

MRI Prostate in Practise – How I Use it

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Introduction

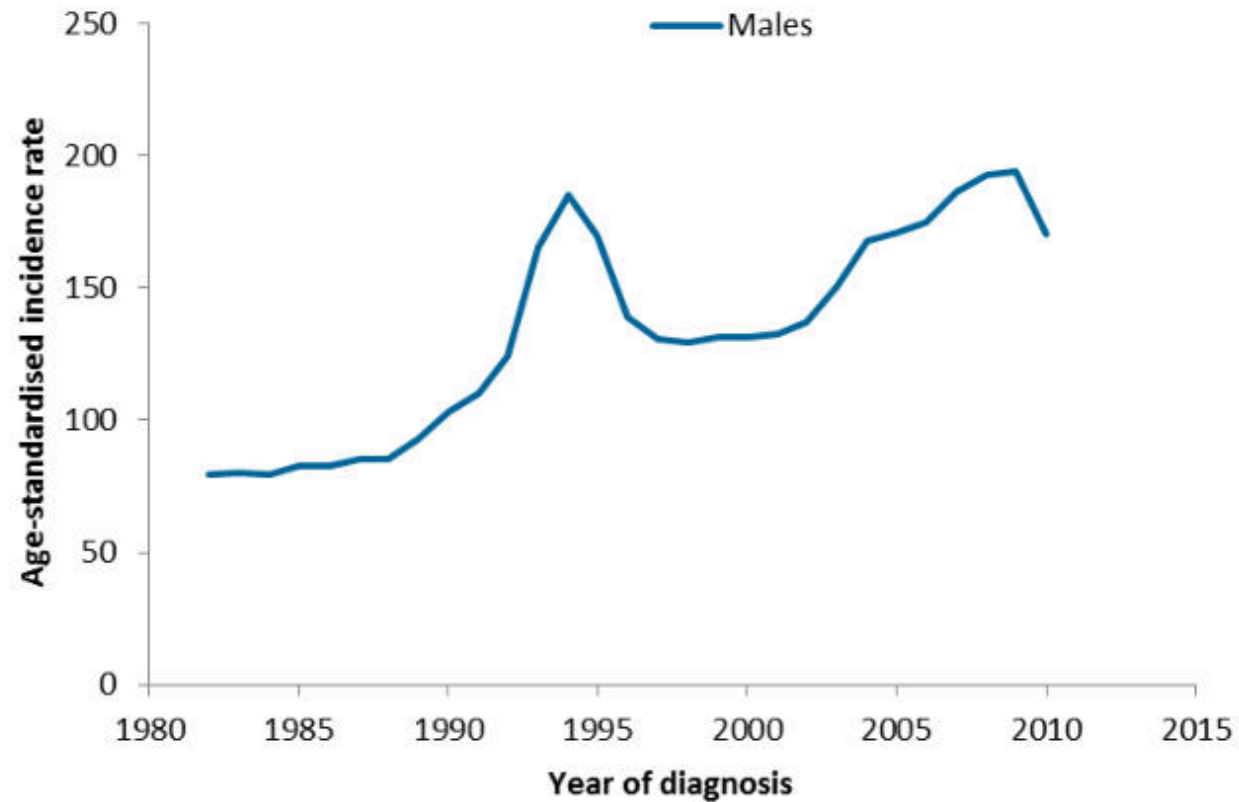
- * Overview of prostate cancer
- * Current procedures for prostate biopsy
- * Overview of multiparametric MRI
- * Case series and literature review
 - * Screening, biopsy and active surveillance
 - * T-Staging
- * Video illustrating robotic prostatectomy correlating to MRI

Overview

- * Prostate cancer is the most common diagnosed cancer in Australia
 - * Risk of diagnosis before age 85 is 1 in 5
- * Mortality rates are decreasing
 - * Prostate cancer 5-year survival has improved from 59% in 1986 to 90% in 2007.
- * Differing rates of diagnosis for people in different geographical location
 - * Aboriginal and Torres Strait Islanders were less likely to be diagnosed but more likely to die from prostate cancer compared with non-Indigenous populations
 - * Males living in Remote/Very remote areas were less likely to be diagnosed with prostate cancer compared to other areas

Overview

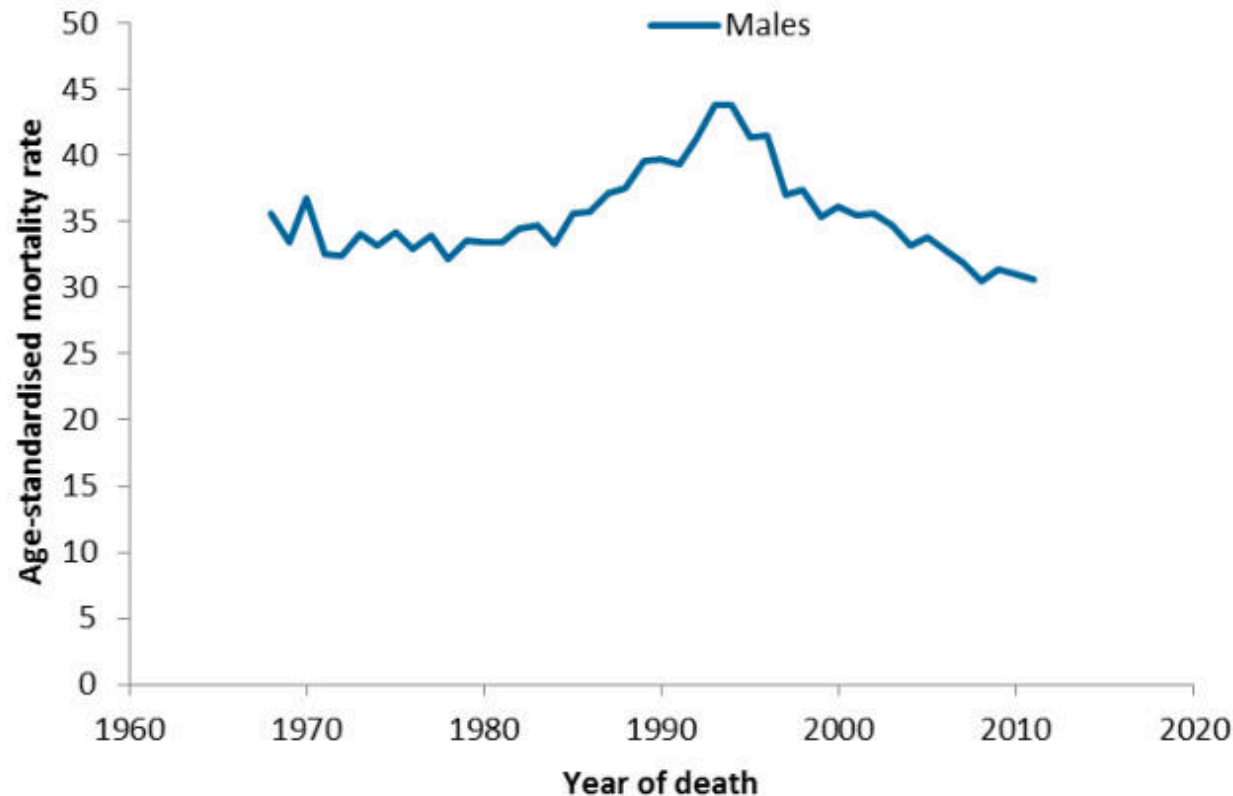
Age-standardised incidence rate by year



Source: Australian Institute of Health and Welfare

Overview

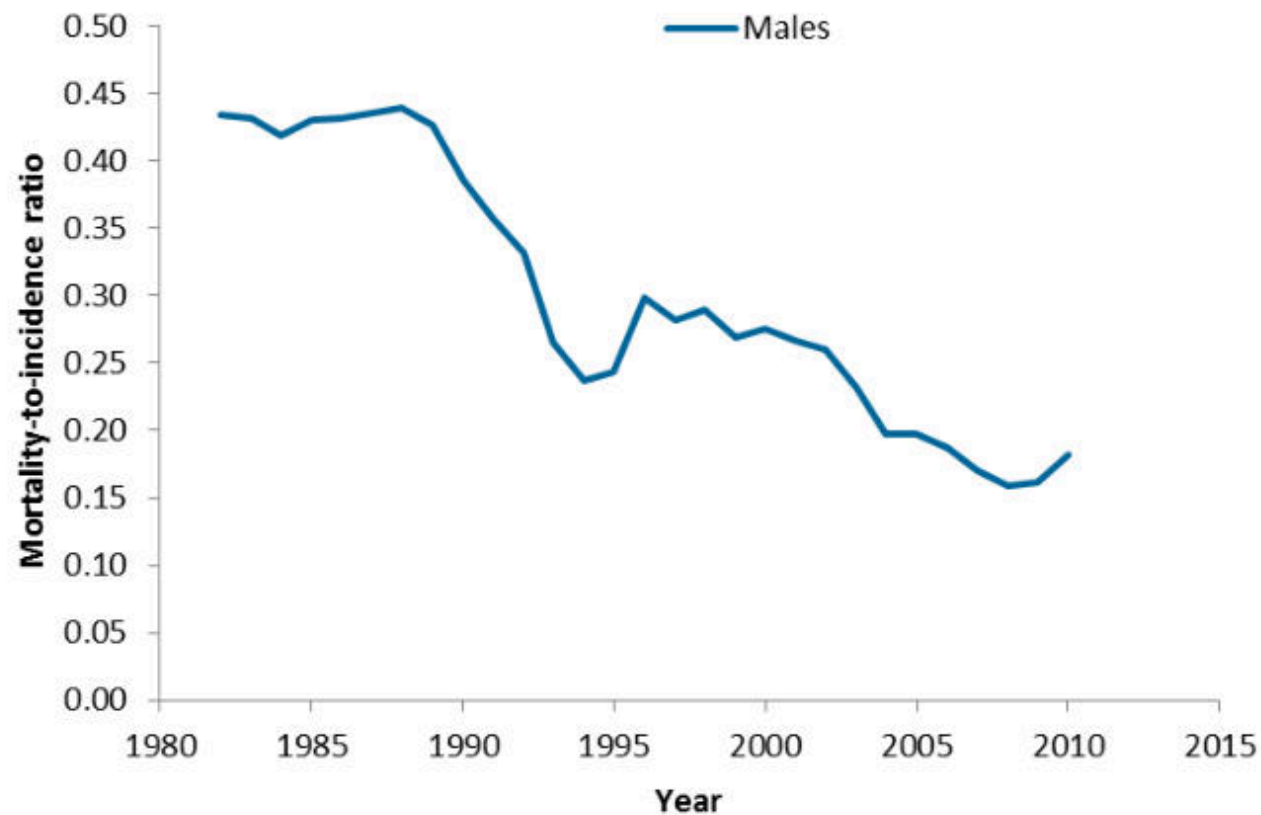
Age-standardised mortality rate by year



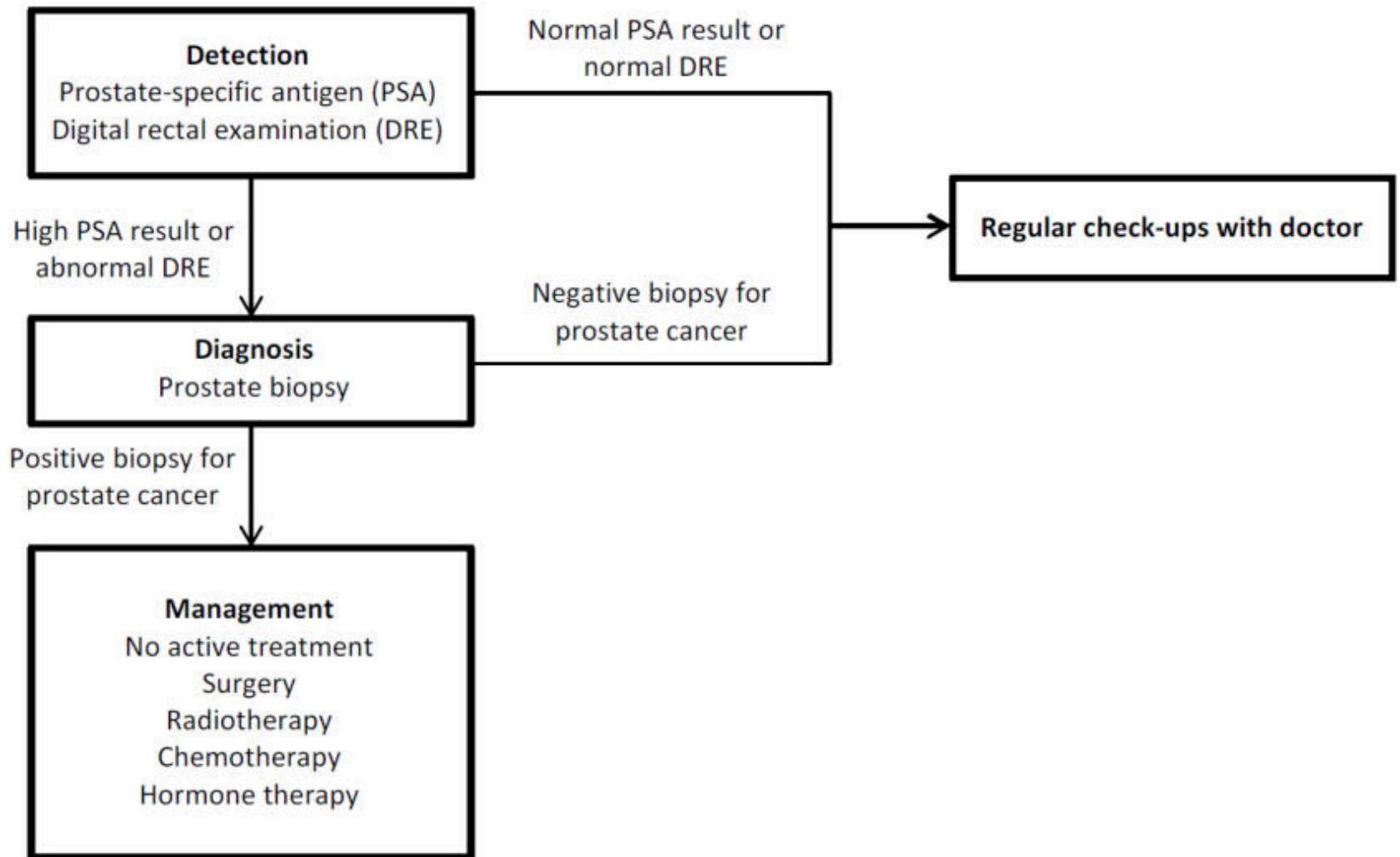
Source: Australian Institute of Health and Welfare

Overview

Mortality-to-incidence ratio by year



Source: Australian Institute of Health and Welfare



Source: American Urological Association 2007; Andrology Australia 2011.

