MRI – Prostate Imaging

Dr Tristan Barrett

Addenbrooke's Hospital, University of Cambridge, UK

UNIVERSITY OF CAMBRIDGE @Tristan_Radiol Addenbrooke's Hospital NHS Cambridge University Hospitals NHS Foundation Trust

Background

- **Prostate Cancer = 2nd commonest male cancer**
  - 48,487 cases/year; 11,855 deaths/year [1,2]
  - 120,000 Urology clinic referrals per year
  - High prevalence means MRI acquisition and reporting cannot be the preserve of tertiary referral hospitals
- **International guidelines recommend mpMRI pre-biopsy**
  - For lesion detection and biopsy guidance
  - Also a key role in local **T-Staging** of the gland

[1] National Cancer Intelligence Network. Stage Breakdown by CCG 2014. London: NCIN; 2016

Primer on prostate "Multiparametric" MRI

- **mpMRI = Anatomical + Functional sequences**
  - T2 (axial key plane) + DWI + DCE
- **Anatomy overview**
  - Peripheral Zone (70% Pca)
  - Transition Zone (BPH)
  - Central Zone (around SV/Ejac ducts)
- **Key sequences**
  - Peripheral Zone **DWI**
  - Transition Zone **T2**
  - The post treatment gland **DCE**

PI-RADS and Prostate "Multiparametric MRI"

- **2012: "ESUR prostate MRI guidelines"**
  - *[retrospectively termed PI-RADS version 1]*
  - Focus acquisition: minimal/optimal parameters
- **2015: PI-RADS version 2**
  - Dropped MRSI. ↓ Role for DCE
  - More explicit in how to assess/score lesions
- **2019: PI-RADS version 2.1**
  - Minor change simplify assessment ↓ variability
  - T2WI in TZ / DWI scores 2-3 / "negative" DCE

Level 1 Evidence : Biopsy naïve patients

GI 3+4 ≥0.5 cm³ (≈ 10 mm)
GI ≥4+3 ≥0.2cm³ (≈ 7 mm)

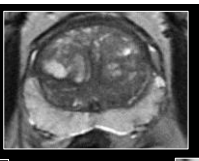
csPCa detected (PROMIS, PRECISION, MRI-1st, 4M) [1-4]

- PI-RADS 1-2 = **8.3%** (3 - 11) → **NPV 91.7%**
- PI-RADS 3 = **18.3%** (12 - 21)
- PI-RADS 4 = **47.3%** (32 – 60)
- PI-RADS 5 = **79.3%** (70 – 83)

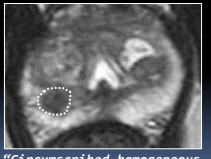
} **PPV 49.9%**

[1] Lancet. 2017; 389:815-22 [2] N Engl J Med. 2018; 378(19):1767-77 [3] Lancet Oncol 20(1):100-109 [4] Eur Urol 75(4):570-578

T2WI

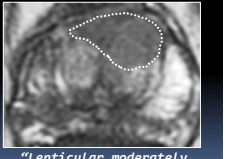


Peripheral Zone (70% PCa)



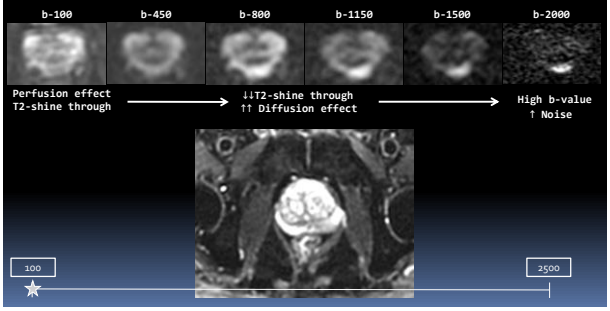
"Circumscribed homogeneous hypointense focal mass"

Transition Zone (BPH)



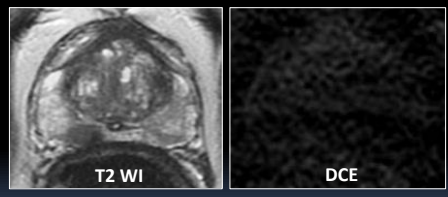
"Lenticular moderately hypointense (erased charcoal)"

DWI - b-values



DCE-MRI

Scored as "positive" or "negative"



Focal AND Enhances earlier vs normal **AND Matches suspicious** T2W/DW area

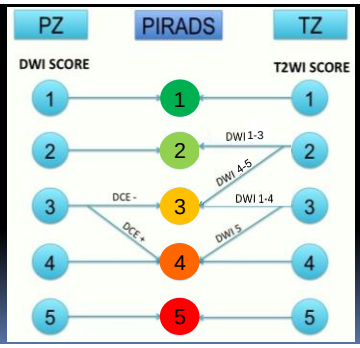
BUT: Prostatitis + BPH can show early contrast wash-in and wash-out

