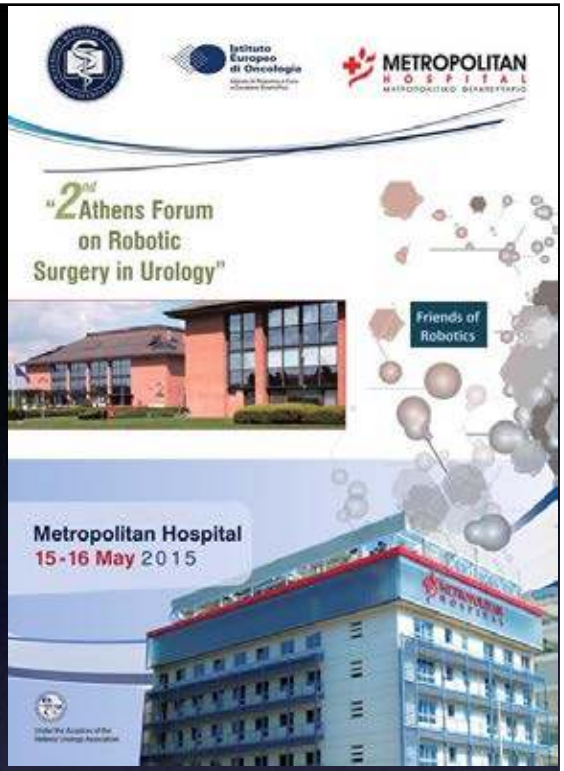
MRI: its role in the detection of the relapse



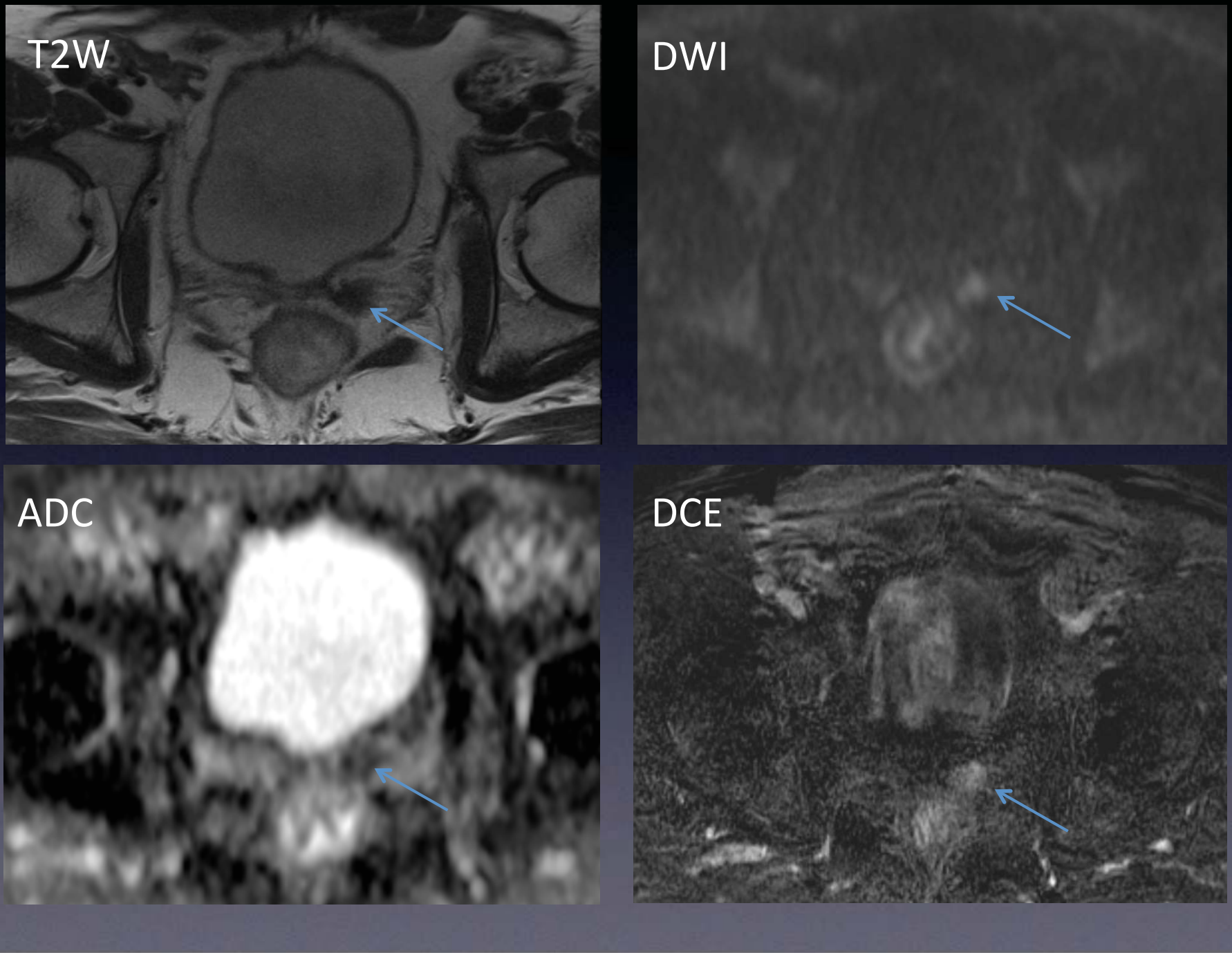
Sarah Alessi

IEO
European Institute of Oncology

Research for care

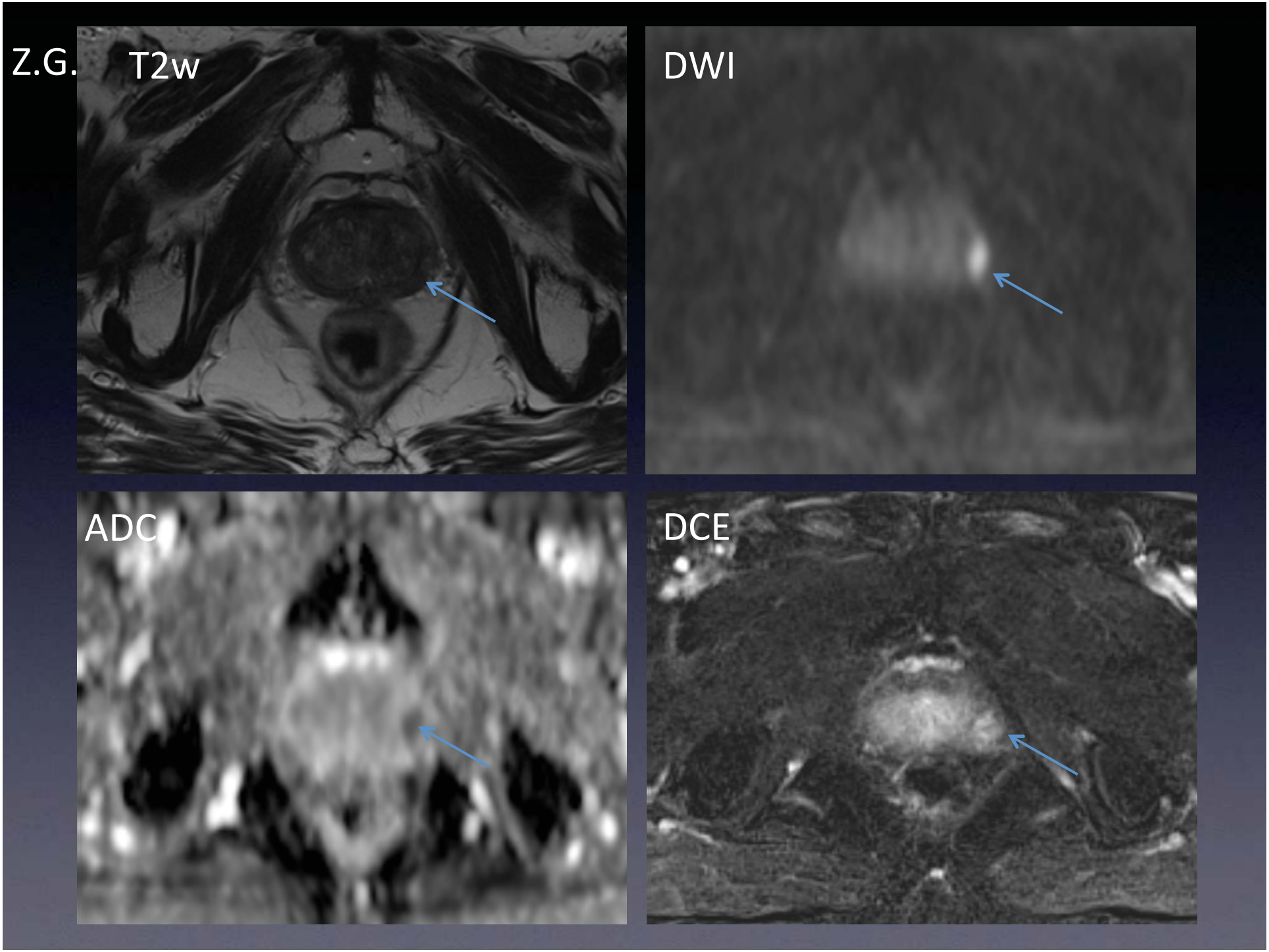
Case - C.E.

- 2011 prostatectomy (pT3b pNx GS 4+4)
- PSA progression (PSA= 2ng/ml)
- Choline-PET/CT (2012) → negative
- 2013 PSA= 9.6ng/ml
- mp-MRI (01/2014)


T2W
DWI
ADC
DCE

Case - Z.G.