Figure 2.1: Flow chart of prostate cancer detection, diagnosis and management

Overview of Current Procedure

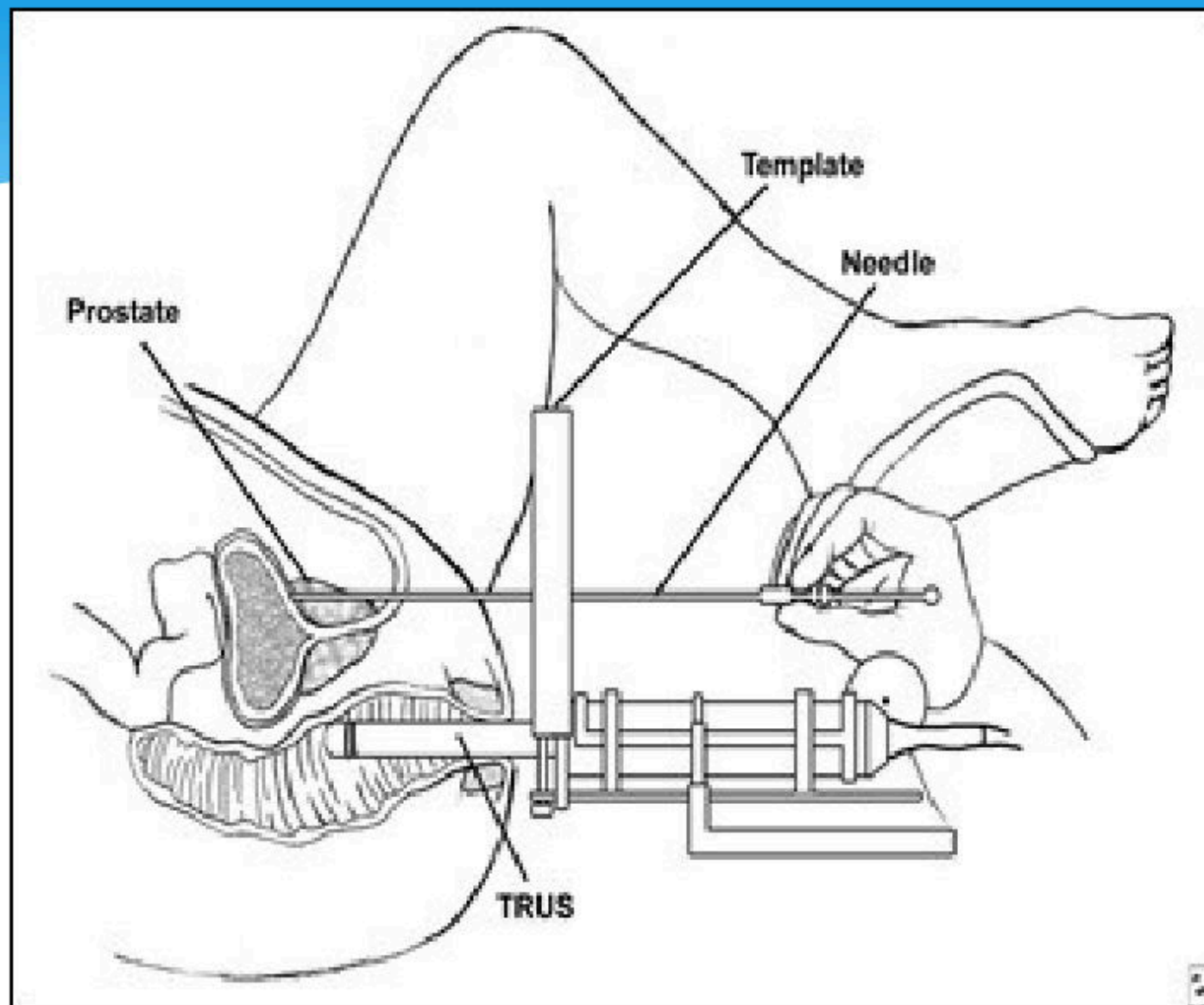
- * PSA/DRE – poor sensitivity and specificity
- * TRUS biopsy – 20% false-negatives¹
 - * 30-45% of risk of upstaging or down-staging
- * Saturation or template mapping biopsies¹
 - * Increased costs
 - * Increased complications
 - * Over-detection rate of clinically insignificant cancer
 - * Still significant risk of missing high grade cancer

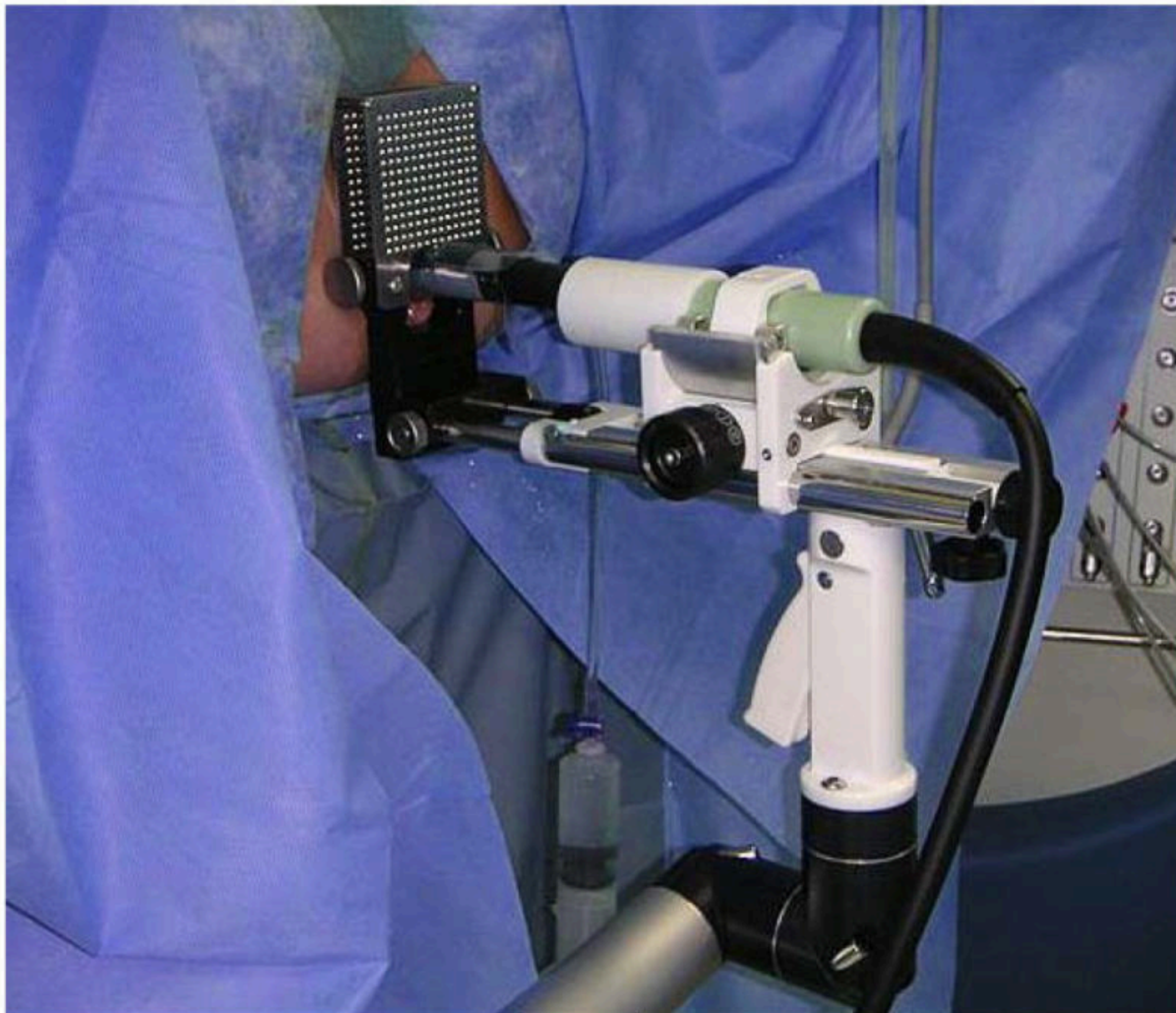
1. Thompson, J., Lawrentschuk, N., Frydenberg, M., Thompson, L. & Stricker, P. (2013). The role of magnetic resonance imaging in the diagnosis and management of prostate cancer. *BJU Int*, 112, Supplement 2, p6-10

Overview of Current Procedures

- * Transperineal biopsy²
 - * Cancer detection in 35.6% following previous negative biopsy with transrectal ultrasound
 - * Higher detection rates in smaller prostates (<50mL)
 - * No difference in likelihood of significant vs insignificant cancer at radical prostatectomy in those in active surveillance

2. Symon, JL., Huo, A., Yuen, CL, Haynes, AM, Matthews, J., Sutherland, RL., & Stricker, PD. (Sept 2013). Outcomes of transperineal template-guided prostate biopsy in 409 patients. *BJU Int*, 112(5), p585-593





Emerging Role of MRI in Prostate Cancer

- * ? Screening
- * Selecting patients for initial biopsy
 - * Freehand/cognitive MRI guided
 - * MRI-TRUS fusion
 - * In Gantry/real-time
- * Active surveillance
- * T-staging

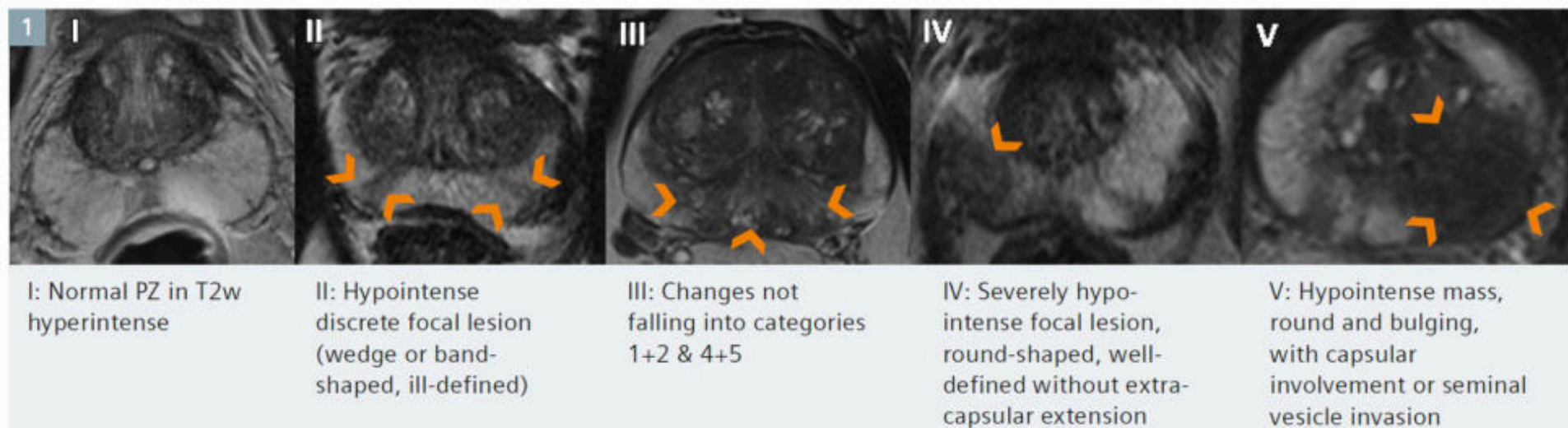
Overview of MRI

- * Multiparametric(mp) MRI's are an emerging modality
- * PI-RADS (Prostate Imaging – Reporting and Data System) system
 - * Standardised reporting system by 5 point scale
 - * 1 = “extremely unlikely”
 - * 2 = “unlikely”
 - * 3 – “equivocal”
 - * 4 = “likely”
 - * 5 = “extremely likely”

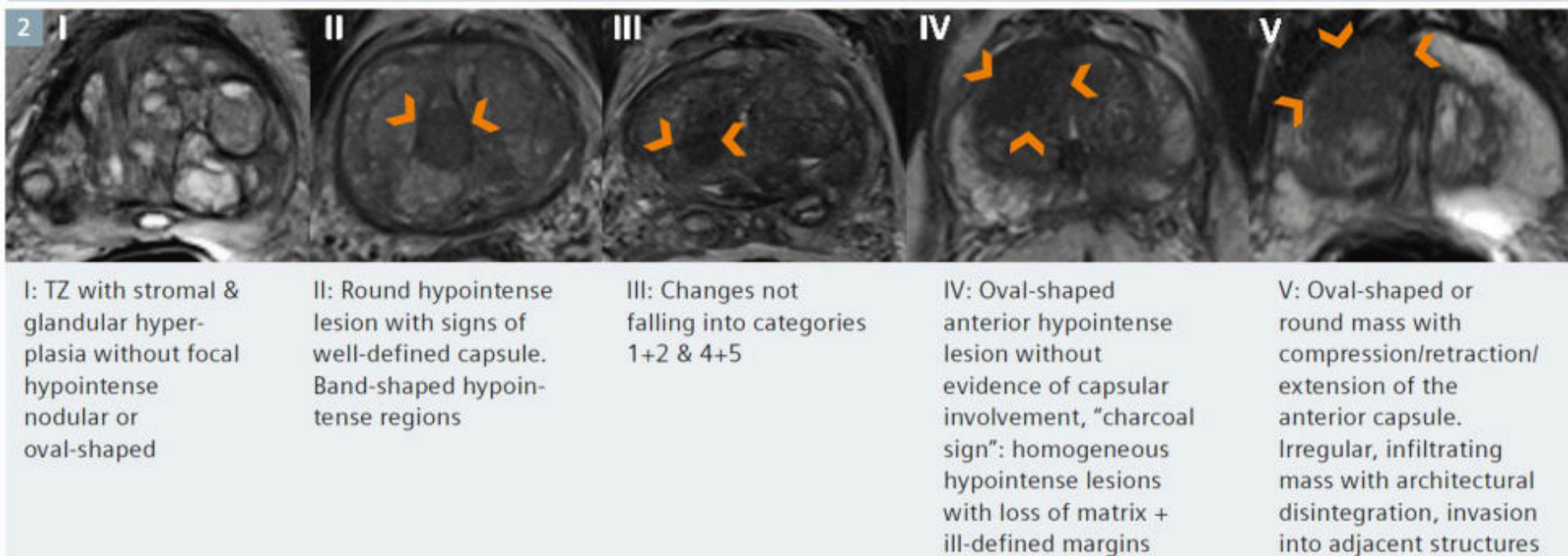
Overview of MRI

- * T2 Weighted Imaging¹
 - * Normal peripheral zone characterized by intermediate to high signal intensity
 - * T1 – highly accurate for differentiating post-biopsy hemorrhage from tumour
 - * Sensitivity of 48-88%, specificity 44-81% form prostate cancer compared to radical prostatectomy

1. Thompson, J., Lawrentschuk, N., Frydenberg, M., Thompson, L. & Stricker, P. (2013). The role of magnetic resonance imaging in the diagnosis and management of prostate cancer. *BJU Int*, 112, Supplement 2, p6-10



1 PI-RADS classification of T2w: peripheral glandular sections.



2 PI-RADS classification of T2w: central glandular sections.

Overview of MRI

- * Diffusion weighted imaging (DWI)¹
 - * Measures diffusion of water molecules – mapped as apparent diffusion coefficient (ADC) and b-values
 - * Reduced diffusion(decreased ADC, high b-values) with prostate ca
 - * Combined sensitivity and specificity with T2WI – 85-90% compared to radical prostatectomy

1. Thompson, J., Lawrentschuk, N., Frydenberg, M., Thompson, L. & Stricker, P. (2013). The role of magnetic resonance imaging in the diagnosis and management of prostate cancer. *BJU Int*, 112, Supplement 2, p6-10

3

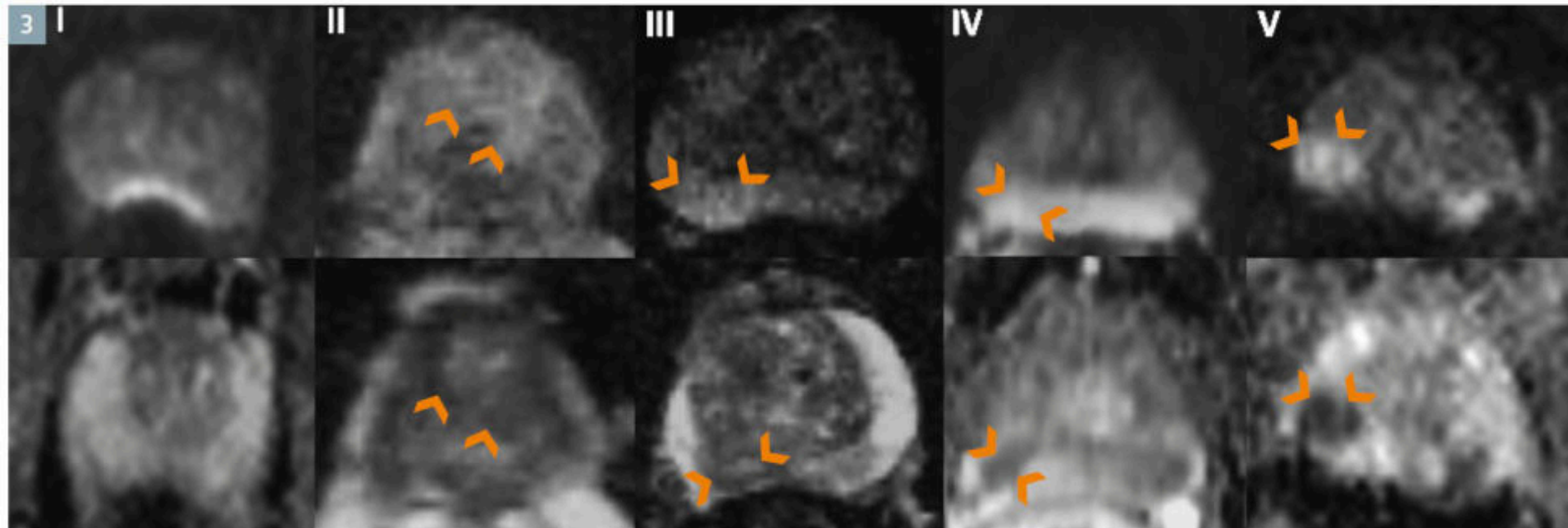
I

II

III

IV

V



I: No reduction in ADC compared with normal tissue / no increase in SI on $\geq$ b800 images

