agreement rates

		MRI			
		Cat 3 (high risk +ve)	Cat 2 (equivocal)	Cat 1 (low risk -ve)	
microUS	Cat 3 (high risk +ve)	**63% (n = 40)**	43% (n = 9)	5% (n = 1)	50
	Cat 2 (equivocal)	17% (n = 11)	19% (n = 4)	16% (n = 3)	17
	Cat 1 (low risk -ve)	20% (n = 13)	38% (n = 8)	**68% (n = 13)**	34
Total n =		64	21	16	101

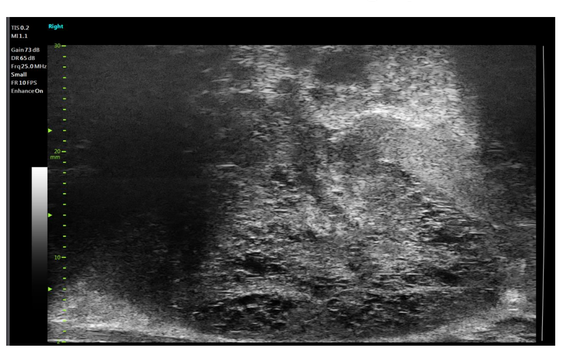
Graph 1: distribution of MRI categories between histology outcomes

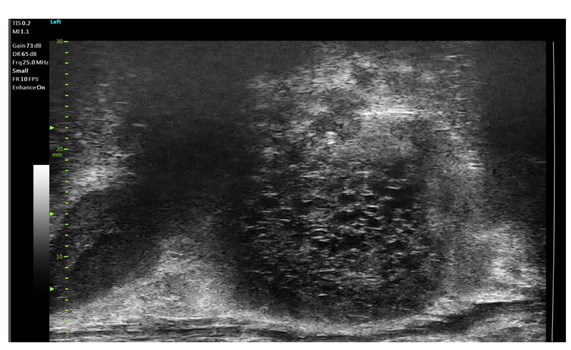


Graph 2: distribution of micro-US categories between histology outcomes

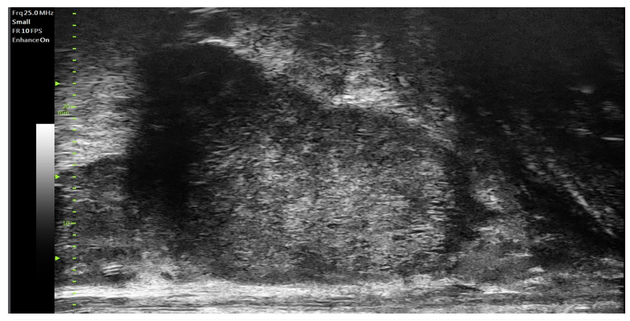


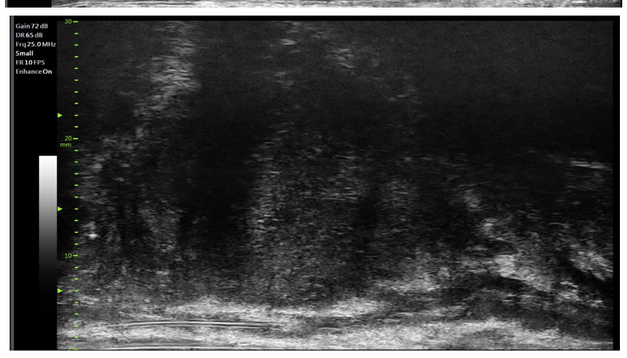
Category 1 – low risk microUS of the prostate



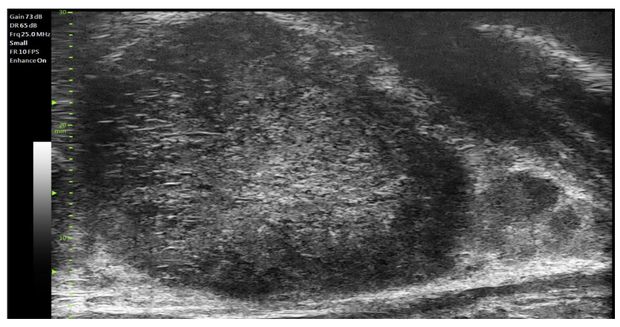


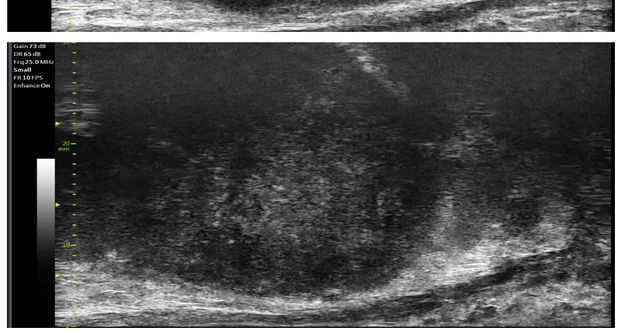
Category 2 – equivocal findings at microUS





Category 3 – high risk microUS of the prostate





Summary

Using a three point risk stratification system, microUS demonstrates reasonable identification of high risk cat 3 disease and reasonable identification of low risk stratification. In our cohort, microUS performed better in the low risk histology criteria than MRI. A role for microUS in negating the need for biopsy will be considered in future studies.

Our early experience of microUS has identified that this modality is a reasonable predictor of the presence or absence of disease. Further experience is required to improve high risk cancer detection. A limitation of this early data collection is that the sonographers performing microUS were not blinded to MRI findings and this may have introduced bias. Further study will include analysis of microUS interpretation, blinded to the MRI imaging or histology outcomes.

Remarkable people. Extraordinary place.

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