- 2008 RT (GS= 3+4)
- PSA= 0.63 ng/ml (07/2008)
- PSA= 2.87 ng/ml (02/2013); PSA= 4.27ng/ml (07/2013); PSA= 5.25ng/ml (10/2013)
- Choline-PET/CT → prostate uptake
- mp-MRI (10/2013)


Z.G.
T2w
DWI
ADC
DCE

Relapse: definition

- PSA>0.2 ng/ml after RP
  - Two consecutive values of PSA higher than 0.2 ng/ml.
- PSA>2 ng/ml above the nadir after RT

RELAPSE

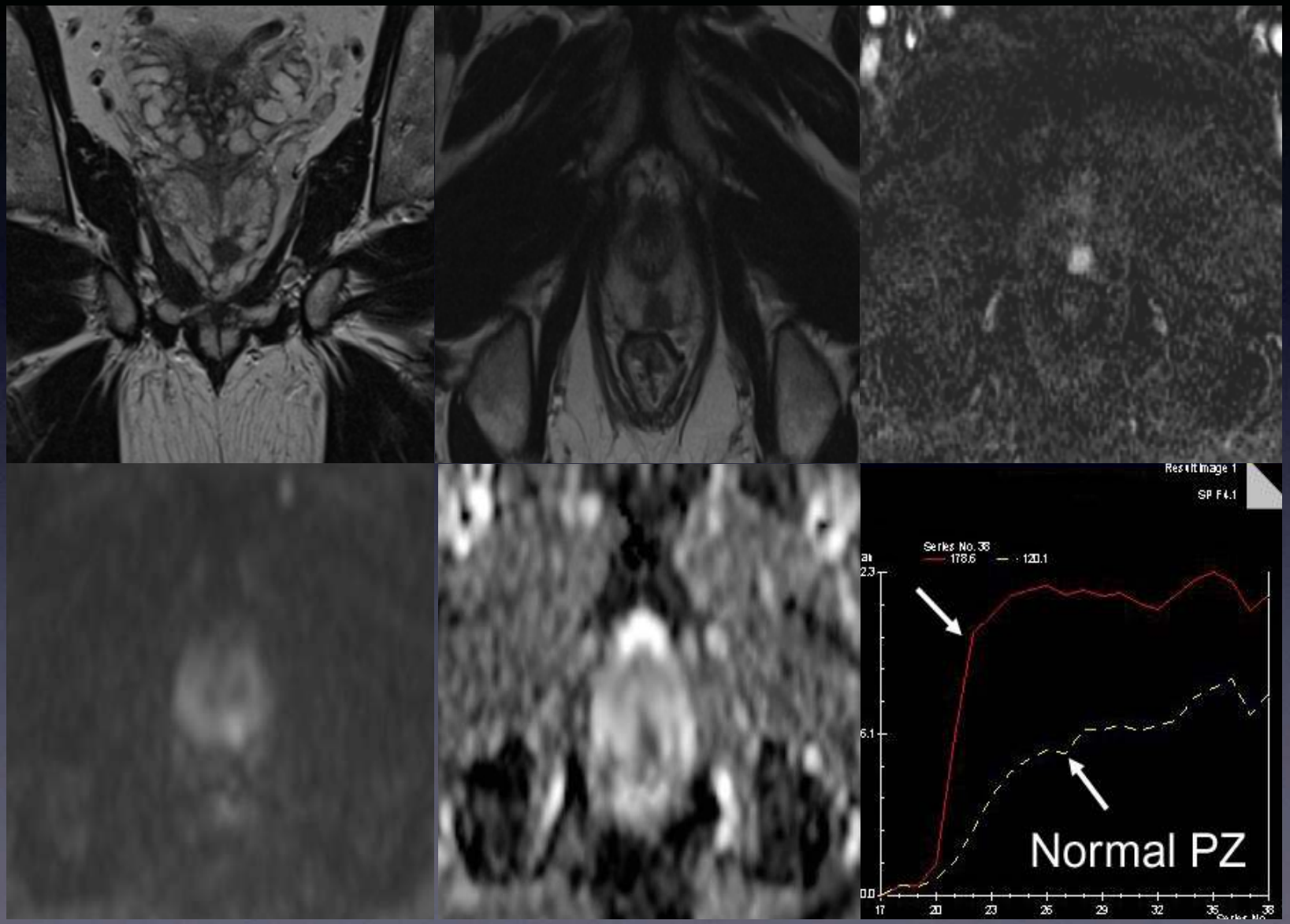
- Two patterns of relapse :
  - Local→ RT → mpMRI
  - Distant→ ADT → WB-MRI

MR

- accurate biomarker for restaging

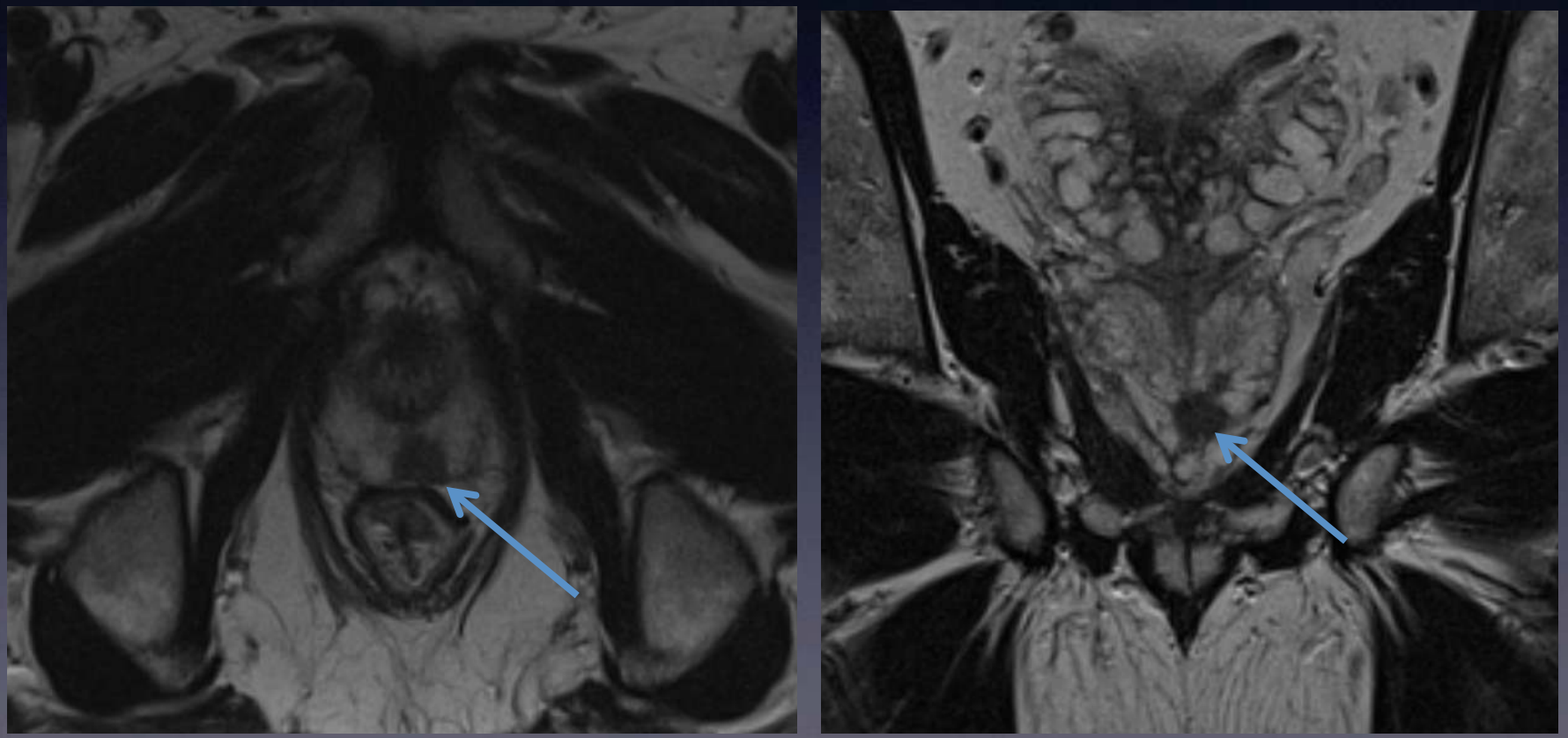
Picchio M, Mapelli P, Panebianco V et al. Imaging biomarkers in prostate cancer: role of PET/CT and MRI Eur J Nucl Med Mol Imaging (2015) 42:644–655.

Mp-MRI


Result Image 1
SP F4.1
Series No. 38
178.6
120.1
2.3
6.1
0.0
17
20
23
26
29
32
35
38
Normal PZ