II: Diffuse hyperintensity on $\geq$ b800 image with low ADC, no focal lesions: linear, triangular or diffuse areas permitted

III: Unilateral hyperintensity on $\geq$ b800 image with diffuse reduced ADC (no focal lesions)

IV: Focal area with reduced ADC but isointense SI on $\geq$ b800 image

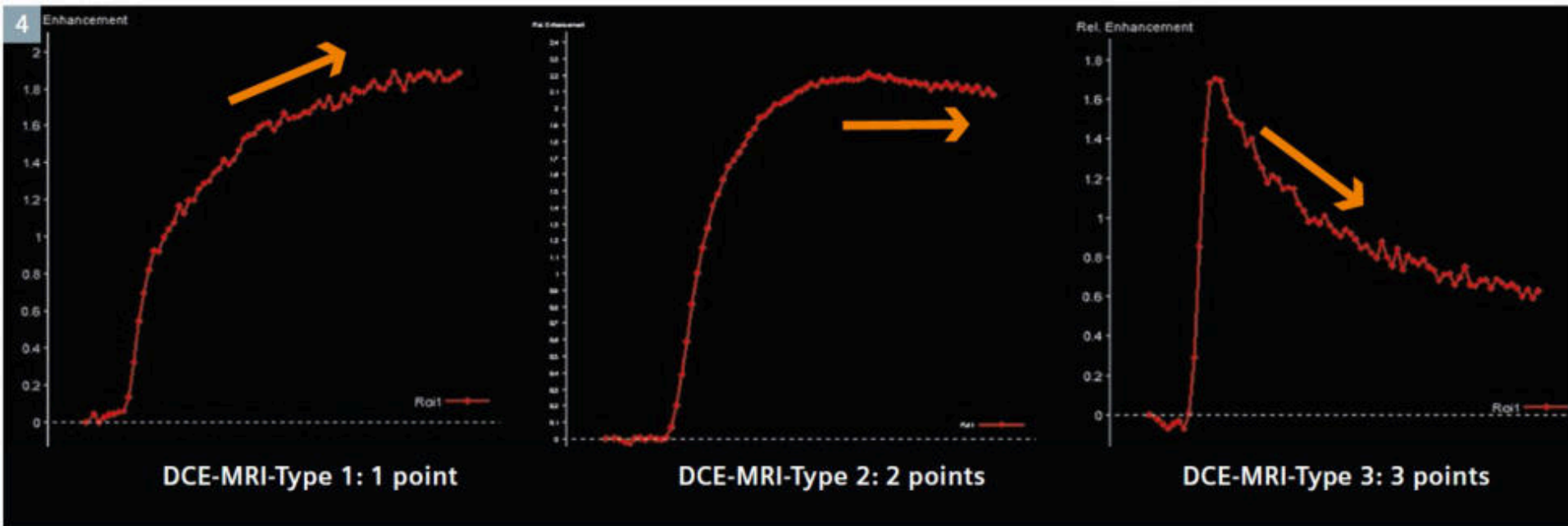
V: Focal hyperintense area/mass on $\geq$ b800 image with reduced ADC

3 PI-RADS classification of DWI (high b-values and ADC).

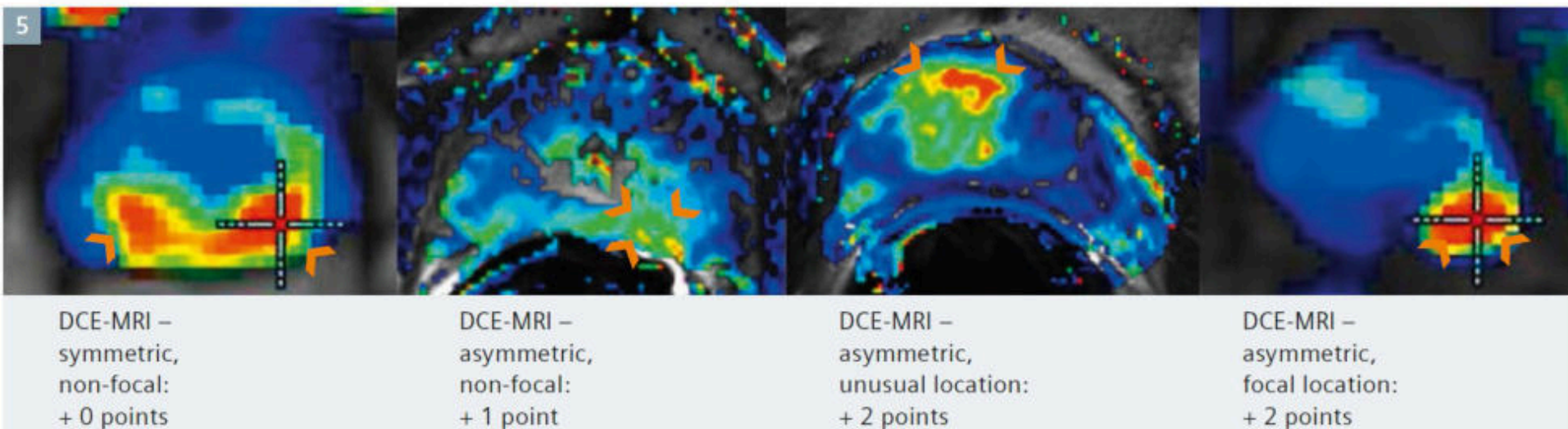
Overview of MRI

- * Dynamic Contrast Enhanced Imaging (DCEI)¹
 - * Maps perfusion in spatial regions using gadolinium contrast at a single point in time
 - * High grade tumour defined by a focal type 3 curve, which is characterised by early, intense contrast enhancement and rapid washout
 - * Combined sensitivity and specificity with T2WI – 90-95% compared to radical prostatectomy

1. Thompson, J., Lawrentschuk, N., Frydenberg, M., Thompson, L. & Stricker, P. (2013). The role of magnetic resonance imaging in the diagnosis and management of prostate cancer. *BJU Int*, 112, Supplement 2, p6-10



4 PI-RADS classification of DCE-MRI, part 1: Curve types.



5 PI-RADS classification of DCE-MRI, part 2: Additional points for distribution patterns with curve types II + III.

Overview of MRI

- * Magnetic Resonance Spectroscopy¹
 - * Functional technique measuring ratio of concentration of choline, creatinine and citrate
 - * High grade tumour – increased concentrations of choline and creatinine and decreased citrate
 - * Combined sensitivity with T2WI – 72-89% compared to radical prostatectomy
 - * Combined specificity with T2WI – 79-93% compared to radical prostatectomy
 - * High specificity in detecting tumours >3mm in peripheral zone – 98%, but poor sensitivity -53%

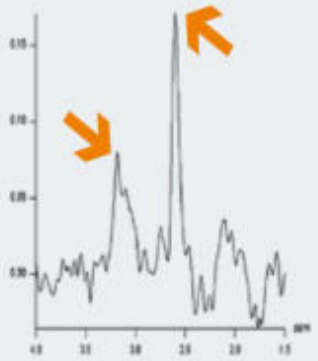
1. Thompson, J., Lawrentschuk, N., Frydenberg, M., Thompson, L. & Stricker, P. (2013). The role of magnetic resonance imaging in the diagnosis and management of prostate cancer. *BJU Int*, 112, Supplement 2, p6-10

I Choline Citrate



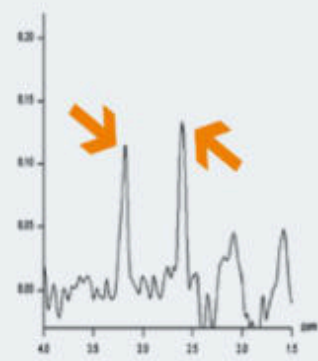
I: Cho << Citrate

II Choline Citrate



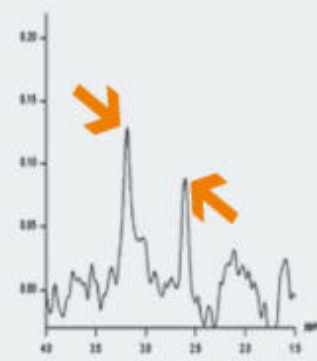
II: Cho << Citrate

III Choline Citrate



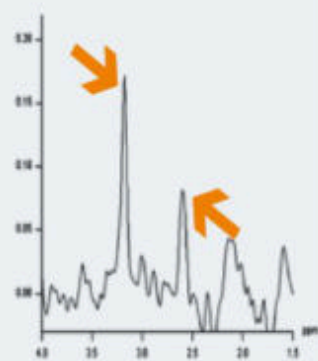
III: Cho = Citrate

IV Choline Citrate



IV: Cho > Citrate

V Choline Citrate



V: Cho >> Citrate

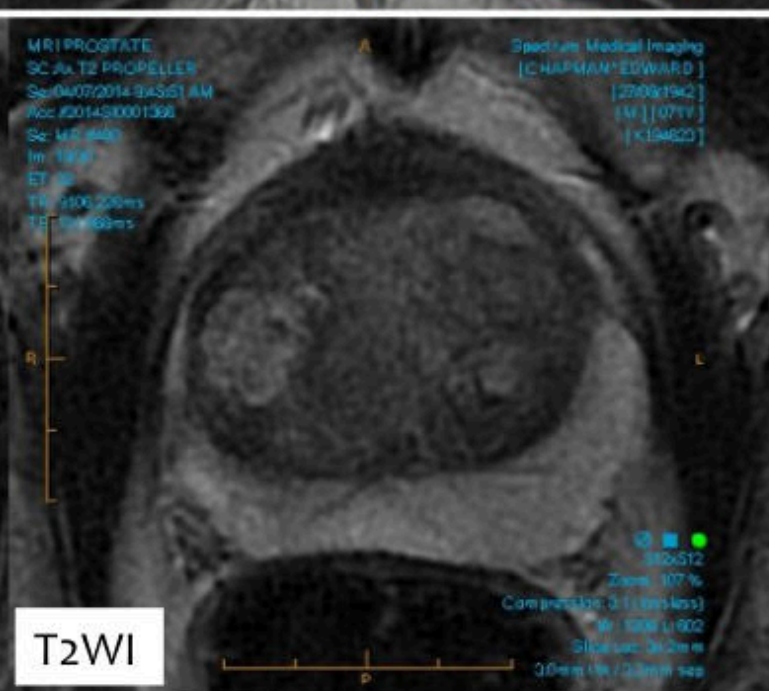
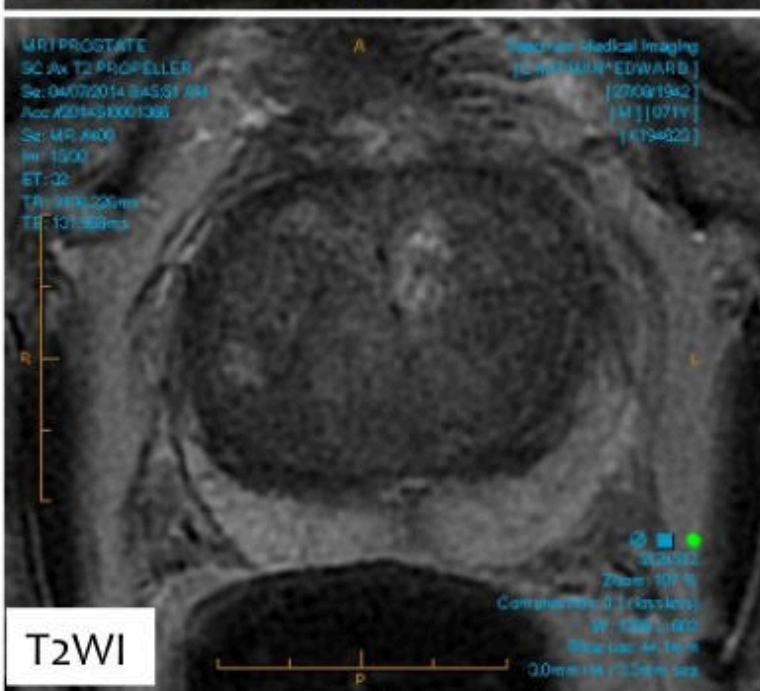
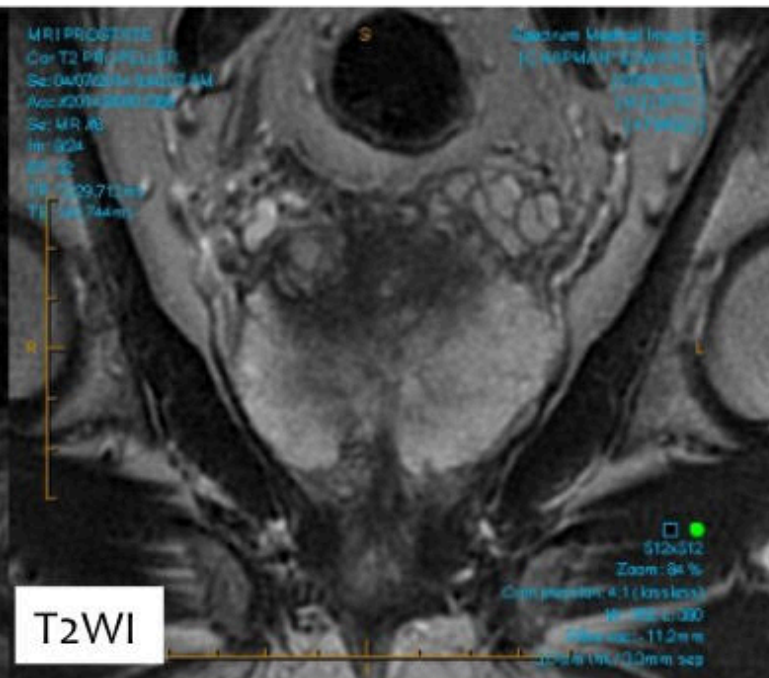
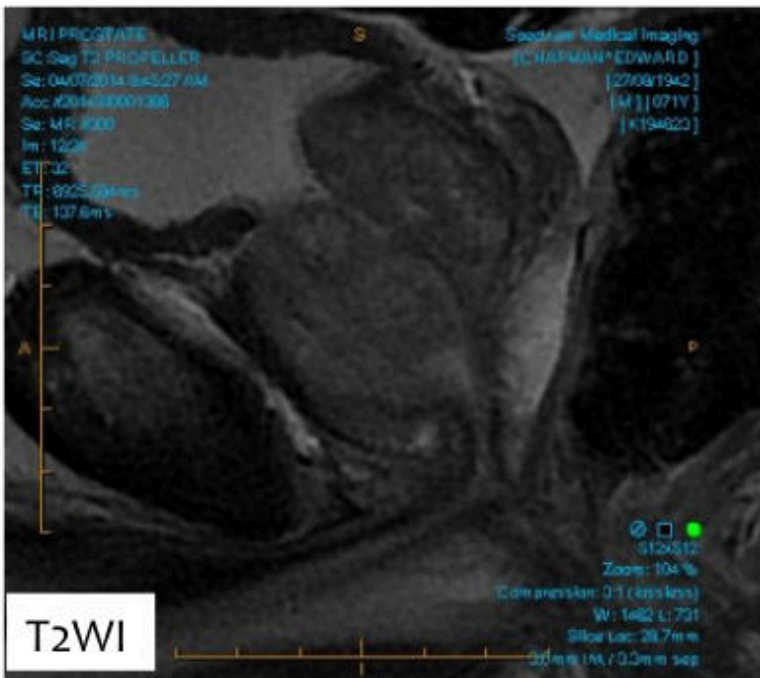
Role of MRI in screening

- * mpMRI has a specificity of 90-95% for prostate cancer¹
- * Potential for use as “second-line screening” tool
- * No published studies

1. Thompson, J., Lawrentschuk, N., Frydenberg, M., Thompson, L. & Stricker, P. (2013). The role of magnetic resonance imaging in the diagnosis and management of prostate cancer. *BJU Int*, 112, Supplement 2, p6-10

Case Study 1

- * Mr E.C is a 70 y.o male
- * HPI: PSA 5.1 (R-20%)
- * TRUB on 2002, 09/09, 10/10 and 08/11 all negative
 - * Path: multifocal prostatic intraepithelial neoplasia
- * PSA 6.2 (R 16%)
- * Patient anxious
- * MRI
 - * 109 cc prostate. Moderate benign prostatic hyperplasia (PRIADS 2)
- * For observation and nil further biopsy