Deriving overall score: Dominant Sequences

- **PZ assessment: DWI (scored ?/5)**
  - Low T2 signal in the PZ non-specific
- **TZ assessment: T2WI (scored ?/5)**
  - BPH nodules can be highly cellular with restricted diffusion
- **Secondary sequences**
  - DCE in PZ and DWI in TZ
  - If dominant sequence "indeterminate" may ↑ score
  - Can replace the primary if inadequate

DWI in PZ Dominant

DCE in PZ Secondary



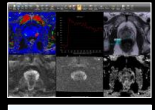
T2 in TZ Dominant

DWI in TZ Secondary

So What's the Big Issue?

New 28-day Cancer Diagnostic Standard

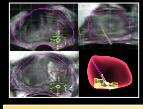
UK diagnostic interval 56 days (all cancers = 40 days) *BMC Cancer 2018; 13: 559*



RADIOLOGY

MRI = scarce resource
40+ min / 2,000+ images
Limited Reporters

Abbreviated protocols
General MRI lists



UROLOGY

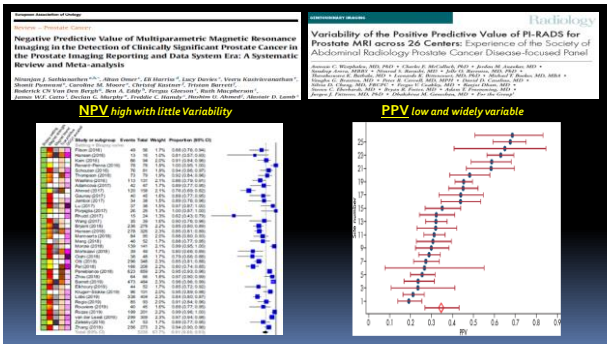
Fusion outlining step
Some cases GA/Theatre

RAPID: One Stop
LA TP Biopsy

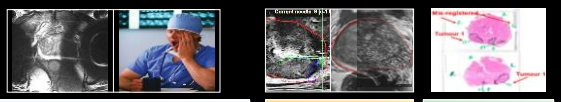
PATHOLOGY

12+ cores acquired
Limited Reporters

Target only cores
Omit MDT re-review



Quality Important at all steps

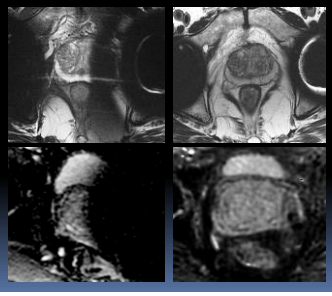


RADIOLOGY			UROLOGY	PATHOLOGY	
Patient Factors	Image Quality	Interpretation	Data Processing	Biopsy	Pathology
Metalwork Motion Rectal Gas Prior Biopsy Sparse Tumour	1.5T vs 3T mp vs bpMRI Surface vs ERC	Learning curve Time Pressure	Bx Threshold Outlining Fusion software	Learning curve Cognitive errors Core Quality	Inter-reader variability (esp @ GS 7)

Modifiable factors (?)

Patient Factors

Spasmolytics
Rectal prep
Prone imaging
Metal reduction techniques



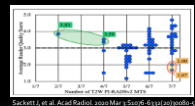
Modifiable factors (?)

Patient Factors

Spasmolytics
Rectal prep
Prone imaging
Metal reduction techniques

Image Quality

PI-RADS technical standards



Sackett J, et al. Acad Radiol. 2020 Mar;27(3):328-333. doi: 10.1016/j.acra.2019.03.014. Epub 2019 Apr 25.

Age of MR Scanner <7 years

DCE Quality less degraded

Born P, et al. Clin Radiol. 2019; 74(11): 894.e19-894.e25

DCE helps if less experienced

Gatti M, et al Abdom Radiol. 2019;44:3883-3893

Modifiable factors (?)

Patient Factors

Spasmolytics
Rectal prep
Prone imaging
Metal reduction techniques

Image Quality

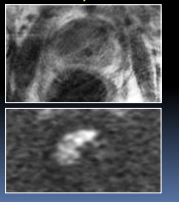
PI-RADS technical standards
NEW: PI-QUAL

MRI Prostate with contrast
Technique:
T1-weighted post-biopsy change:
Prostate size:
T2-weighted and DWI findings:
DCE-MRI findings: Moderate-to-Severe
Extra-capsular extension:
Seminal vesicle invasion:
Bone lesions:
Lymph nodes:
Impression: Moderate-to-Severe Affecting Interpretation

Nil or Mild = Not Mentioned

Prostate Imaging Quality (PI-QUAL): A New Quality Control Scoring System for Multiparametric Magnetic Resonance Imaging of the Prostate from the PRECISION trial

Rule-in ability >> Rule-out



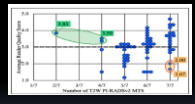
Modifiable factors (?)