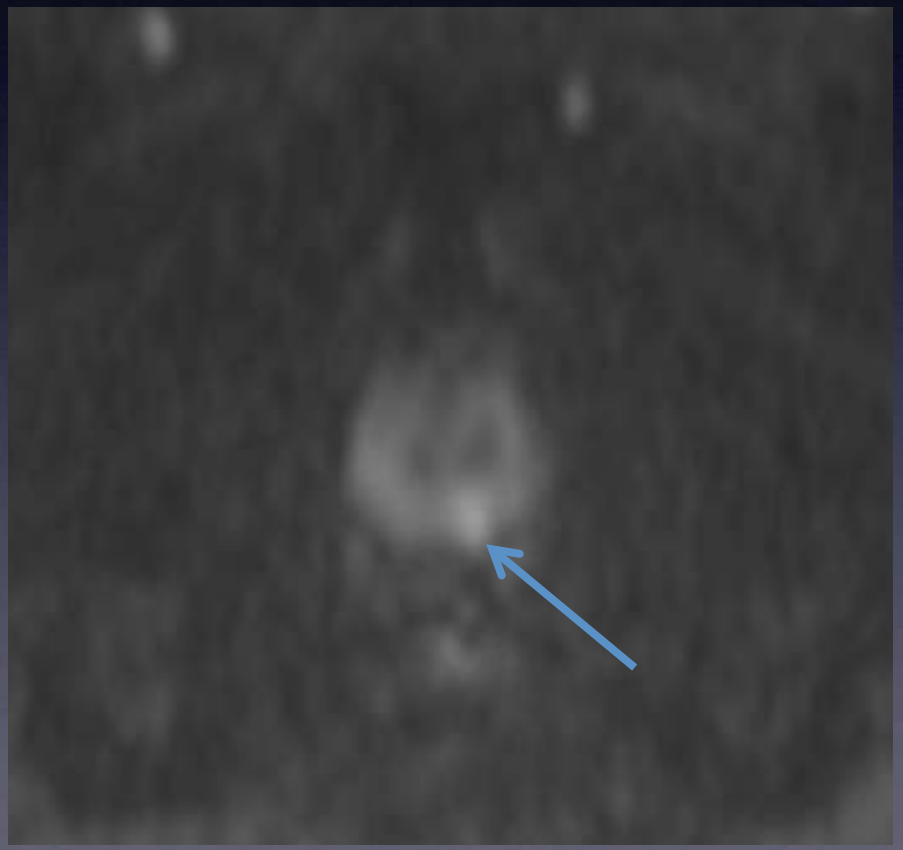
Anatomy

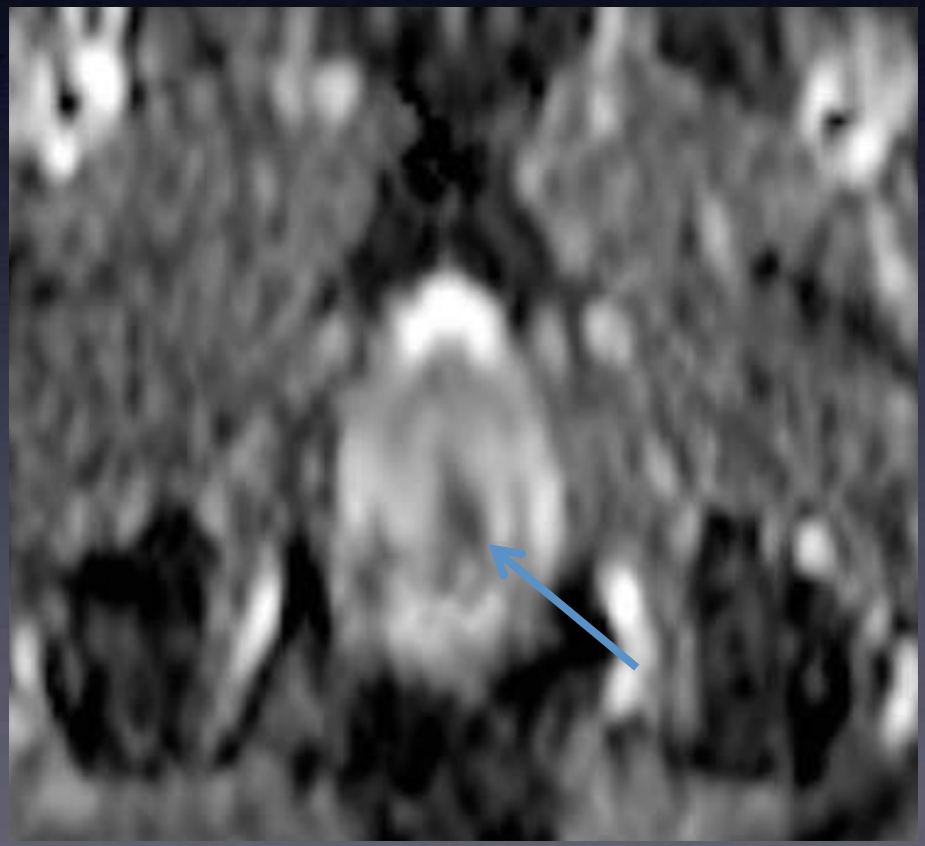
- Hi-Res T2WI → Pixel = 0.6 x 0.6 mm



Cellularity

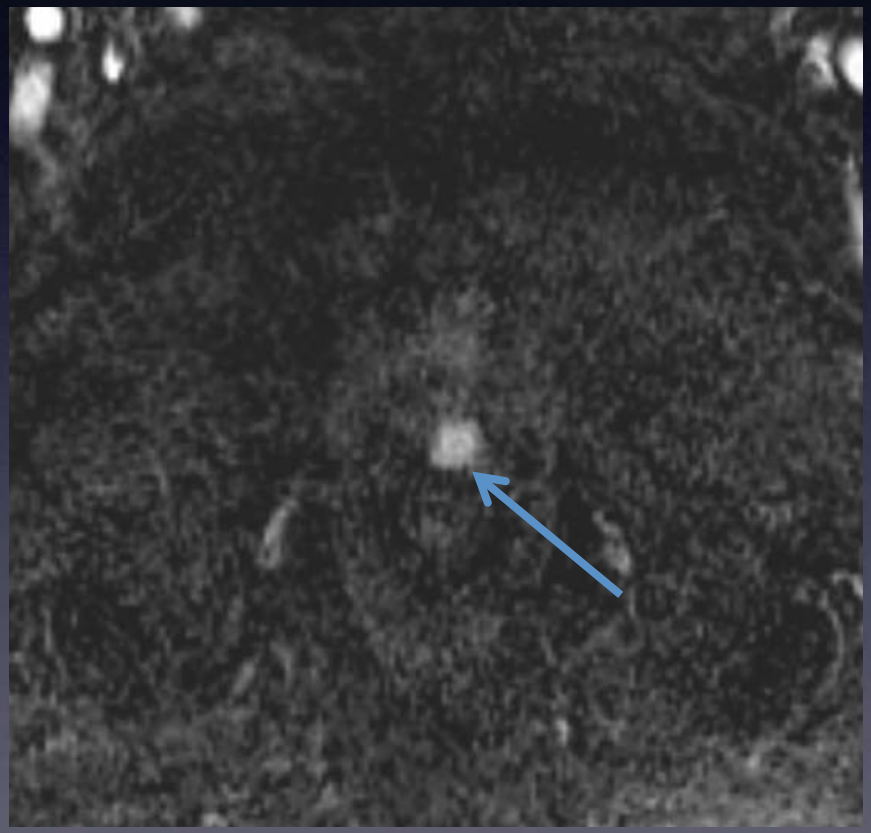
- DWI → Diffusion Weighted Imaging

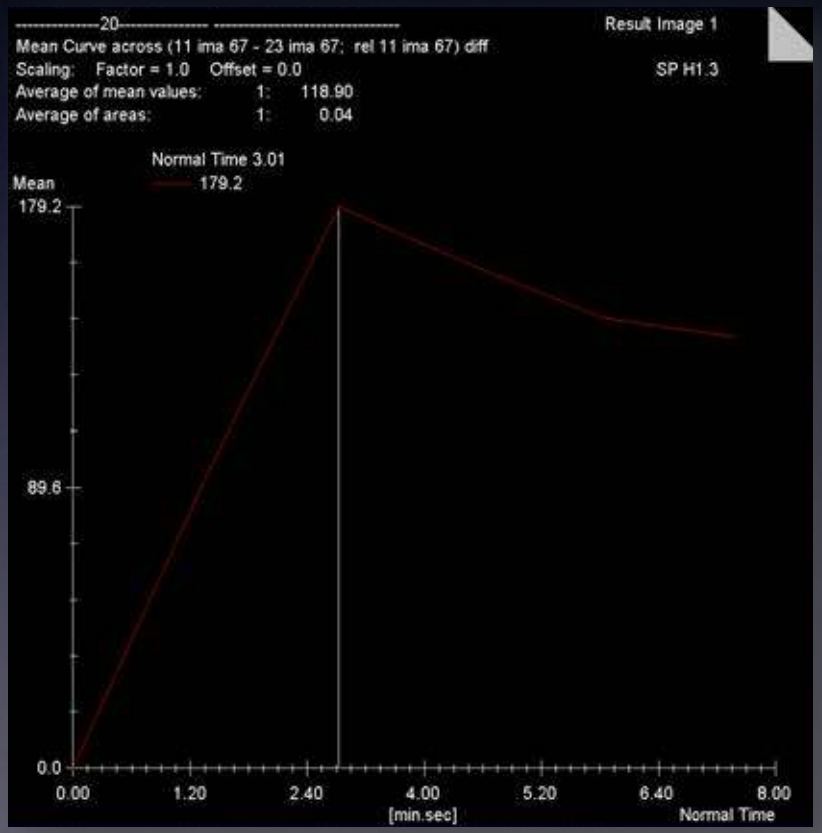




Vascularity

- DCE → Dynamic Contrast Enhanced





Local relapse

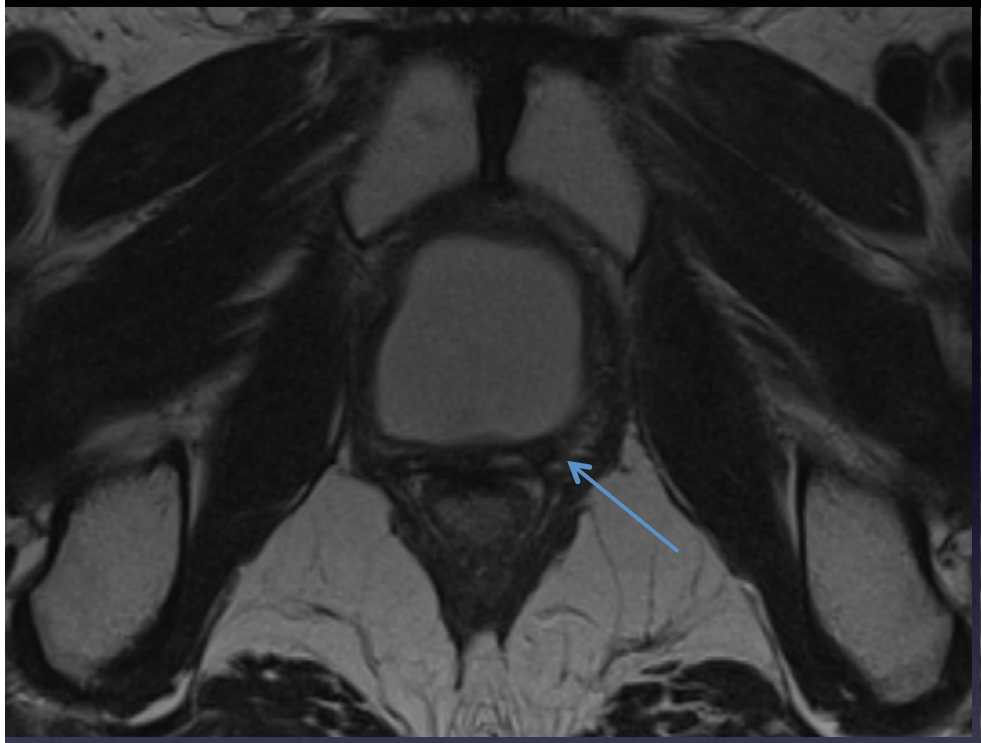
	MRI	PET/CT
Sensitivity	88%	54%
Specificity	84%	92%
Accuracy	87%	65%

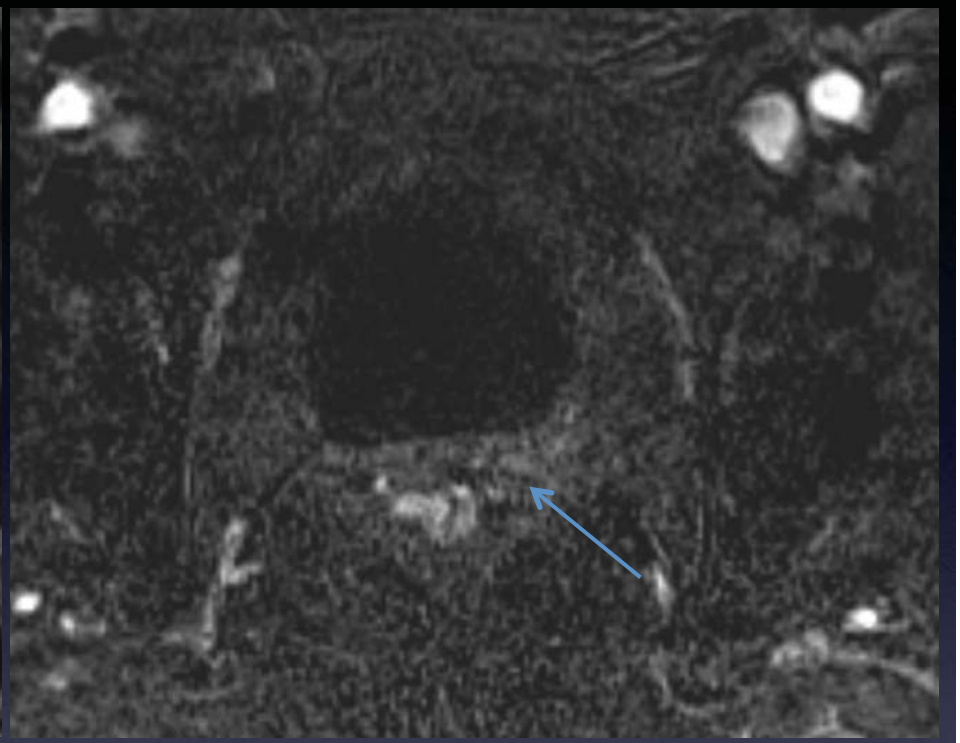
Kitajima K, Murphy RC et al. J Nucl Med. 2014;55:223–32.