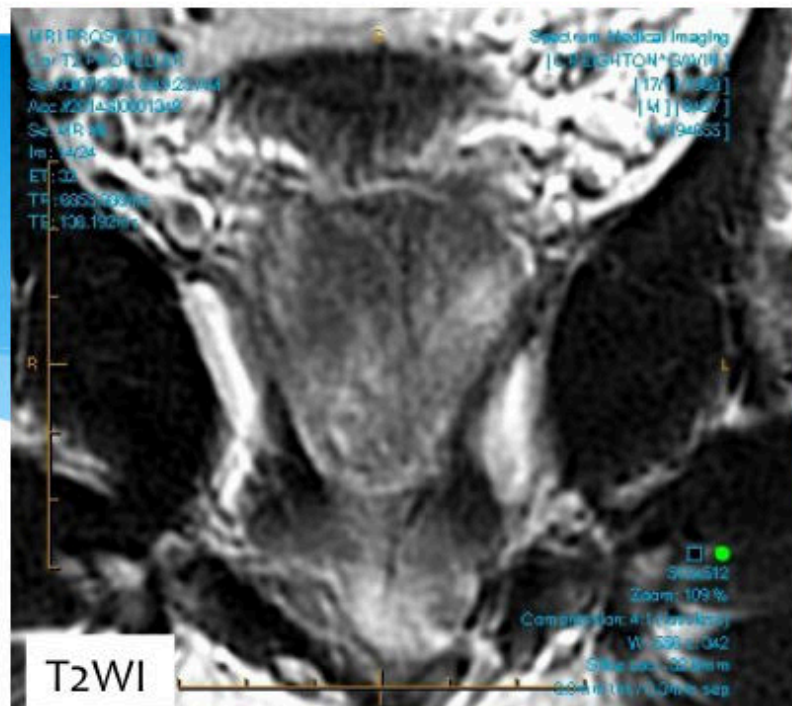
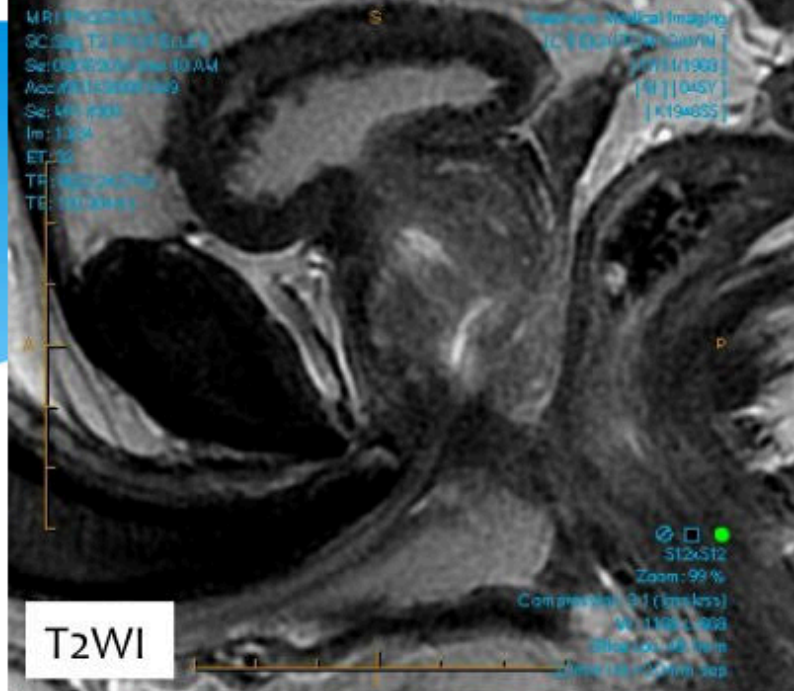


Role of MRI in Biopsy

1. MRI informed, free hand/cognitive TRUS guided biopsy
2. MRI-TRUS fusion biopsy
3. In gantry(real time) MRI guided biopsy

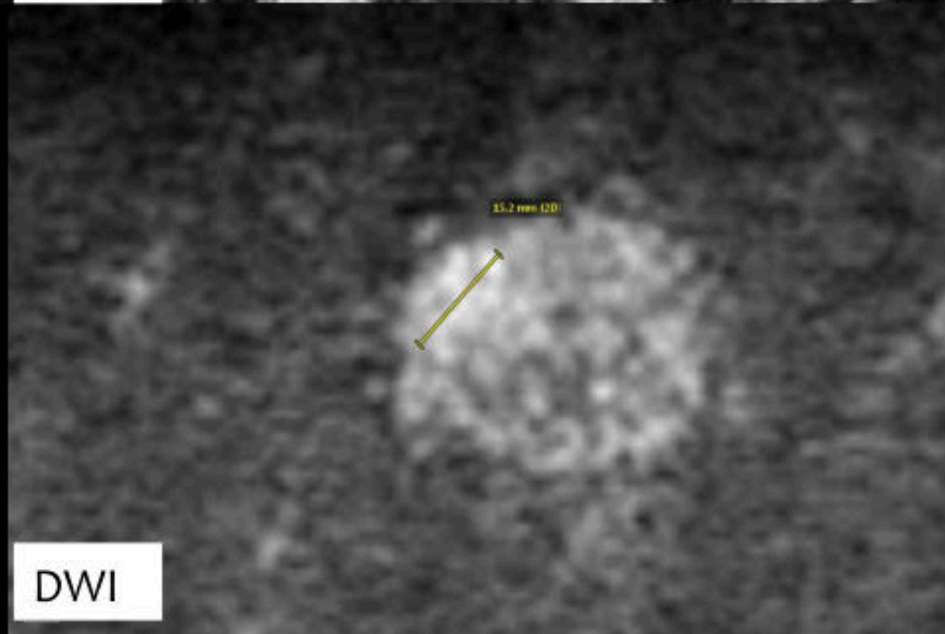
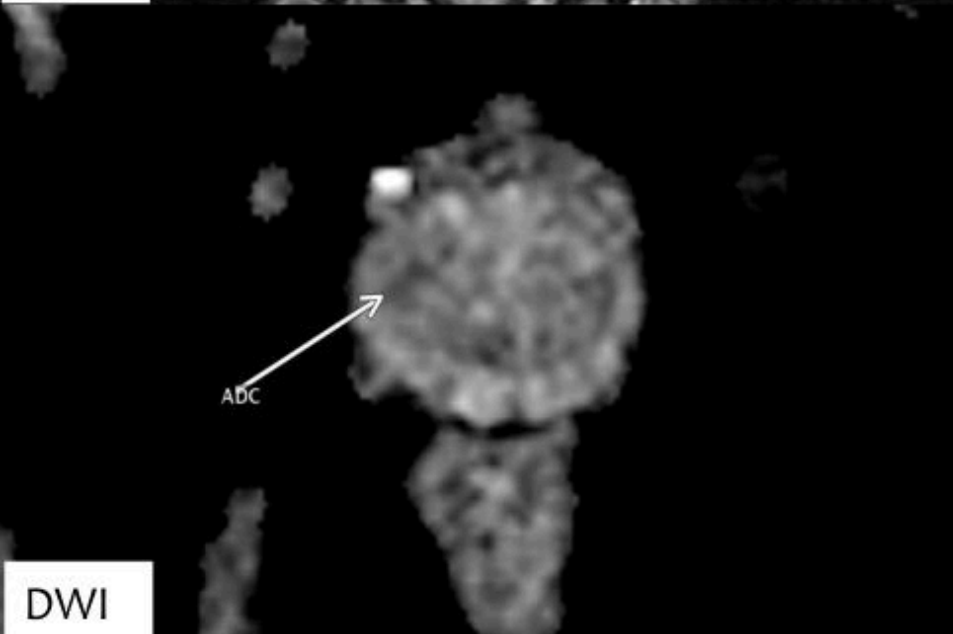
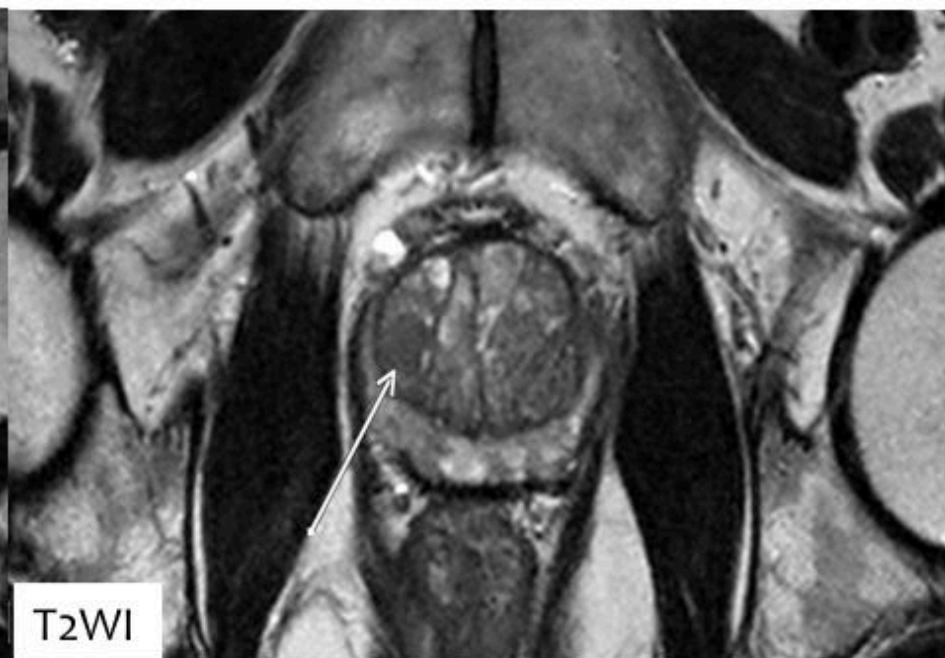
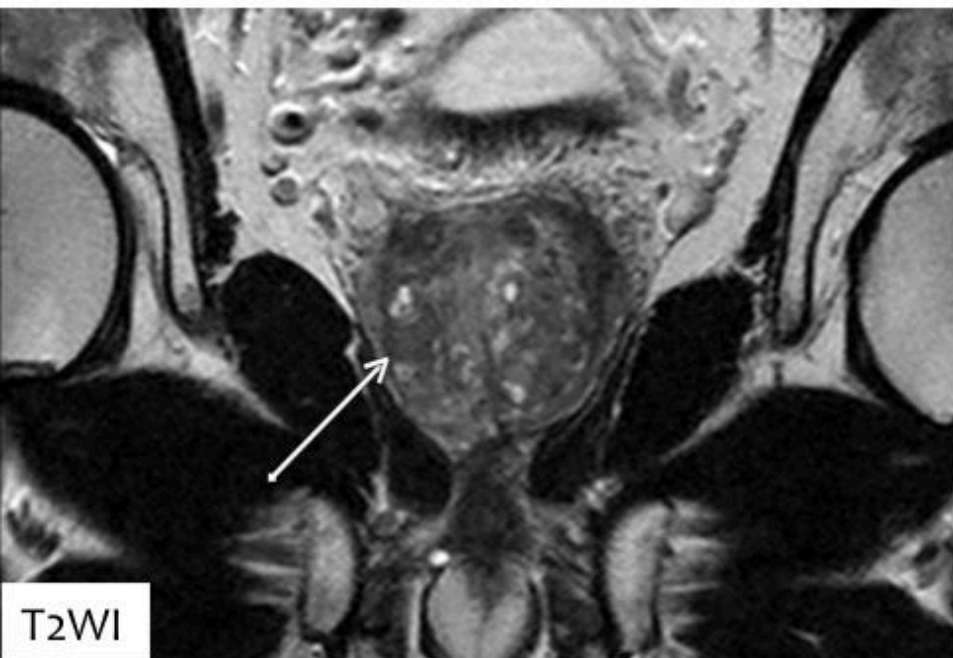
Case Study 2

- * Mr G.C is a 45 y.o man
- * HPI: PSA 2.3(R 10%) in Oct 2013 increased to 2.6(R11%) in June 2014
- * MRI
 - * Widespread inflammation. Nil focal lesions (PIRADS 2)
- * Transrectal prostate biopsy
 - * Multifocal glandular atrophy and inflammation
- * Learning Point - ? Could have omitted biopsy



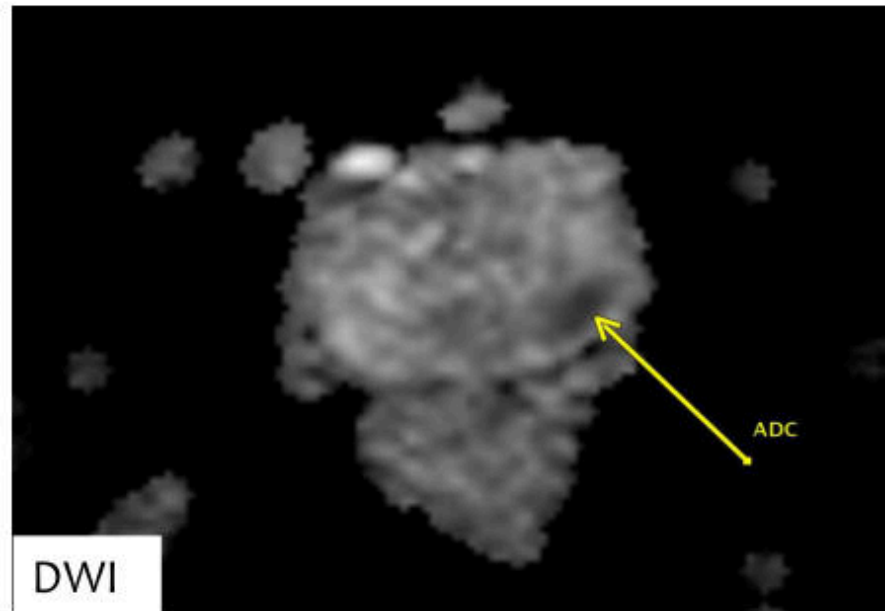
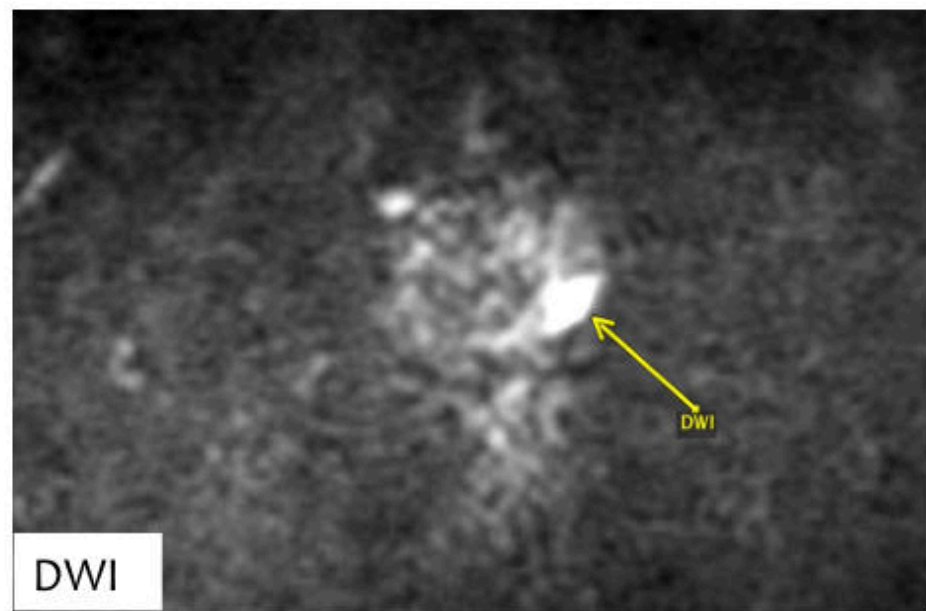
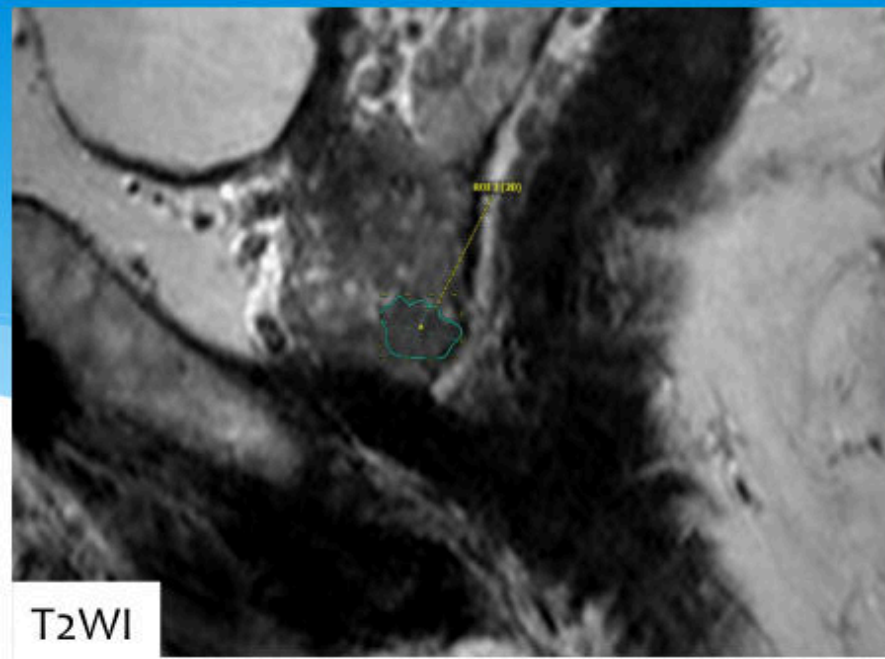
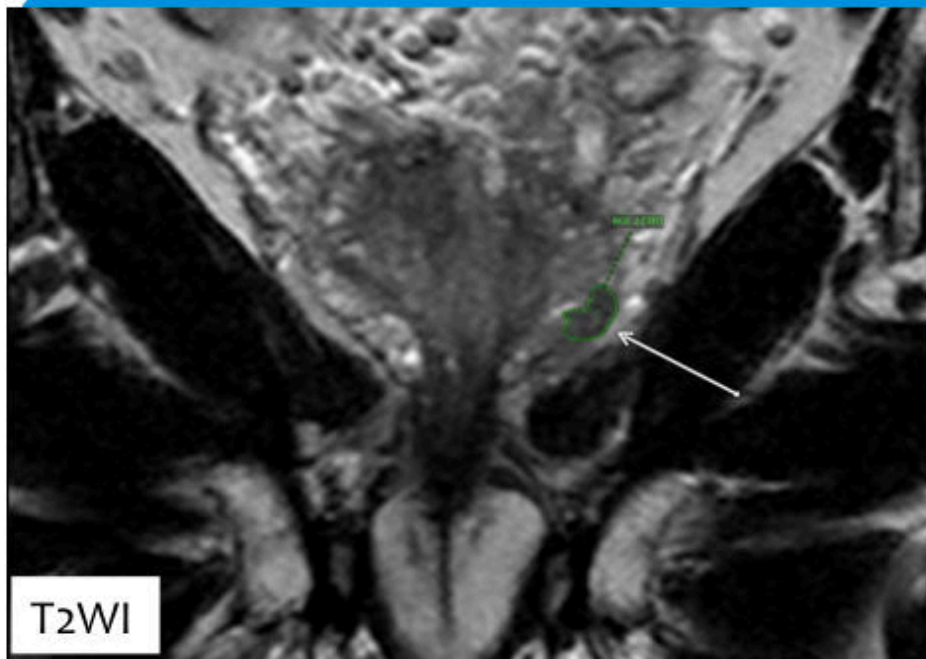
Case Study 3