Patient Factors

Spasmolytics
Rectal prep
Prone imaging
Metal reduction techniques

Image Quality

PI-RADS technical standards
NEW: PI-QUAL



Prostate Imaging Quality (PI-QUAL): A New Quality Control Scoring System for Multiparametric Magnetic Resonance Imaging of the Prostate from the PRECISION trial

Radiologist Interpretation

Learning curve
NEW: Certification

Defining the learning curve for multiparametric magnetic resonance imaging (MRI) of the prostate using MRI-transrectal ultrasonography (TRUS) fusion-guided transperineal prostate biopsies as a validation tool

BJUI

Research Communication

Certification in reporting multiparametric magnetic resonance imaging of the prostate: recommendations of a UK consensus meeting

Issues in Dx Pathway

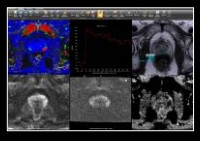


Image Quality Reporter Learning Curve

120,000 referrals/year
Cannot be the preserve of tertiary centres

Best Practice Guidelines

Disseminating Current Best Practice

- How can we control Image Quality?
- How can we improve Interpretation?

AI: Image Quality / Augment Interpretation

Education / Certification

Advancing Current Best Practice

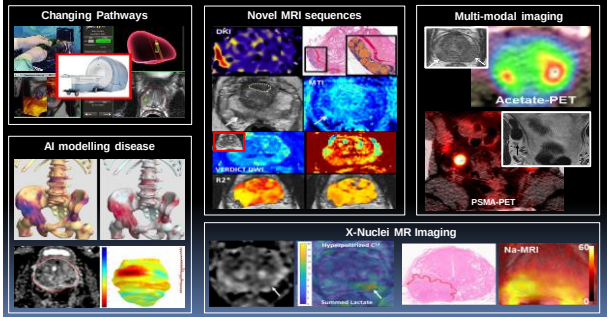
- How can we improve NPV / PPV?
- Can we better risk stratify patients?

Novel Imaging Techniques

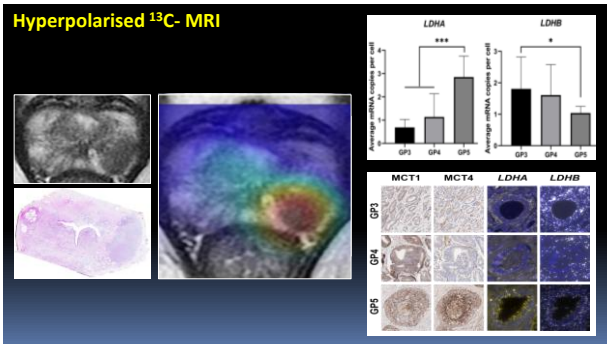
Patient Management - Areas for Improvement

- ***(… is there a need for)* Novel imaging techniques?**
  - Technically challenging to perform, post-processing of results
  - ↑ Time MRI scanning = ↑ ↑ cost … Additional equipment may ↑ cost
- **Prostate Cancer Mx based on Risk groups**
  - *Low Risk (GS 6-7, ISUP 1-2)* : Indolent disease, Active Surveillance (AS)
  - *Intermediate Risk (GS 4+3, ISUP 3)* : Radical Rx (Surgery / RTx)
  - *High Risk (GS 8-10, ISUP 4-5)* : Radical Rx / Multi-modal Rx / Systemic Tx
- **Areas where a difference can be made**
  - Biopsy sampling error → MRI "samples" whole tumour → better risk stratify
  - Selection for AS and identify progression on AS → Treatment
  - In BCR identify region/s of recurrence → Focal salvage Treatments

@ CUH …



Hyperpolarised ^{13}C- MRI



Summary

- **MRI now integral for prostate cancer diagnostics**
  - Recent paradigm shifts: MRI for PCa detection and PSMA-PET for PCa staging
- **SoC imaging good, but room for improvement**
  - High disease prevalence means all hospitals need to scan even smaller DGHs
  - Novel methods only adopted if quick/easy/cheap **and** have "incremental" value
  - Disseminating best practice for SoC imaging provides the "biggest gains"
- **There is still a need for research in this area**
  - Novel techniques often expensive and require a large support team
  - Line of sight key: Identify niche areas where imaging can impact on Mx decisions

@Tristan_Radiol