Mp-MRI: local relapse

- Most reliable imaging biomarker for detecting local PCa recurrence in patients with biochemical failure after RP and PSA values for which PET/CT is not indicated (0.2 – 1 ng/ml)
- Useful for discriminating between relapse and residual glandular tissue, fibrosis/scar and granulation tissue.

Panebianco V, Barchetti F, Musio D et al. Biomed Res Int. 2014;2014:827265.
Barchetti F, Panebianco V. Biomed Res Int. 2014;2014:316272.





Perianastomotic fibrotic tissue

Mp-MRI: local relapse

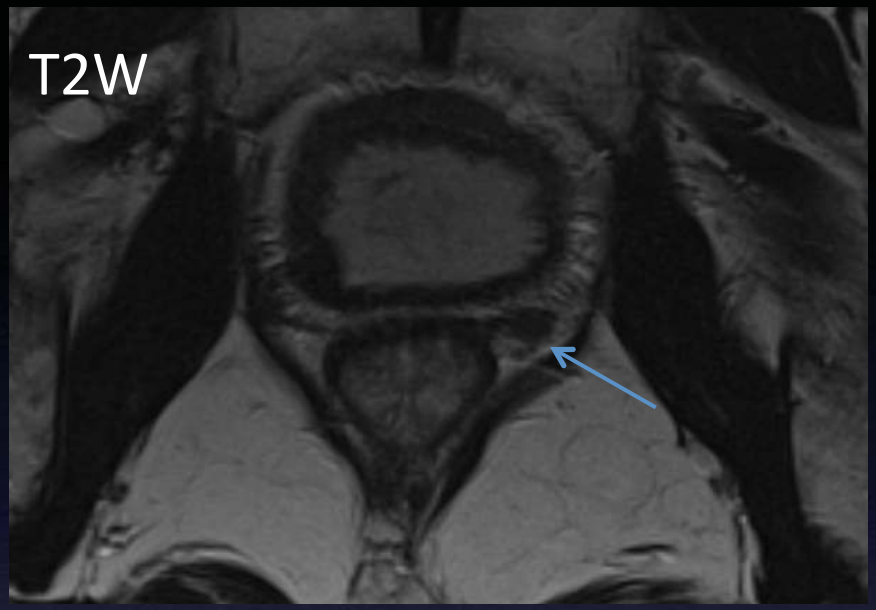
- DCE-MRI
  - Traditionally the most reliable technique in detecting locoregional recurrence
- DWI
  - recent studies demonstrated its role (more practical and simpler)
- Overall, DWI and DCE are comparable
  - T2w+DWI+DCE: 82–87% specificity, 81–87% accuracy.

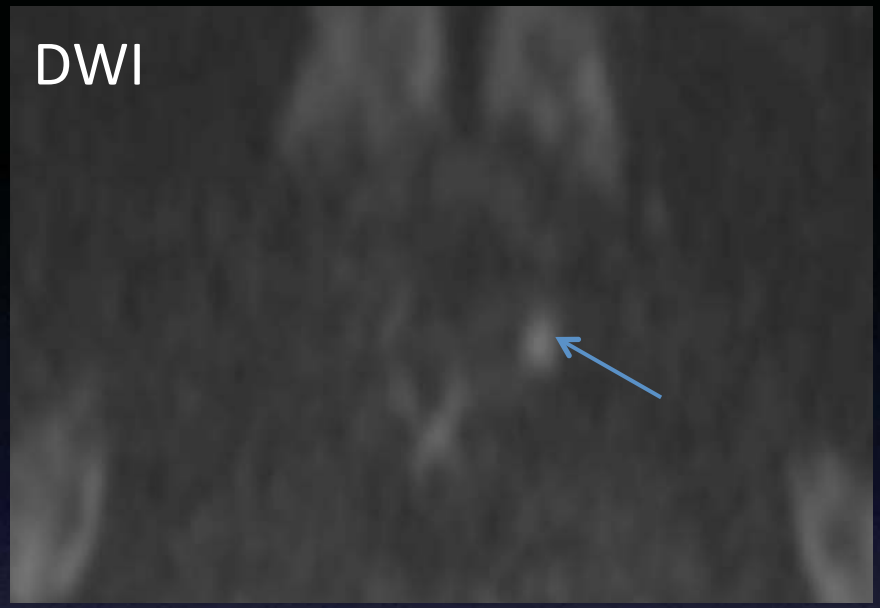
V. Panebianco, A. Sciarra, D. Lisi et al., European Journal of Radiology, 81 (2012) p. 700– 708.
Cha et al., Magnetic Resonance Imaging 33 (2015) 407–412.

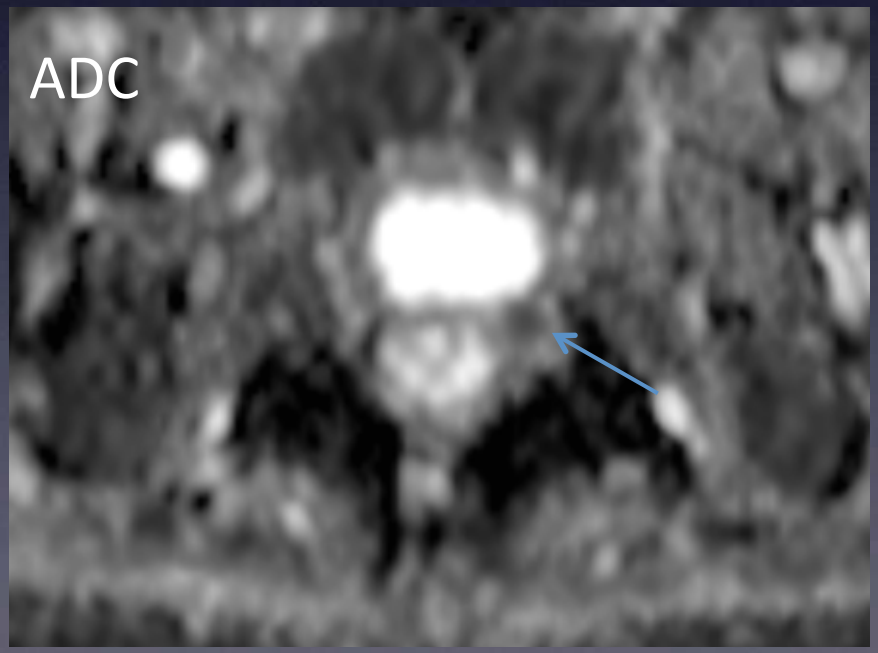
Mp-MRI: guide for RT

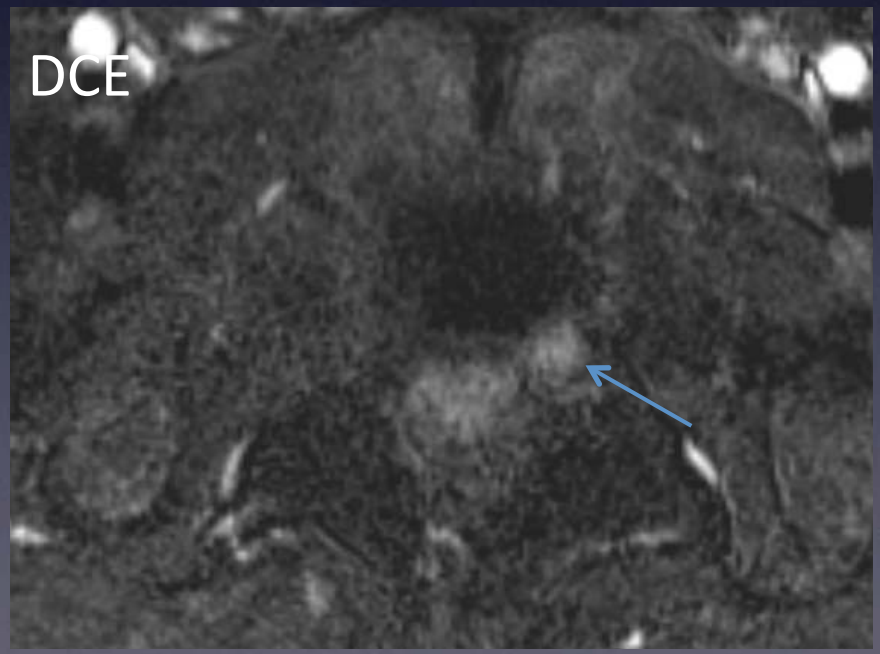
- Individualization of the field of irradiation (EBRT)
- Stereotactic boost to the recurrence site improving the control of local disease avoiding further locoregional relapses.

Case-F.M.