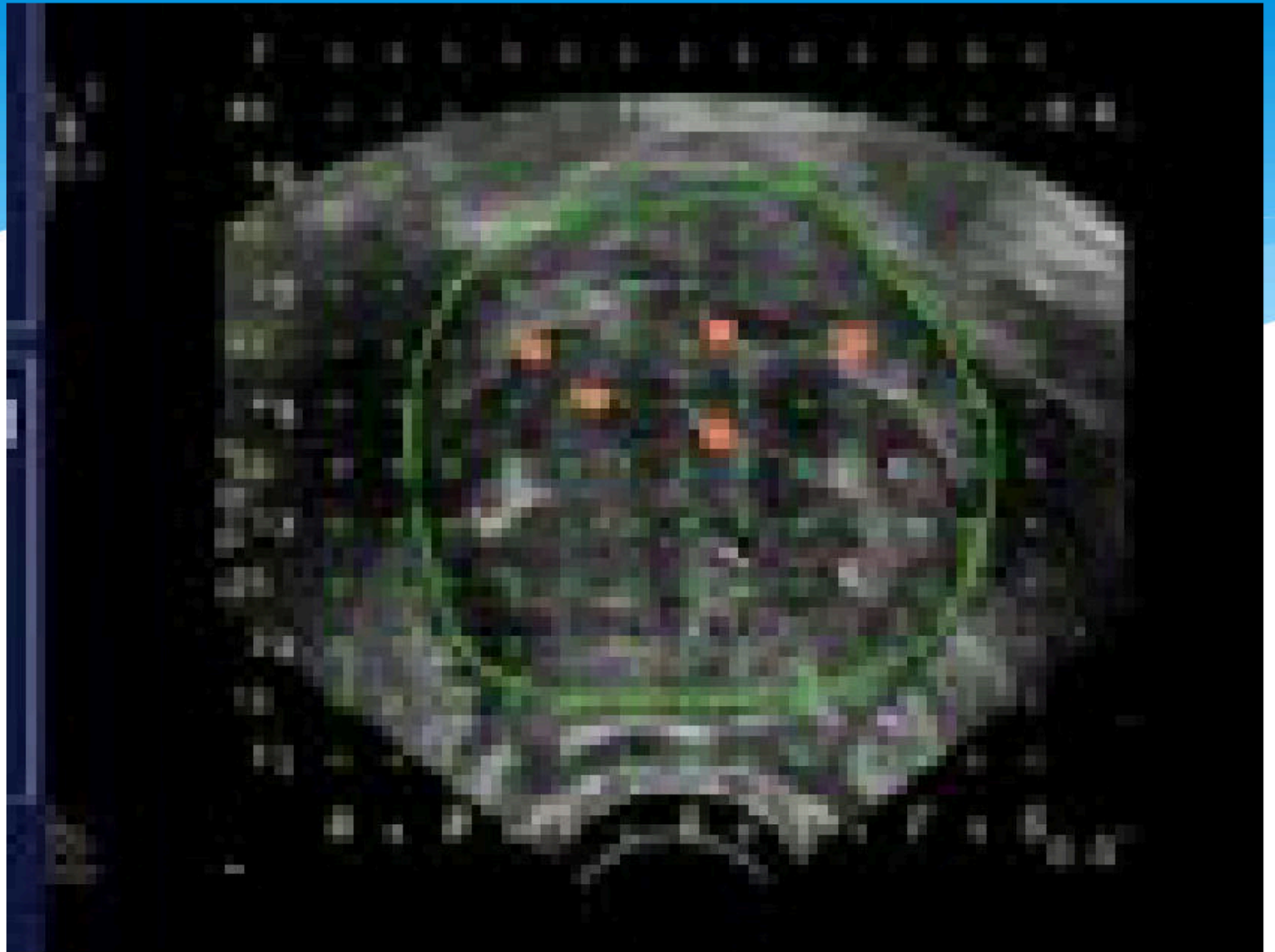
- * Mr W.S is a 58 y.o male
- * HPI: PSA 4.2 and patient anxious
 - * Previous biopsy (08/13) negative and complicated by post op infection
- * MRI – lesion at mid T2 (PIRADS 3)
- * Transperineal biospy
 - * Negative
- * Learning point –Follow up with MRI



Case Study 4

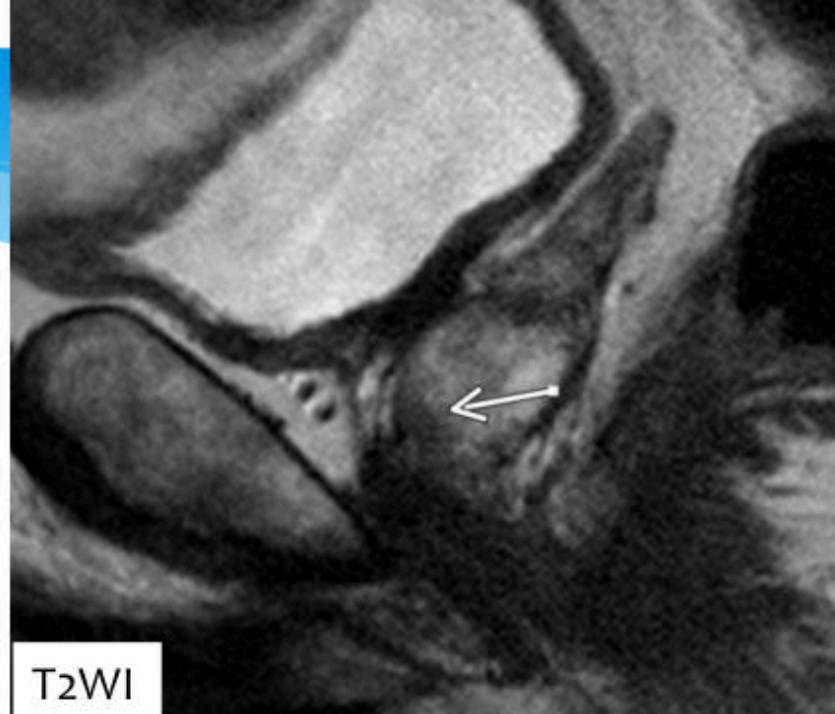
- * Mr G.F 75 y.o male, previously well
- * HPI: erectile dysfunction
- * PSA rise from 2.5 (02/02/11) to 4.6 (02/06/14)
- * Options included
 - * Observation
 - * Biopsy
 - * MRI
- * MRI- highly suspicious lesion left mid apex P2 (PIRADS 5)
- * Underwent MRI fusion biopsy
 - * Abnormal area $4 + 3 = 7$ (60% of cores involved)
 - * Transperineal biopsy $3 + 4 = 7$ (low % of core involvement)
- * Learning Point: MRI guided biopsy more sensitive





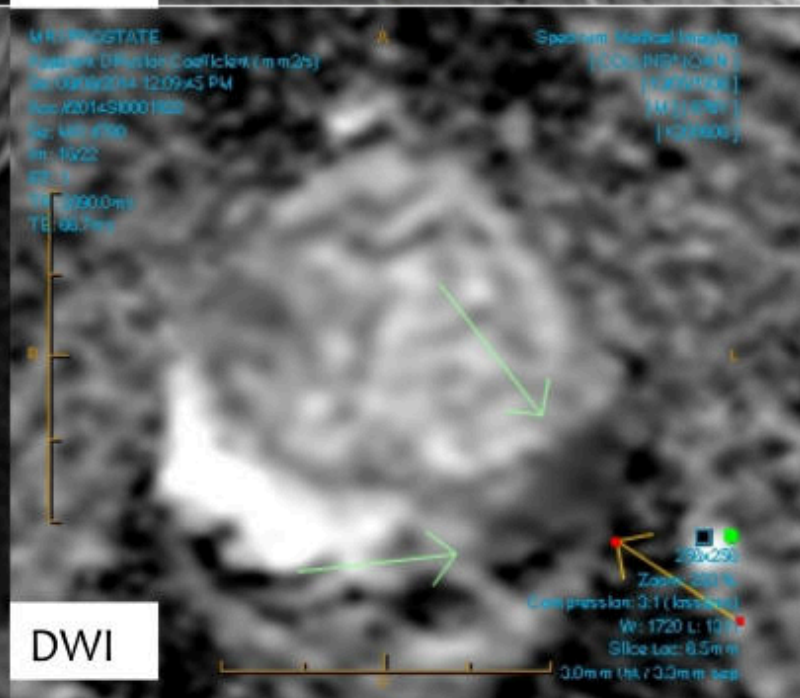
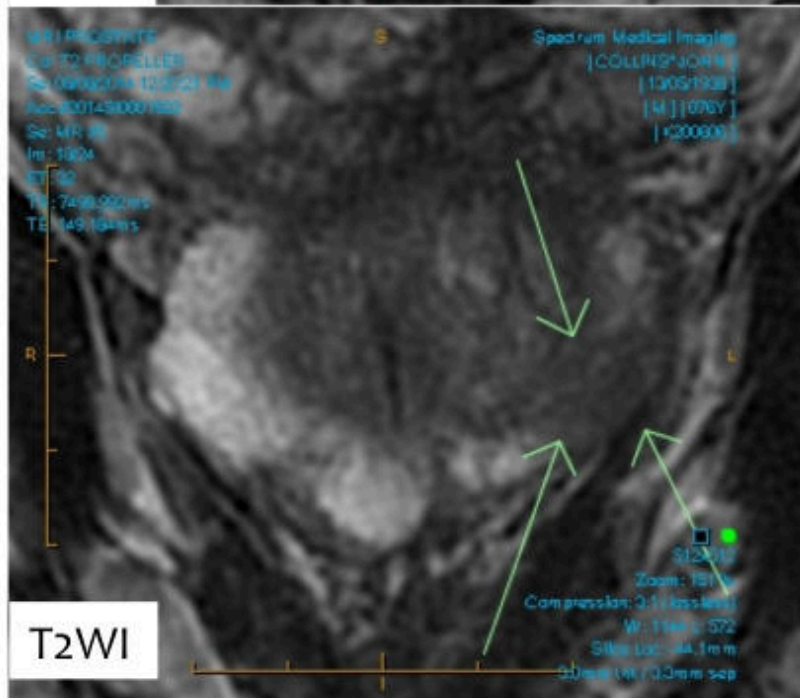
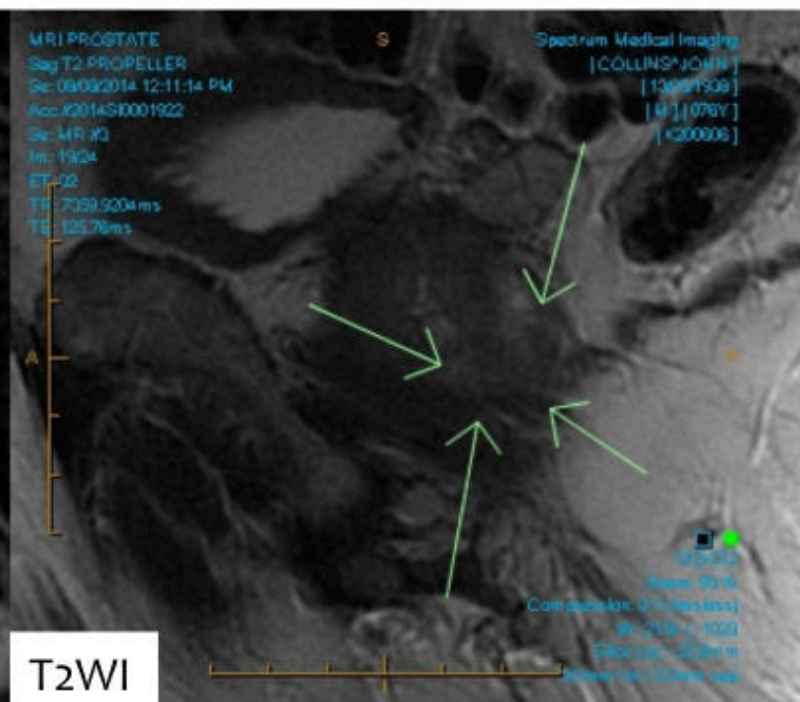
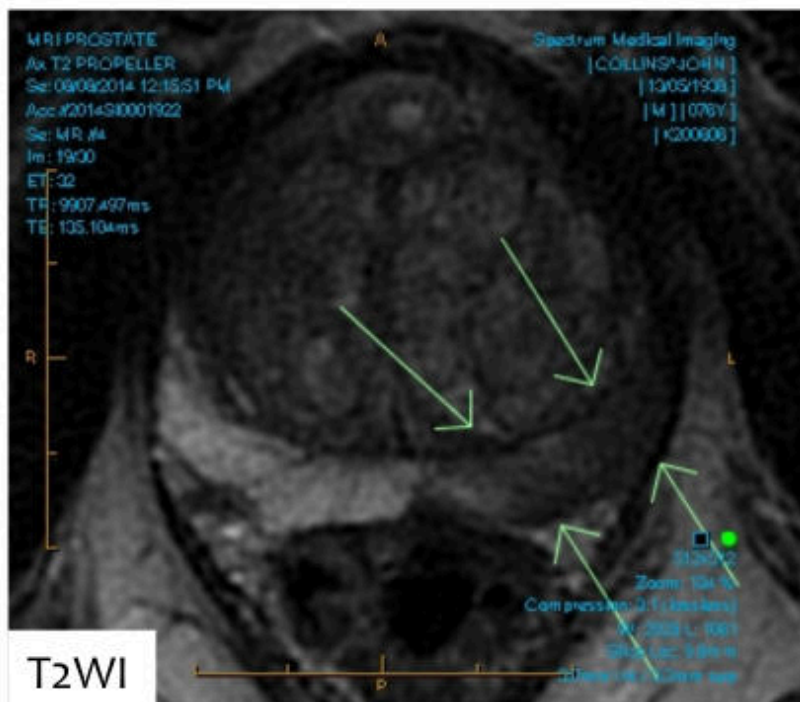
Case Study 5