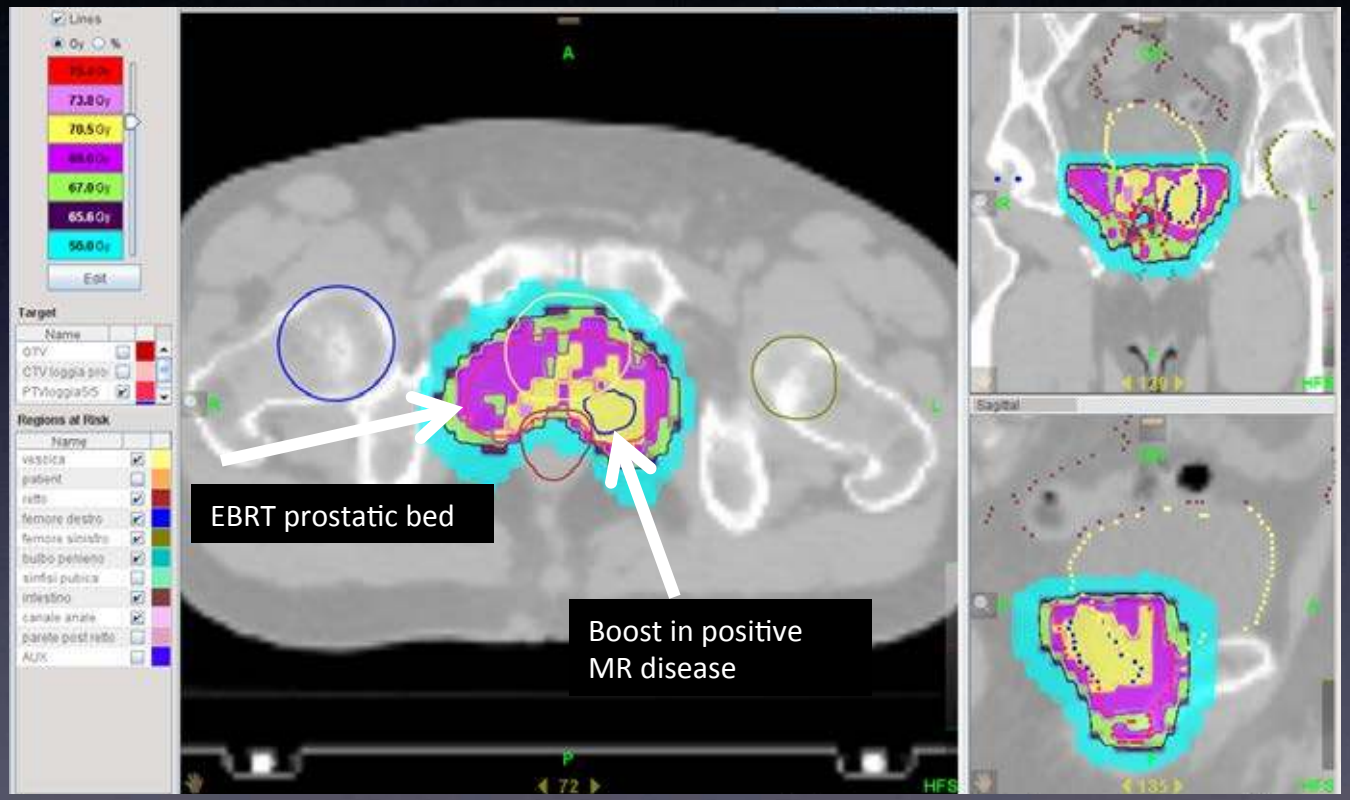








Radiotherapy in prostatic bed with boost in positive MR disease



Mp-MRI: advantages

- Very good spatial and contrast resolution
- Well differentiate healthy glandular tissue from neoplastic zones
- Guide targeted TRUS-guided biopsy of suspicious areas
- Appropriate treatment selection and planning
- Improve the targeting of salvage RT
- Potential to change patient management

Characteristics of the different reviewed studies on mp-MRI for the diagnosis of local recurrence after RP.

Authors	Cases	mean PSA (ng/dL)	Mean lesion size (mm)	T2W %	DCE %	MRSI %	DWI %	Combined techniques %
Silverman and Kerbs	41	1.4	16	SE 100 SP 100 PPV 100 NPV 100				
Sella et al	48	2.18	14	SE 95 SP 100				1.7
Cirillo et al	72	1.5	17	SE 61 SP 82 PPV 84 NPV 57	SE 84 SP 89 PPV 92 NPV 78			32.0
Casciani et al	46	1.9	15	SE 48 SP 52 PPV 54 NPV 46	SE 88 SP 100 PPV 100 NPV 88			44.3
Sciarra et al	70	1.2	13(A) 6(B)		SE71 SP94 PPV96 NPV67	SE 71-84 SP 83-88 PPV 91 NPV 56-74		MRSI+DCE SE 86 SP 94-100 PPV 96-100 NPV 75-79
Panebianco et al	84	1.1	6(A) 13(B)					MRSI+DCE SE 92 SP 75-100 PPV 96-100 NPV 57-60
Wu et al			6.4	SE 72 SP 74	SE 85 SP 95			MRSI+DCE SE 92 SP 95
Roy et al	28	0.98	100.0	SE 56	SE 94	SE 50	SE 65	T2+DCE SE 97 T2+DWI+DCE SE 94 T2+DWI+DCE+MRS SE 74 T2+DWI SE 65

Barchetti et al. BioMed Research International 2014

Characteristics of the different reviewed studies on mp-MRI for the diagnosis of local recurrence after RT

Authors	Cases	mean PSA (ng/dL)	T2W %	DCE %	MRSI %	DWI %	Combined techniques %
Sala et al	45	3.57	SE 36-76% SP 65-81%				
Westphalen et al	59		SE 62-74% SP 64-68% PPV 70-80% NPV 50-70%				
Haider et al	33	2.1	SE 38 SP 80 PPV 24 NPV 88	SE 72 SP 85 PPV 46 NPV 95			
Kara et al	20		SE 86 SP 100 PPV 100 NPV 71	SE93 SP 100 PPV 100 NPV 83			
Wu et al			SE 74 SP 65	SE 90 SP 81			MRSI+DCE SE 90 SP 90
Kim et al	36	3.4	SE 25 SP 92 PPV 57 NPV 74				T2w+DWI SE62 SP 97 PPV91 NPV 81
Akin et al	24	1.6	SE13-81 SP25-88				T2w+DCE+DWI SE 81-94 SP 75-100
Donati et al	53		SE54-66 SP39-61 PPV63-77 NPV 30-48				T2+DCE SE63;SP56-89 T2+DWI SE 54 T2+DWI +DCE SE 49-71 SP 94 PPV 94-96 NPV 49-63.

Barchetti et al. BioMed Research International 2014

WB-MRI: distant relapse

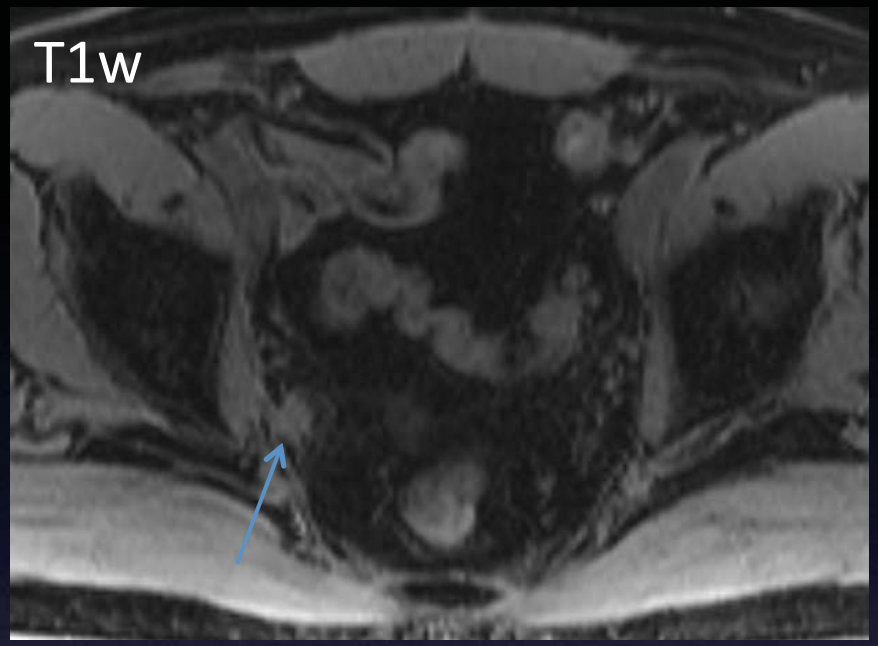
- Lymph nodes (N)
- Metastases (M)

- 20-30% PCa pts develop systemic disease after local treatment preferentially in the pelvic and lumbar lymph nodes and in the skeleton.

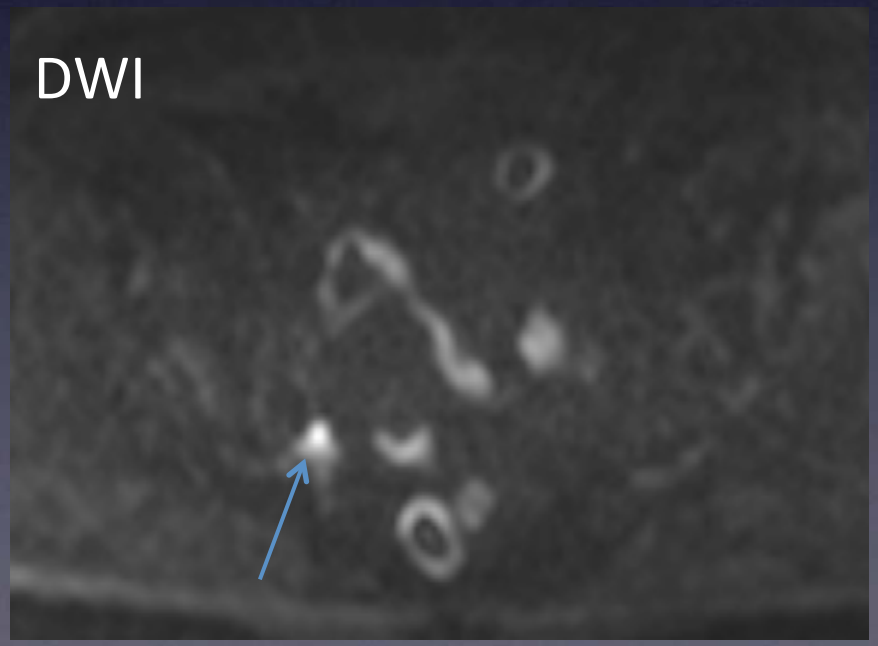
Case - C.F.

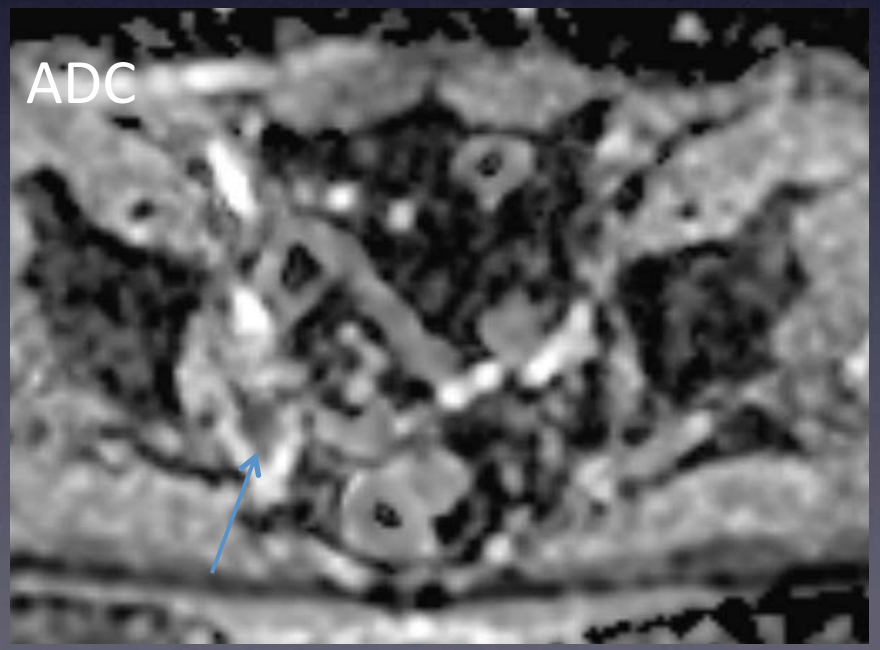
- 2009 surgery + LAD pT3a pN0 M0 GS 4+3
  - PSA = 0.3 ng/ml
  - Adiuvant RT and hormone therapy (2009-2010)
  - PSA= 0.37ng/ml (03/2013); PSA= 0.47ng/ml (04/2013)
- Choline-PET/CT: negative (07/2013)
- Prostatic bed biopsy (07/2013): negative

  - PSA=0.4 ng/ml (10/2013); PSA= 0.54 (02/2014)
  - PSA= 1.1 ng/ml (03/2014)
- WB-MRI (IEO 05/2014)



N+

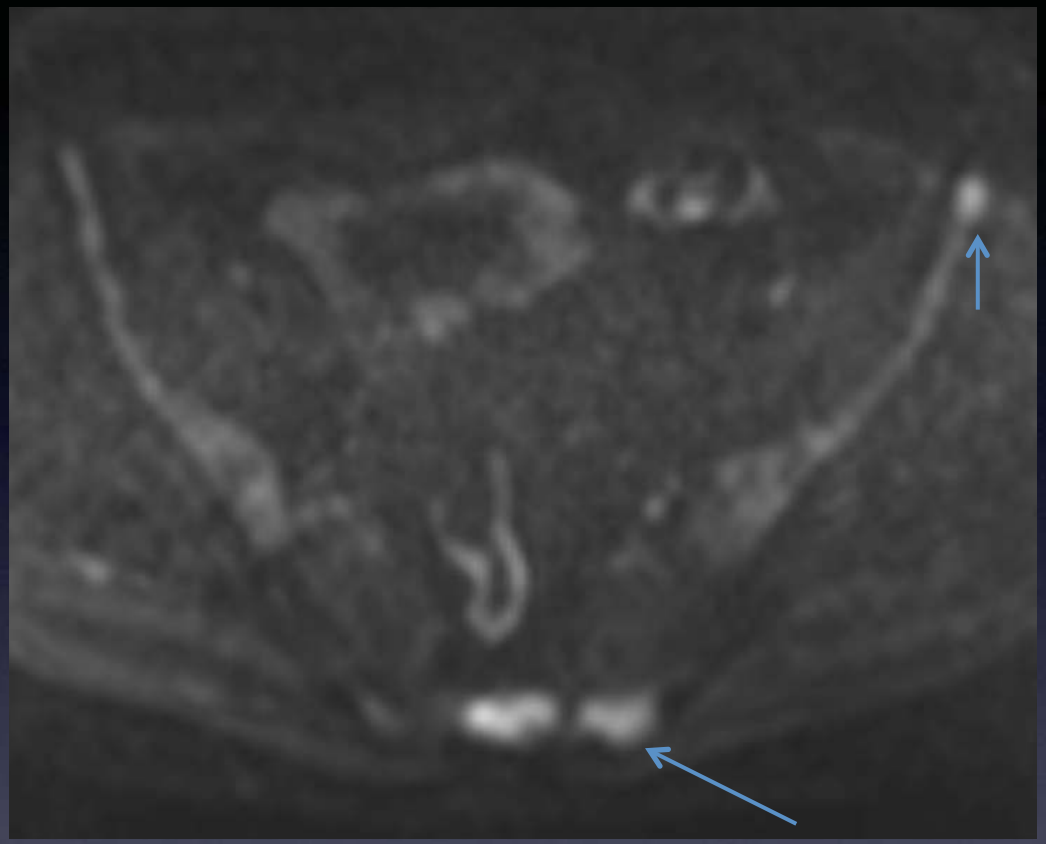




Case - C.F.

- N+ : right internal iliac lymph node (8mm) in contact with the antero-lateral side of the mesorectal fascia
- RT of the nodal recurrence (05/2014) : complete response

- Follow up: WB-MRI (09/2014)



M+ sacrum and left iliac bone

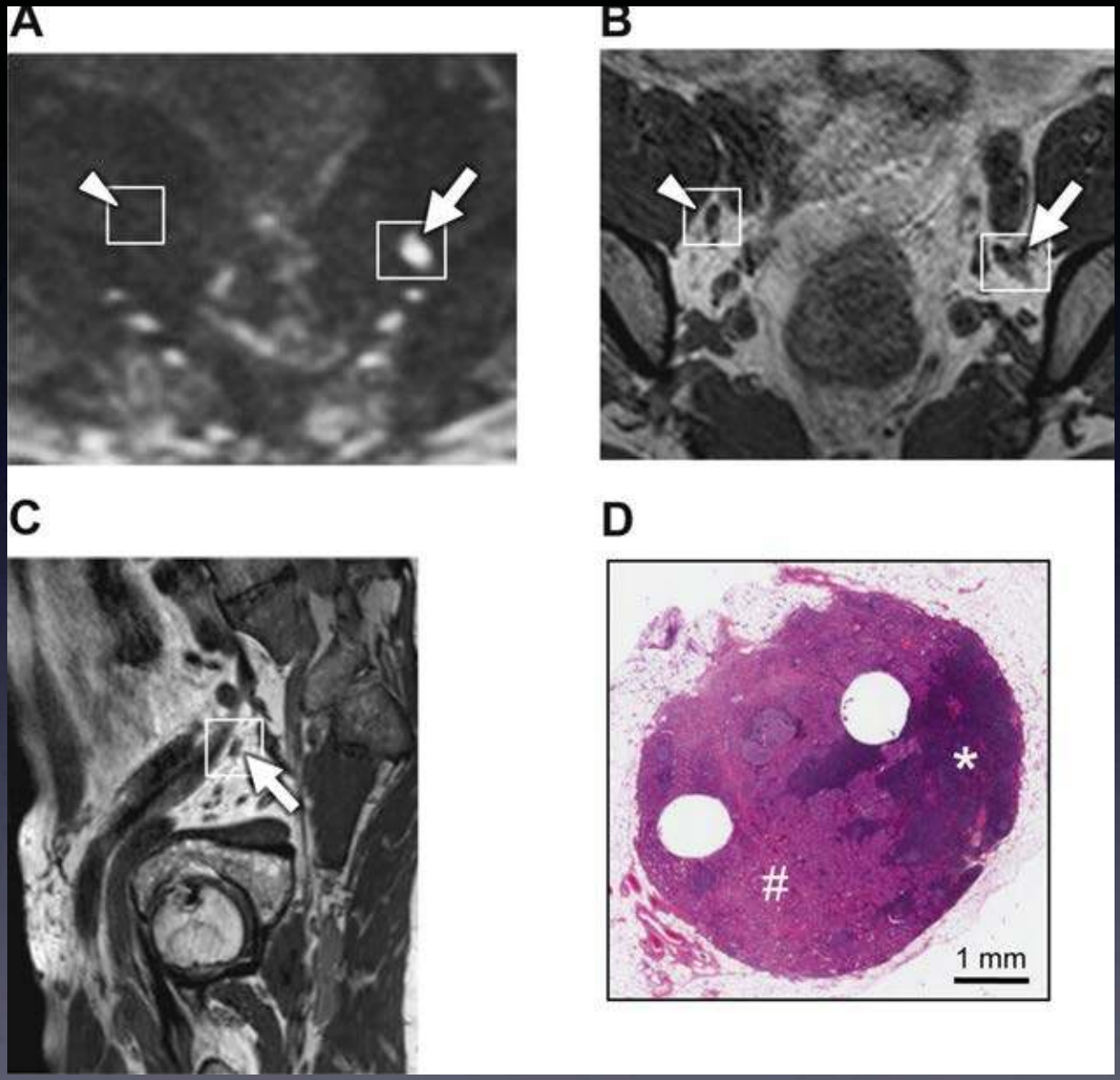
Case - C.F.

- RT bone mtx (10/2014)
- PSA progression (11/2014): PSA= 7.35 ng/ml
- Hormone therapy (LHRH agonist)
- 03/2015: PSA= 1.3 ng/ml

MRI and LN

- Still FP & FN
  - Giannarini et al.
    - Sensitivity: 86%;
    - specificity : 85%;
    - diagnostic accuracy: 86%[1]
  - Budiharto et al.
    - Sensitivity: 42.9%[2]

[1]Giannarini G., Petralia G. et al. European Urology 61 (2012) 326-340
[2] Budiharto T. et al. Eur Urol 2011; 60:125-30



USPIO-DWI MR

DA up to 97%
NPV: 94%

LN mts <5mm

F.Birkhauser, H.C.Thoeny et al. Eur Urol 2013-5228

MRI and LN

	MRI -DWI	Choline -PET/CT
Sensitivity	67-89%	64%
Specificity	78-85%	90%
PPV	86-94%	86%
NPV	67-80%	72%