- * Mr J.W is a 70 y.o male
- * HPI: Holmium Laser Enucleation resection in 02/12
 - * Pathology: 3 + 3=6
- * Transperineal biopsy (04/12)
 - * 1/14 cores (right anterior medial) positive 5%
- * For active surveillance
- * PSA 2.08 (02/05/14)
- * MRI – lesion apex left anterior aspect (PI-RADS 4)
- * Tranperineal biopsy
 - * 4 +5 =9 (95% of cores involved)
- * Learning Point – MRI detected high grade anterior cancer



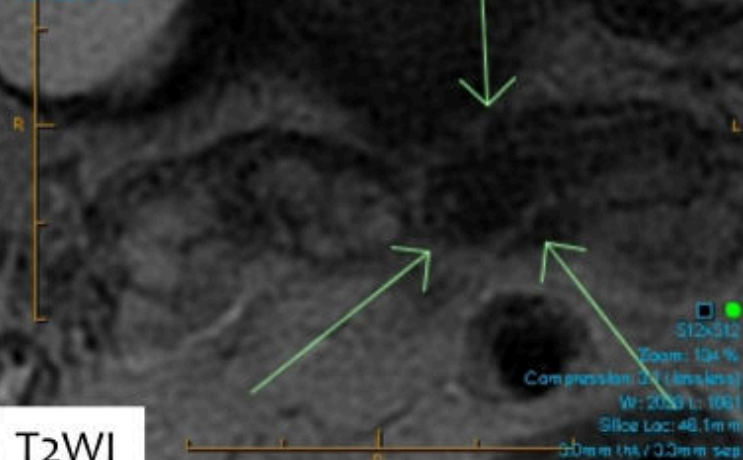
Case Study 6

- * Mr J. C is a 76 y.o man
- * HPI: PSA (10/07/2014) 12 (R 27%) and firm prostatic nodule on DRE
- * MRI:
 - * High grade prostate carcinoma in left posterior-posterolateral zone at mid level with mild extracapsular extension and neurovascular bundle involvement and invasion of left seminal vesicles inferiorly (PIRADS 5).
 - * Second high grade lesion – left posterior-posteromedial peripheral zone at mid-basal level, effaces left prostatovesical angle and invades seminal vesicle inferiorly
 - * Third high grade lesion – right posterior peripheral zone at basal gland level.
- * Transrectal U/S guided biopsy
 - * Adenocarcinoma (Gleason 5 + 4=9)
- * Learning point – Significant lesion in midline (unusual position) may have been missed without MRI



MRI PROSTATE
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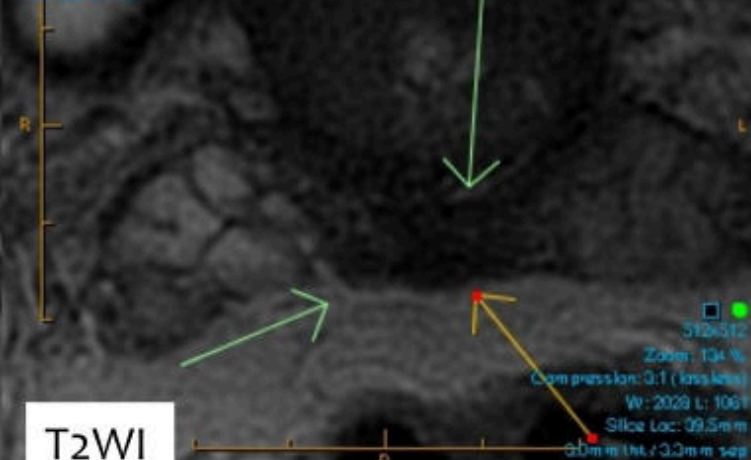
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T2WI

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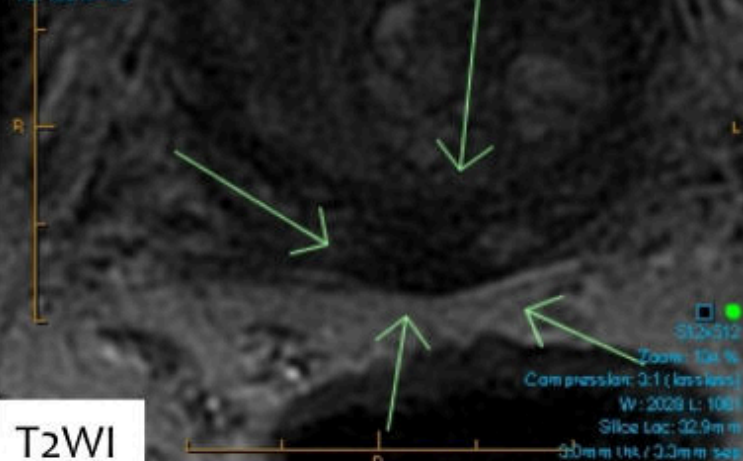
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T2WI

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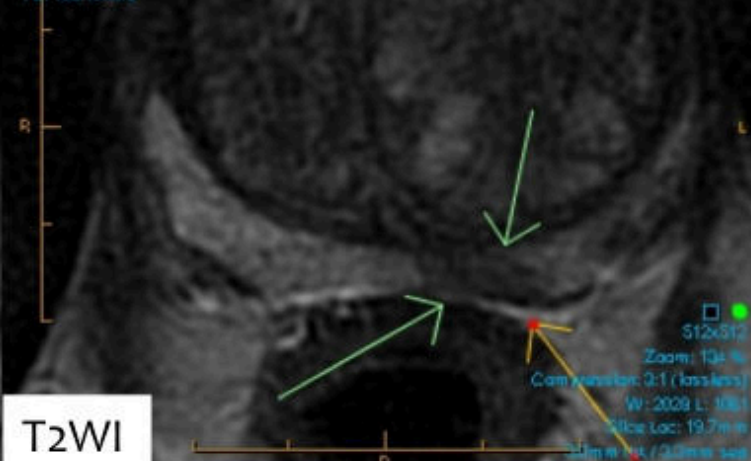
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T2WI

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TR: 9907.497ms
TE: 135.104ms

Spectrum Medical Imaging
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T2WI

Case Study 7

- * Mr J.L is a 76 y.o man
- * HPI – moderately increasing PSA-6.5 (R 18%), prostate volume 90 cc, previous biopsy in 1984 -negative
- * MRI
 - * Suspicious focus in left anterior mid apex TZ (PI-RADS 4) and an equivocal focus in right mid PZ/TZ (PI-RADS 3).
- * MRI-guided biopsy
 - * Lesion 1 – infiltrating acinar adenocarcinoma
 - * Lesion 2 – Benign prostate parenchyma.



MRI in Biopsy-freehand/cognitive

- * MRI informed, free hand/cognitive TRUS guided biopsy
 - * Simple and cost effective however large margin of error
 - * Sensitivity, specificity and accuracy of MRI for significant cancer was 95%, 100% and 98% respectively using combined biopsy as the reference⁶
 - * 37% of biopsies could have been avoided, 5% of significant cancers would have been missed, 13% of insignificant cancers would not have been over-detected
 - * In a RCT MRI group had a OR of 3.9 (95% CI-1.1-13.1) times higher detection rate vs standard TRUS biopsy only (p=0.03)⁷
 - * Most recent prospective study comparing MRI biopsy to transperineal mapping showed significantly⁸:
 - * higher proportion of positive cores (38% vs 14%)
 - * lower rate of over diagnosis of clinically insignificant cancer (9% vs 17%)
 - * Avoidance of high complication rate with MRI biopsy

6. Haffner J, Lemaitre L, Puech P et al. Role of magnetic resonance imaging before initial biopsy: comparison of magnetic resonance imaging-targeted and systematic biopsy for significant prostate cancer detection. *BJU Int* 2011; 108 (8 Pt 2): E171–8

7. Park BK, Park JW, Park SY et al. Prospective evaluation of 3-T MRI performed before initial transrectal ultrasound-guided prostate biopsy in patients with high prostate-specific antigen and no previous biopsy. *AJR Am J Roentgenol* 2011; 197: W876–81

8. Kasivisvanathan V, Dufour R, Moore CM et al. Transperineal Magnetic Resonance Image Targeted Prostate Biopsy Versus Transperineal Template Prostate Biopsy in the detection of Clinically Significant Prostate Cancer. *J Urol* 2013; 189: 860–6

Role of MRI in Biopsy-fusion

- * MRI fusion biopsy
 - * Detects prostate cancer at the same sensitivity but requires half the number of cores⁴
 - * Overall MRI to Biopsy correlation of 69%⁵
 - * 96% of highly suspicious MRI areas were positive
 - * 71% of moderately to high suspicious MRI areas were positive
 - * However, 35% of non suspicious MRI were also positive
- * No data on pathological characteristics or risk classification
 - * Unable to assess whether fusion biopsy detected more clinically significant cancers

4. Pinto PA, Chung PH, Rastinehad AR et al. (2011) Magnetic resonance imaging/ultrasound fusion guided biopsy improves cancer detection following transrectal biopsy and correlates with multiparametric magnetic resonance imaging. *J Urol*. 186, p1281-1285

5. Hadaschik BA, Kuru TH, Tulea C et al. (2011) A novel stereotactic prostate biopsy system integrating pre-interventional magnetic resonance imaging and live ultrasound fusion. *J Urol*, 186, p 2214-2220.

MRI in Biopsy-in gantry

- * In gantry (real time) biopsy
 - * In men with previous negative biopsies MRI-guided biopsy detected significantly more tumours than standard repeat biopsies⁹
 - * MRI –guided biopsy more accurately predicts Gleason grade at radical prostatectomy (88%) compared with standard 10-core TRUS biopsy (55%)¹⁰

9.Hambrock T, Somford DM, Hoeks C et al. Magnetic resonance imaging guided prostate biopsy in men with repeat negative biopsies and increased prostate specific antigen. J Urol 2010; 183: 520–7

10.Hambrock T, Hoeks C, Hulsbergen-Van De Kaa C et al. Prospective assessment of prostate cancer aggressiveness using 3-T diffusion-weighted magnetic resonance imaging-guided biopsies versus a systematic 10-core transrectal ultrasound prostate biopsy cohort. Eur Urol 2012; 61: 177–84

Role of MRI in Selection for Repeat Biopsy /Active Surveillance

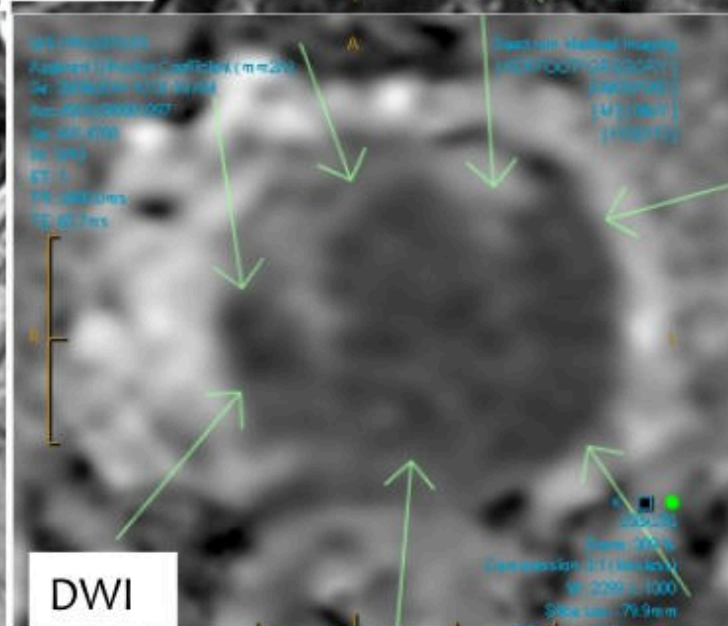
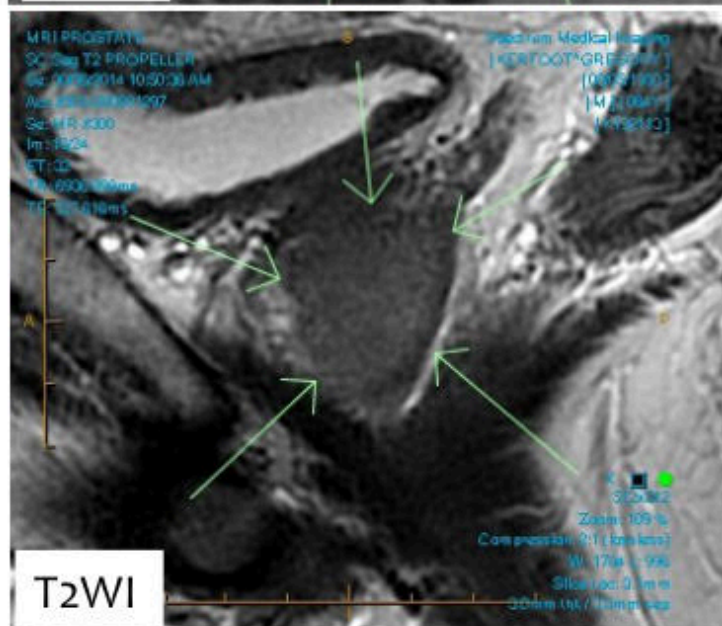
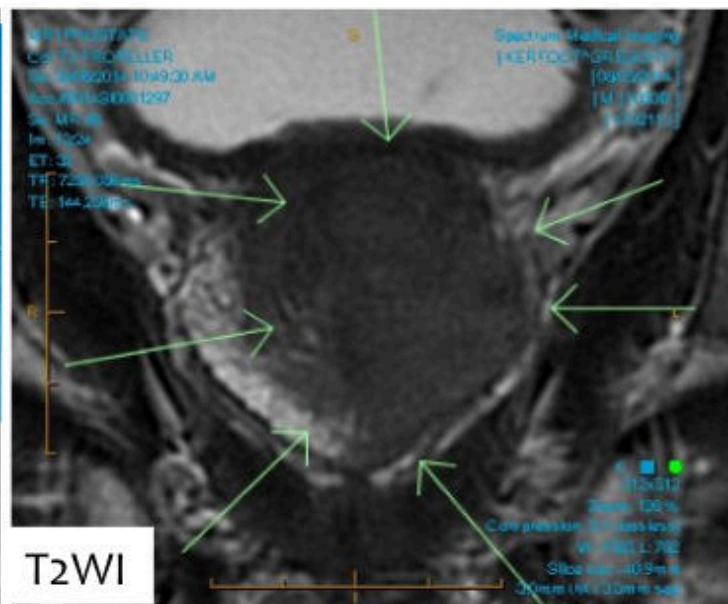
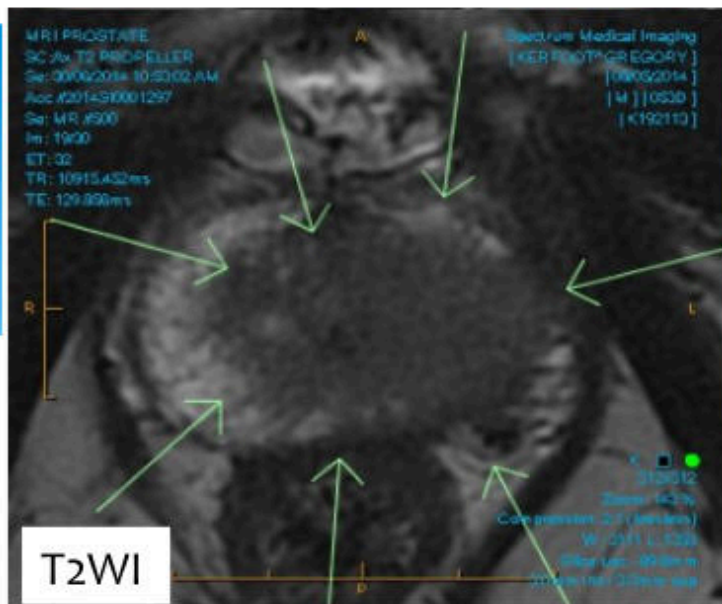
- * Avoids biopsies in low risk men with a normal MRI
- * In a study reporting on men with a previous negative biopsy or on active surveillance MRI had a positive predictive value of 87% with 44% of cancers being Gleason ≥ 7 ¹¹
- * In another study looking at repeat biopsy for rising PSA 54% of cancers were purely detected by MRI-directed and would otherwise have been missed by standard cores¹²
- * Balance of evidence suggests benefit of mpMRI in active surveillance¹
 - * Greatest benefit if used at diagnosis to guide eligibility and then at 1, 4 and 8 years which may aid early detection of significant disease.