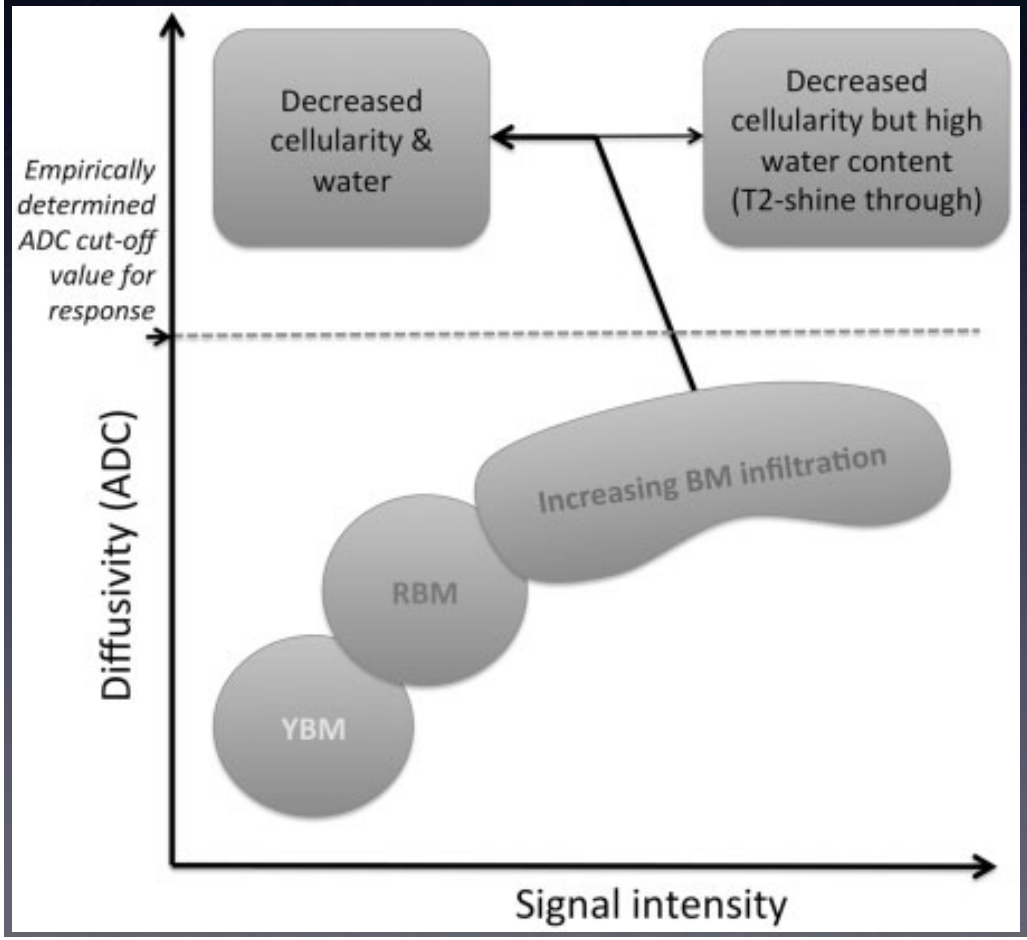
European Urology 52 (2007) 423-429

Choline PET/ CT and MRI :

- Both are accurate diagnostic tools for the detection of LN mtx of recurrent PCa
- High PPV and limited NPV

WB-MRI and BONE

- Ability to detect early tumor cells seeding into the fat-containing hematopoietic compartment → early detection of bone mts



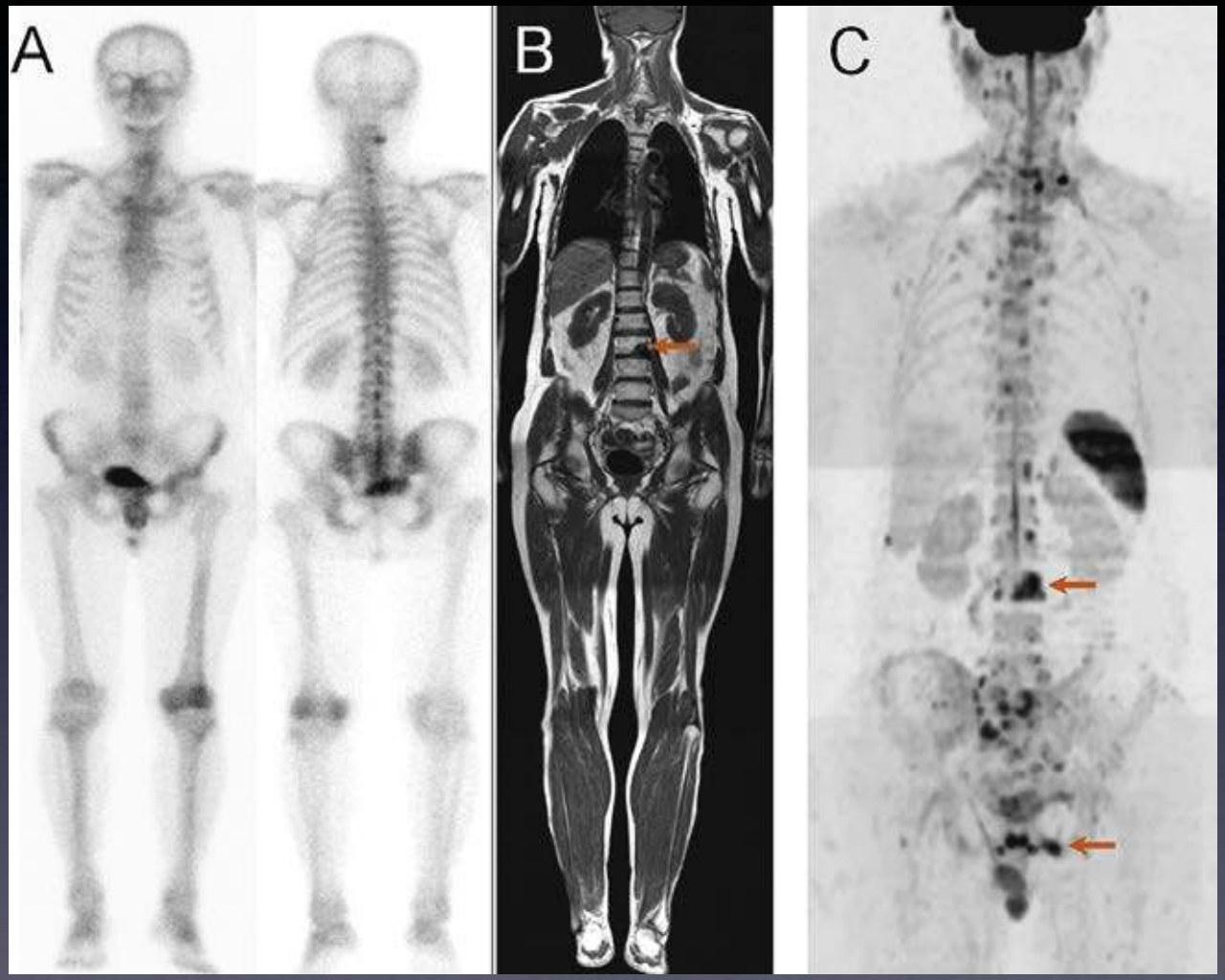
-WB-DWI excels at bone marrow lesion detection.

-Relationship between bone marrow diffusion signal intensity and ADC not always straightforward.

Padhani A.R. et al. Cancer Imaging (2011) 11, S1-S17

WB-MRI and BONE

- Sensitivity 98-100%
- Specificity 98-100%



Lecouvet F.E. et al. European Urology 62 (2012): 68-75

Diagnosis of bone metastases: ^{18}FDG-PET, CT, MRI or bone scan?

- 145 studies for meta-analysis (lung (36), breast (25), prostate (7), other tumor types (44))
- PET = MRI; both are more accurate than CT and BS for detecting bone metastases

	Rank (*p<0.05)	PET	MRI	CT	BS
Per Patient analysis					
Sensitivity	PET=MRI >BS* >CT*	89.7	90.6	72.9	86.0
Specificity	PET=CT=MRI >BS*	96.8	95.4	**94.8**	81.4
DOR	*PET>MRI=CT* >BS**	*232.6*	*143.9*	*76.0*	*29.4*
Per Lesion analysis					
Sensitivity	PET=MRI >BS* >CT*	86.9	90.4	**77.1**	75.1
Specificity	PET >MRI* >BS* >CT*	97.0	96.0	**83.2**	93.6
DOR	*PET=MRI >BS* >CT**	*240.3*	*167.6*	*6.0*	*25.2*

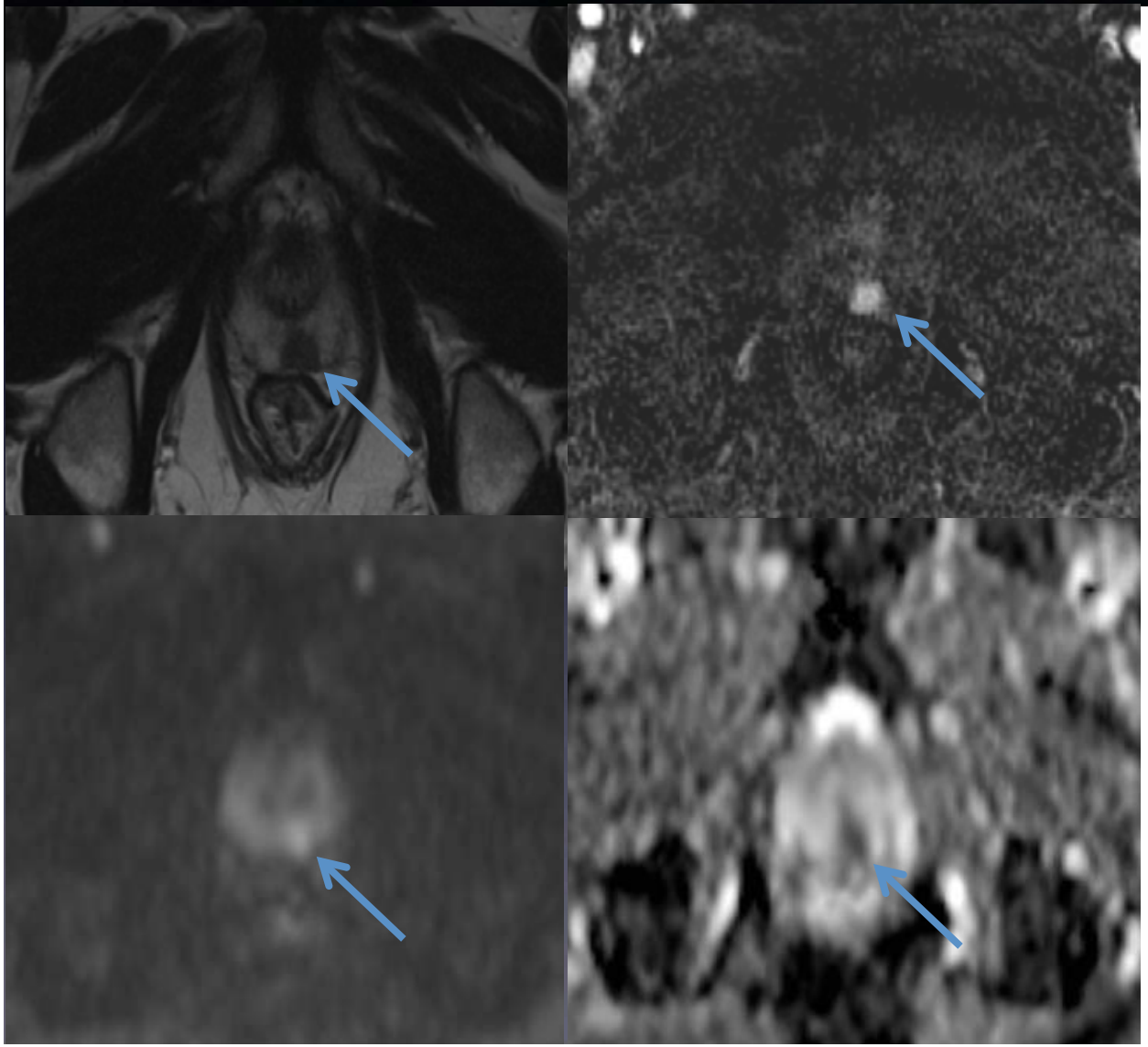
Yang HL, et al. Diagnosis of bone metastases: a meta-analysis comparing ^{18}FDG PET, CT, MRI and bone scintigraphy. Eur Radiol. 2011; 21:2604-17