11. Lawrentschuk N, Haider MA, Daljeet N et al. 'Prostatic evasive anterior tumours': the role of magnetic resonance imaging. BJU Int 2010; 105: 1231–6

12. Lawrentschuk N, Fleshner N. The role of magnetic resonance imaging in targeting prostate cancer in patients with previous negative biopsies and elevated prostate-specific antigen levels. BJU Int 2009; 103: 730–3

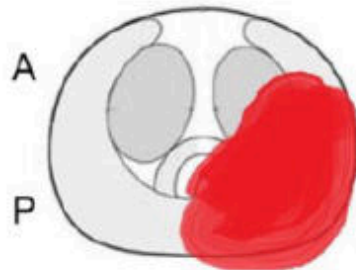
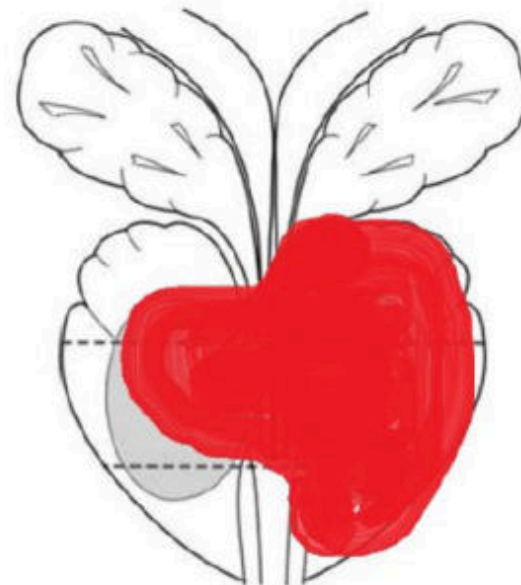
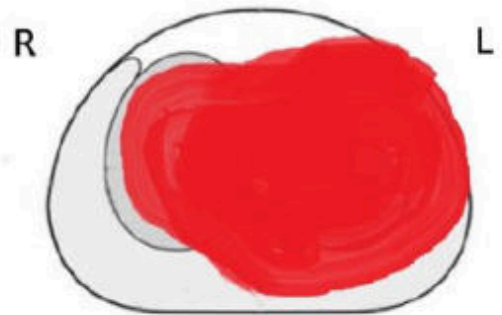
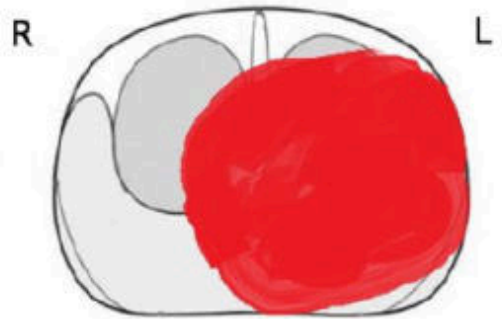
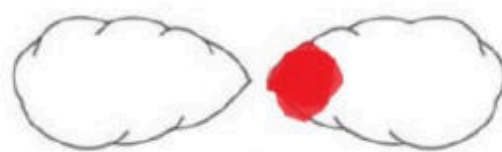
Case Study 8

- * Mr G.K is a 64 y.o man
- * HPI: PSA 2.5 in 05/11 increased to 7.2 in 12/13, PR normal
- * TRUS (17/02/14)
 - * 4 +3 =7 (90% of cores involved)
- * MRI (30/06/14)
 - * High grade prostatic carcinoma involving central and left peripheral zone, moderate extracapsular extension and left neurovascular involvement, inferior vesical involvement, nil pelvic lymphadenopathy (PIRADS 5)
- * Robot assisted radical prostatectomy (03/07/14)
 - * Path: Gleason 4 + 3 =7, extraprostatic extension on left side
 - * Negative margins, pT3b, pNO, pMx
- * Learning Point – Wide resection based on MRI with normal PR



Abnormal regions:

Location	Size	Anatomical	Diffusion	Perfusion	ECE	PI-RADS
Most of TZ and left PZ	4.2 cm	A1-5, A2-5	B5	C4	Yes, mild periprostatic and NVI, and mild left SVI	5





Robot Assisted Radical Prostatectomy

Dr. Raji Kooner

Consultant (Urology), St. Vincent's Hospital, Sydney

www.roboticprostatesurgery.com.au

ST VINCENT'S PROSTATE & KIDNEY CENTRE

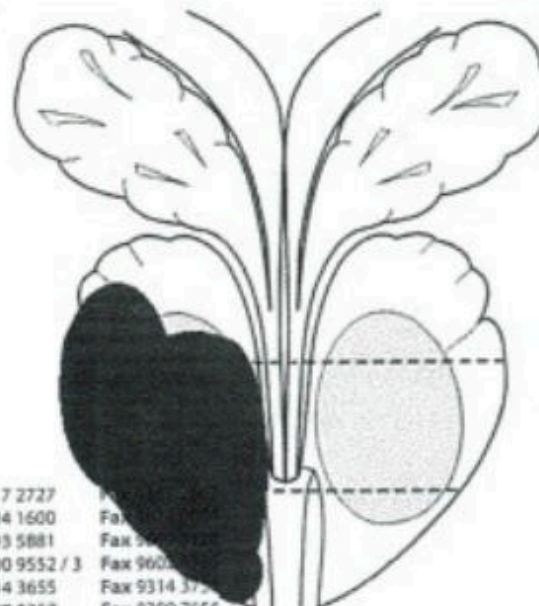
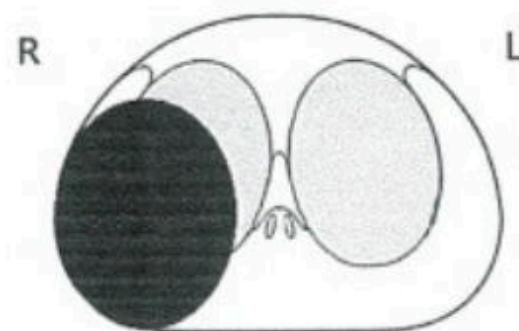
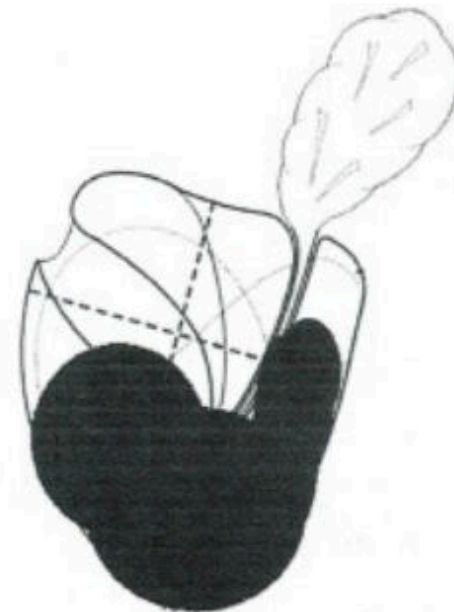
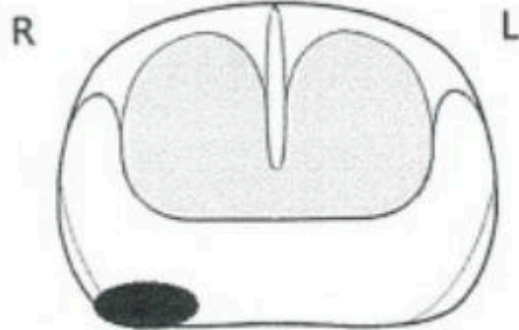
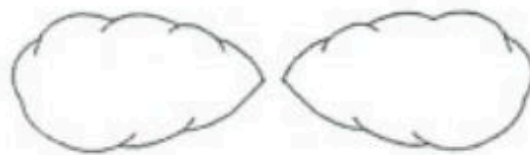


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Case Study 9

- * Mr P.M is a 58 y.o man
- * HPI: PSA 9.7(R 7%), PR showed firmness right lateral lobe
- * TRUB (10/14) – gleason 9
- * MRI (pre biopsy)
 - * Large circumscribed, irregular capsule in right lateral peripheral zone. Nil obvious extension into soft tissue or neurovascular bundles
- * Robot assisted radical prostatectomy (14/08/14)
 - * Extensive T3 Disease
- * Learning Point: Resectable disease with abnormal PR



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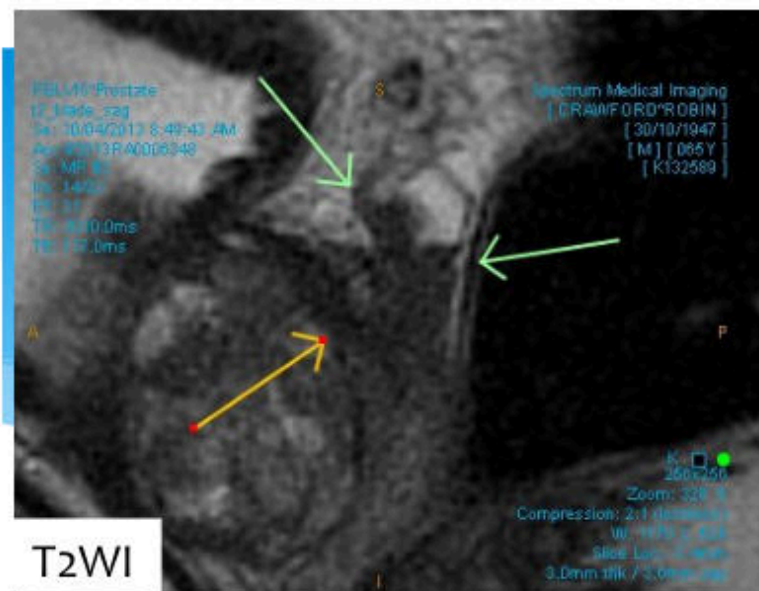
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Case Study 10

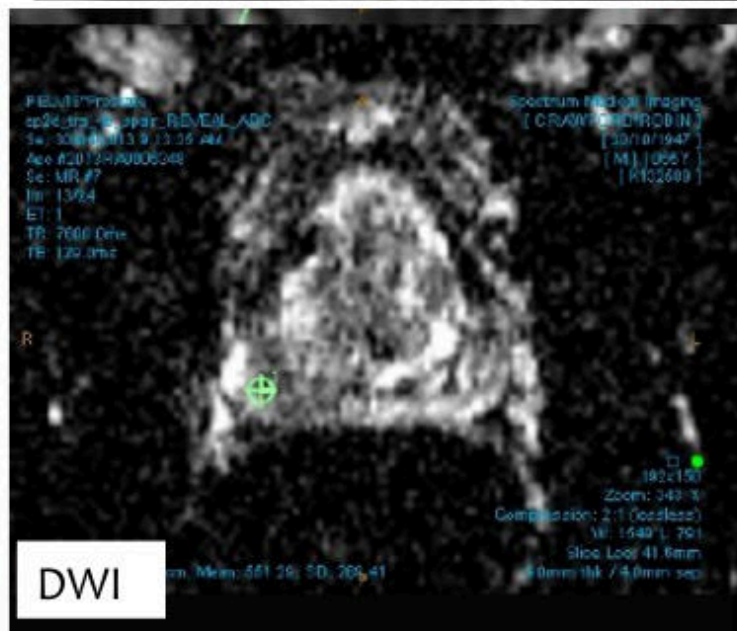
- * Mr R.C is a 65 y. o man
- * HPI: PSA of 11, PR – firm on right side
- * MRI
 - * High grade prostatic carcinoma within right posterolateral peripheral zone at base and involving base of right seminal vesical and irregular interface with prostatic capsule (PIRADS 5), 13mm internal iliac node
- * Choline PET positive for nodal involvement
- * Underwent radical prostatectomy and node dissection
- * Learning point – detection of N1 disease



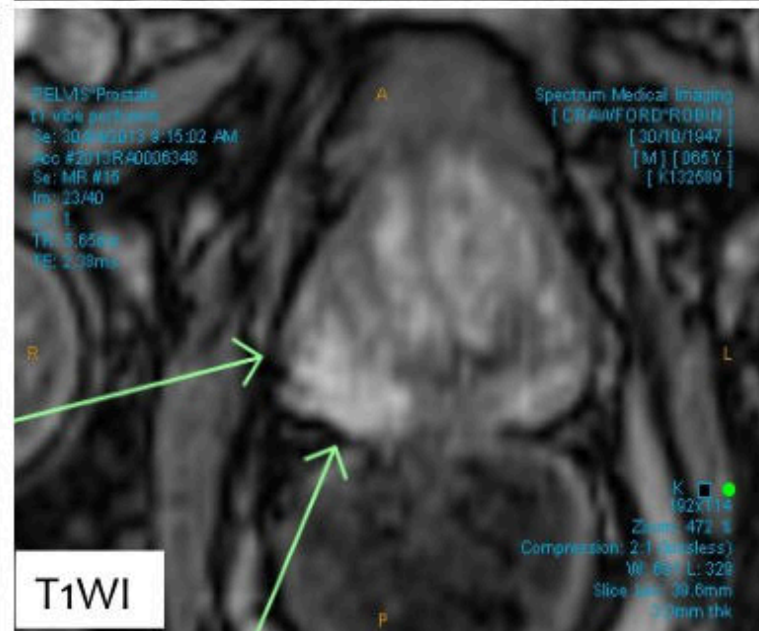
T2WI



T2WI



DWI

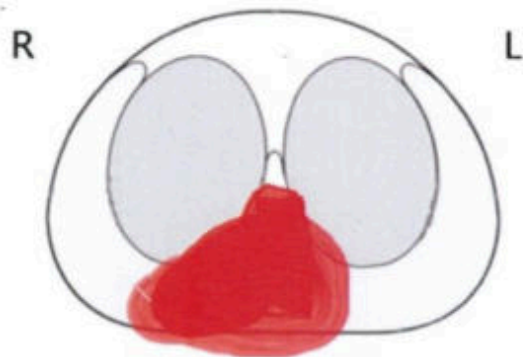
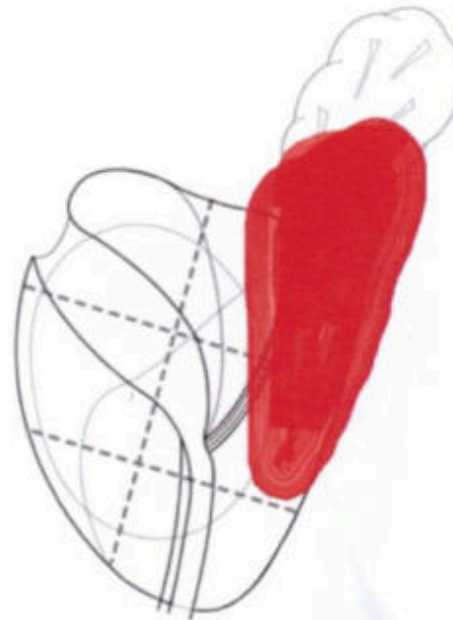
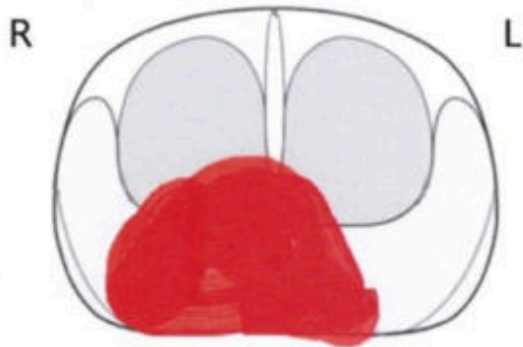


T1WI

Location	Size	Anatomical	Diffusion	Perfusion	ECE/SVI	PI-RADS
R PL PZ base	22 mm	A1-5	B5	C4	R SVI. Possible slight ECE	5

Case Study 11

- * Mr G. D is a 66 y.o man
- * HPI – PSA-40, DRE firm prostate
- * MRI
 - * Large region of high grade prostate cancer within right posterolateral to left posterior peripheral zone at mid and basal gland level. Evidence of extracapsular extension and neurovascular bundle involvement, bilateral seminal vesicle invasion (PIRADS 5)
- * TRUS biopsy
 - * High grade cancer
- * Learning point – High risk of positive margin with resection



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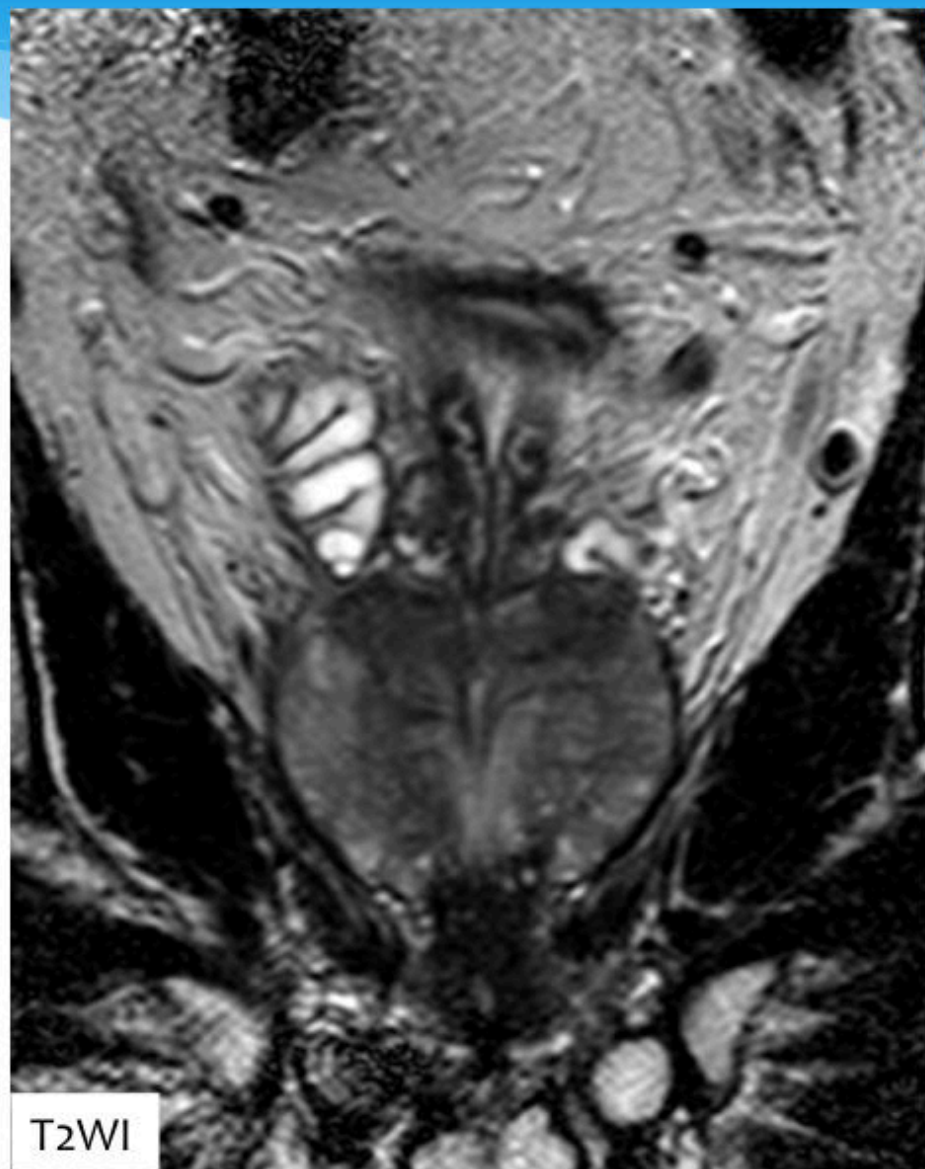
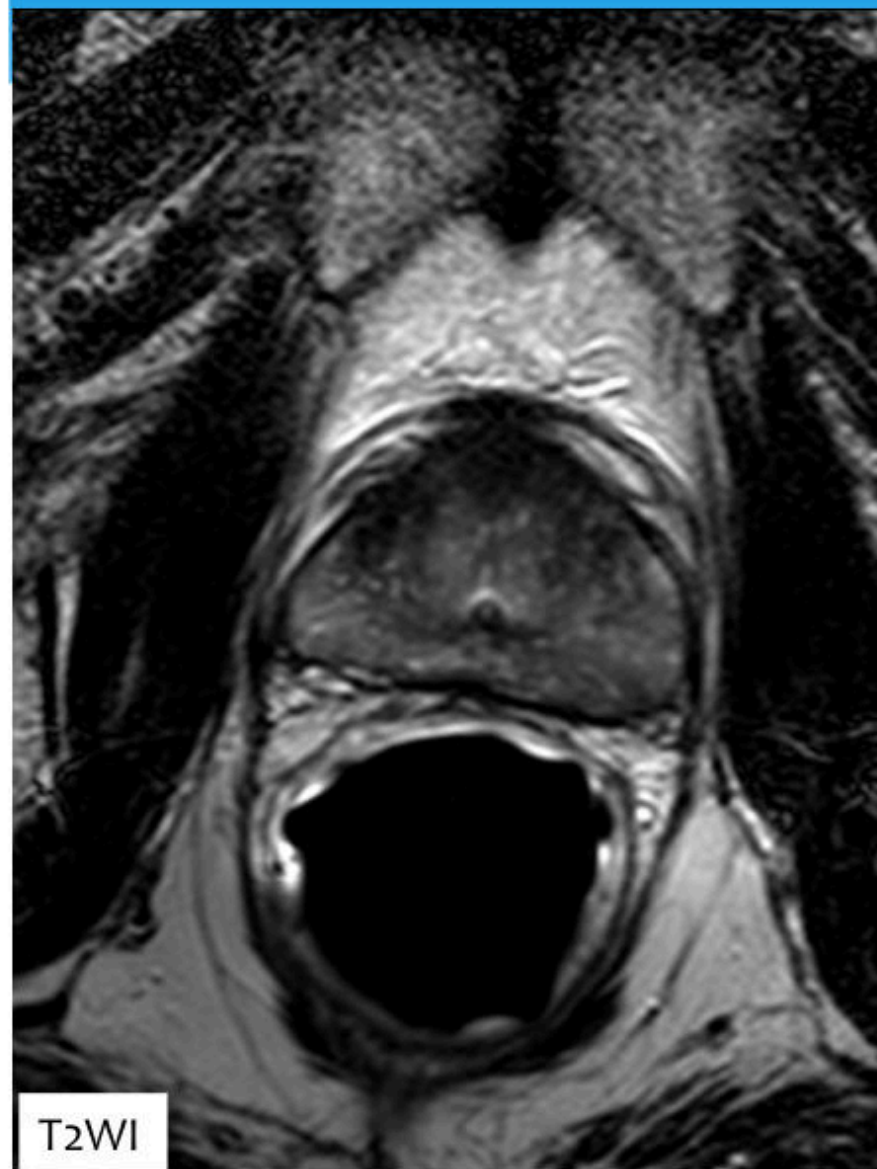
MRI in T-Staging

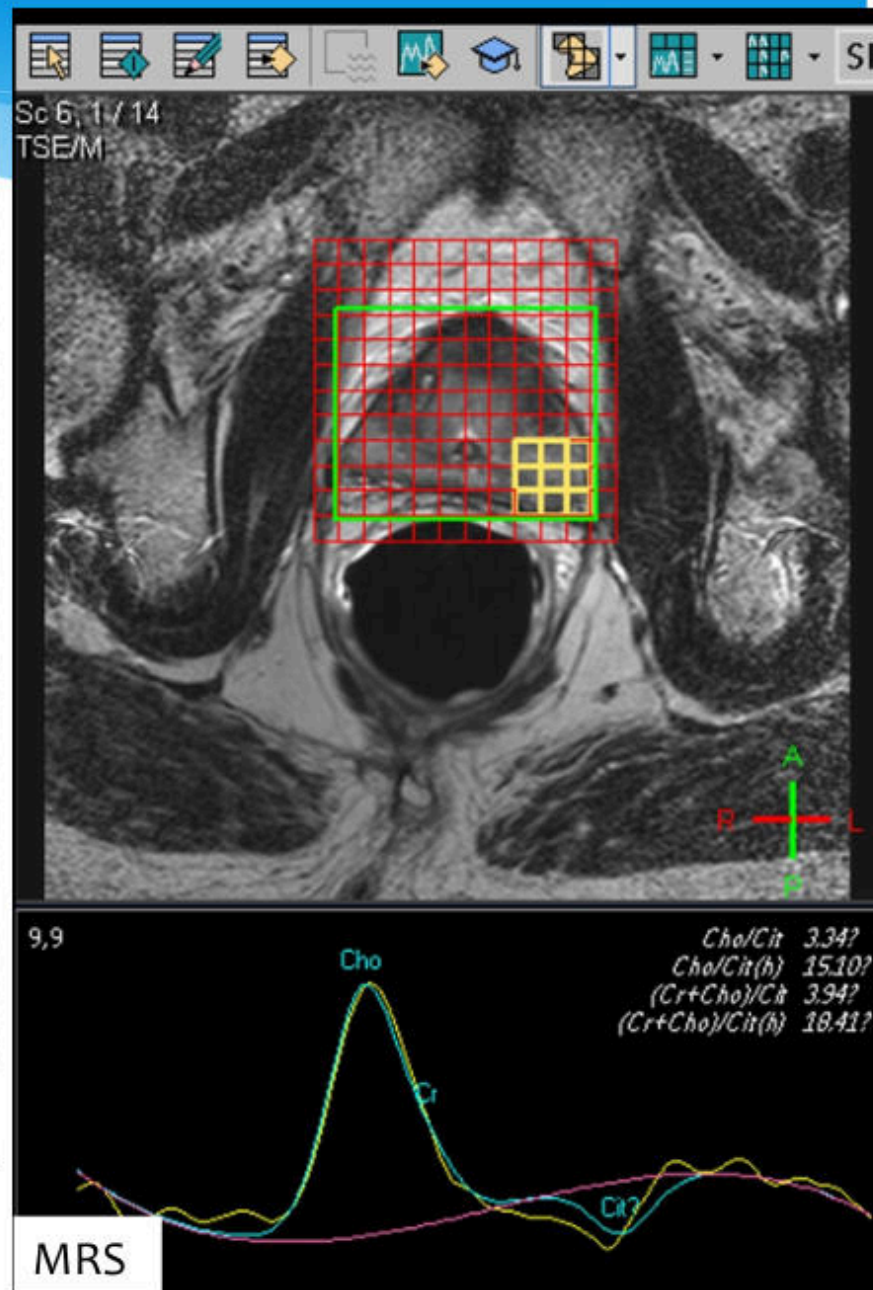
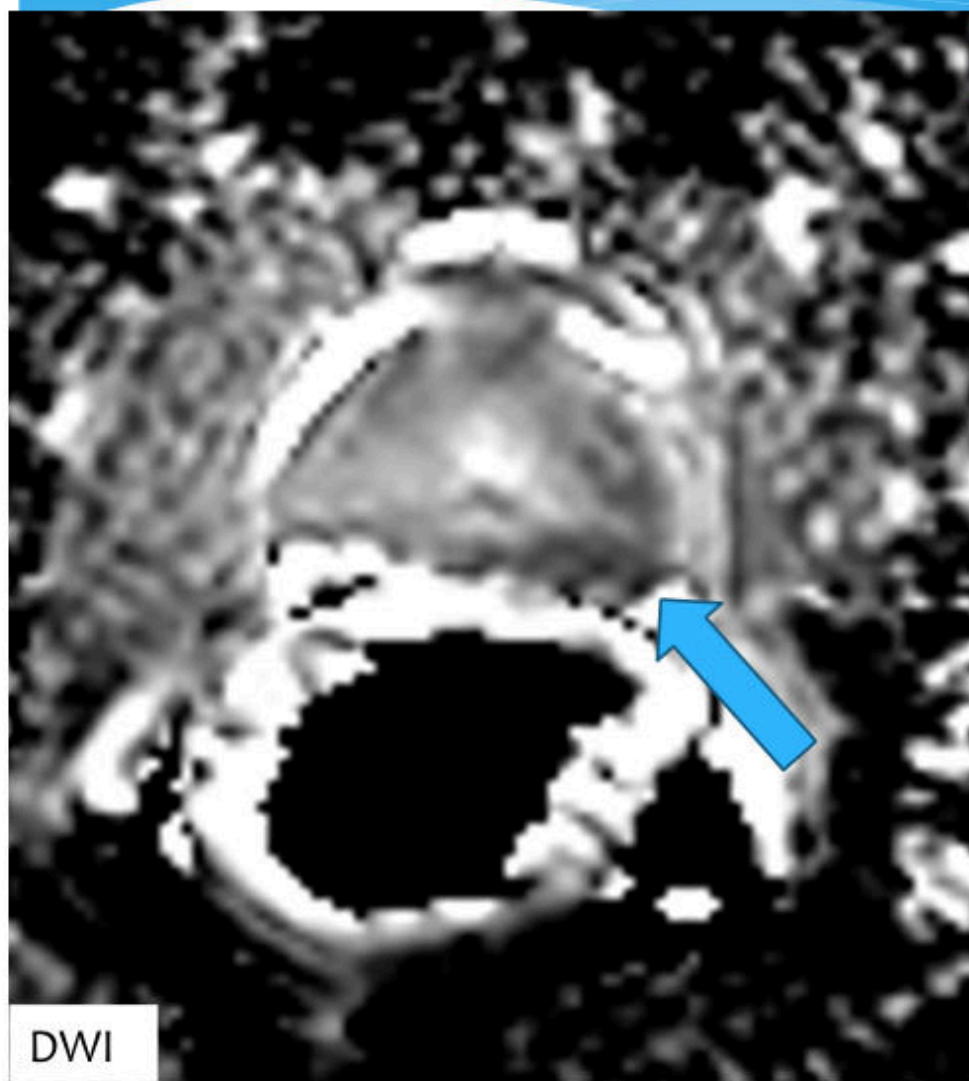
- * Optimal staging protocol is unclear
- * ESUR (2012) guidelines recommend T-staging should include T2WI, DWI, DCEI and ERC and preferably 3T (could omit ERC)¹
- * In one study looking at need for neurovascular resection due to extra-prostatic extension and seminal vesicle invasion¹³
 - * Receiver operating curves- area under the curves (ROC-AUC) were significantly better for post –MRI vs pre-MRI surgical plan
- * MRI is useful in nerve sparing decision and may be of value in guiding width of resection in higher grade/volume tumour or extra prostatic extension¹

13. Hricak H, Wang L, Wei DC et al. The role of preoperative endorectal magnetic resonance imaging in the decision regarding whether to preserve or resect neurovascular bundles during radical retropubic prostatectomy. Cancer 2004; 100: 2655–63

Case Study 12

- * Mr P.D is a 59 y.o man
- * ERBT (2006) – Gleason Score 3 +4 =7
- * Radiotherapy treatment
- * HPI: Gradually increased PSA to 3.2 (12/12), PR – nil nodes,
- * MRI: nil nodes
- * Choline PET – negative
- * Prostate Biopsy – mixed intraductal and invasive adenocarcinoma (Gleason 7-difficult however)
- * Surgery- Salvage Robot Assisted Radical Prostatectomy
 - * T2c margin negative
- * PSA <0.01 (11/10/13)
- * Learning point – resectable disease





Role of MRI in surgical resection post radiotherapy

- * A number of smaller studies have shown that mpMRI is useful to confirm diagnosis of local prostate cancer and thus resectability¹⁴
- * Limitation of studies
 - * Use of core biopsy specimens as the standard of reference for MRIs
 - * Lack of whole-mount radiological pathological correlation due to high complication rates and technical difficulty of radical prostatectomy post radiotherapy

14. Wu, LM., Xu, JR., Gu, HY, Hua, J., Zhu, J., Chen, J., Zhang, W., & Hu, J. 2013. Role of magnetic resonance imaging in the detection of local prostate cancer recurrence after external beam radiotherapy and radical prostatectomy. *Clin Oncol (R Coll Radiol)*, 25(4), p252-264.

Conclusion

- * Emerging modality for the diagnosis and staging of prostate cancer
- * Further literature is needed to demonstrated the indications and benefits of MRI
- * Should be performed by a specialist trained radiologist
- * mpMRI is a useful and practical tool to guide clinical day to day management of patients with prostate cancer

Acknowledgements

- * Dr Rowan Stephenson, Resident, St Vincent's Hospital
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