- Overall FDG-PET = MRI; both are more accurate than CT and BS for detecting bone metastases[4]
- DW-MRI used alone has equal performance to FDG-PET for detecting primary tumors & soft tissue metastases[5]
- DW-MRI needs to be combined with morphologic sequences to improve specificity[6]

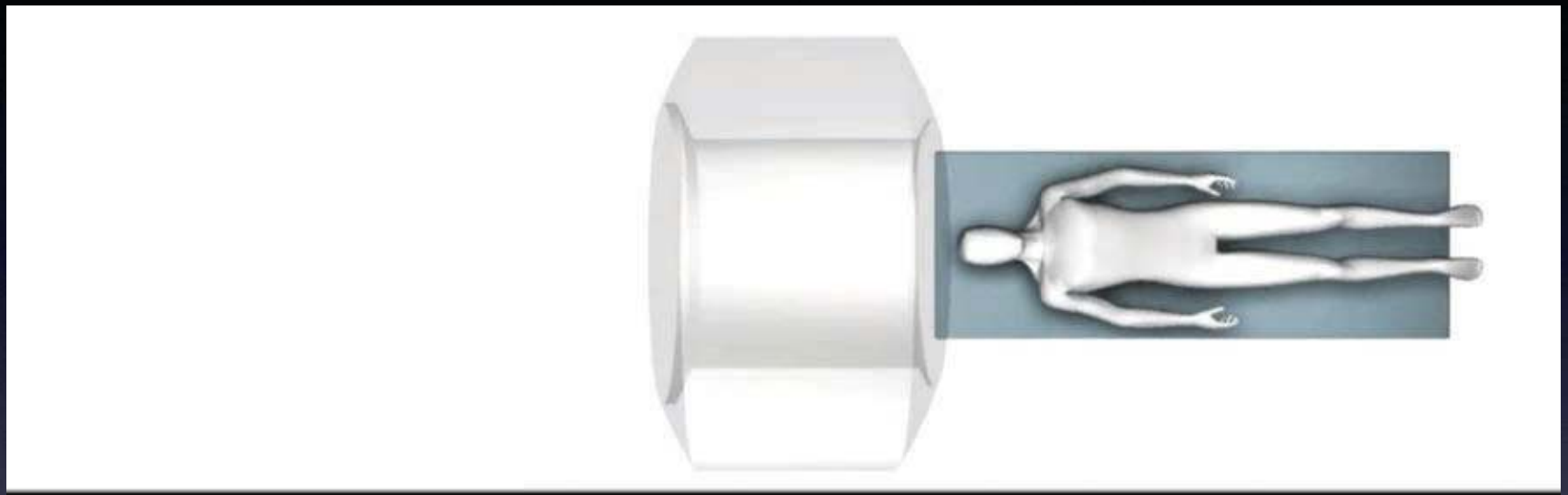
4. Yang HL, et al. Diagnosis of bone metastases: a meta-analysis comparing 18FDG PET, CT, MRI and bone scintigraphy. Eur Radiol. 2011; 21:2604-17
5. Li B, et al. Diagnostic value of whole-body diffusion-weighted magnetic resonance imaging for detection of primary and metastatic malignancies: A meta-analysis. Eur J Radiol. 2014; 83:338-44
6. Wu LM, Diagnostic value of whole-body magnetic resonance imaging for bone metastases: a systematic review and meta-analysis. J Magn Reson Imaging. 2011l;34:128-35

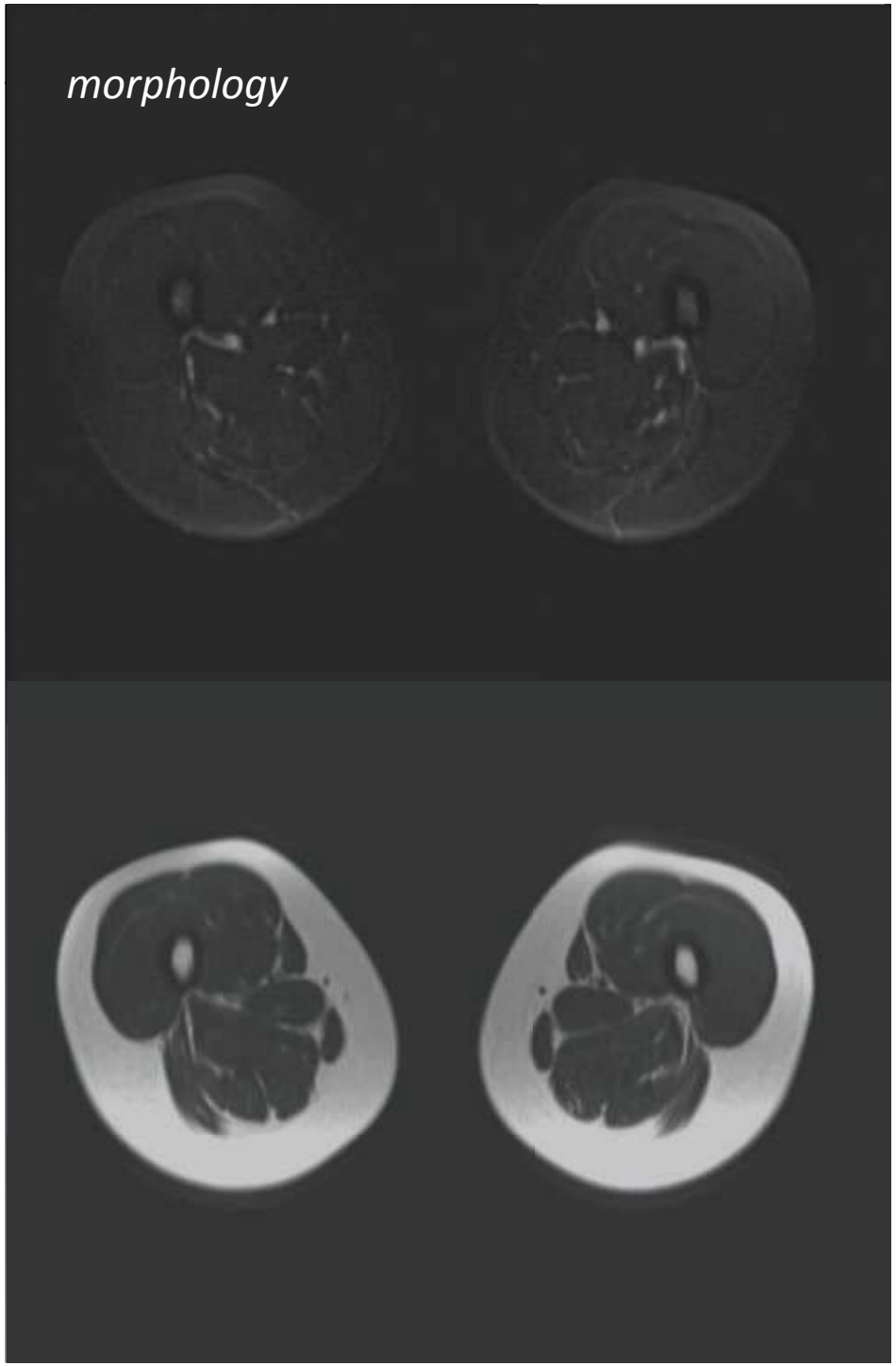
IEO approach → all-in-one

- mp-MRI + WB-MRI



Moving table MRI → acquisition time reduced




morphology


cellularity

Mp-MRI vs Choline-PET/CT

- Retrospective study
  - 115 prostatectomy patients
  - 11C-choline PET/CT and pelvic mp-MRI
  - ROC-curves

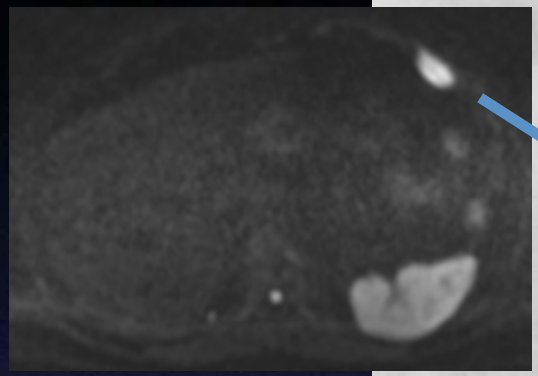
- MRI superior for the detection of local recurrence
- PET/CT superior for pelvic LN metastases
- Both excellent for pelvic bone metastases.

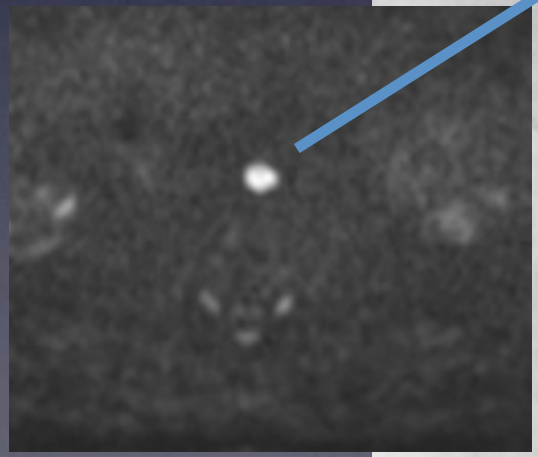
- MRI and choline PET/CT are complementary for restaging prostatectomy patients with suspected recurrent disease.

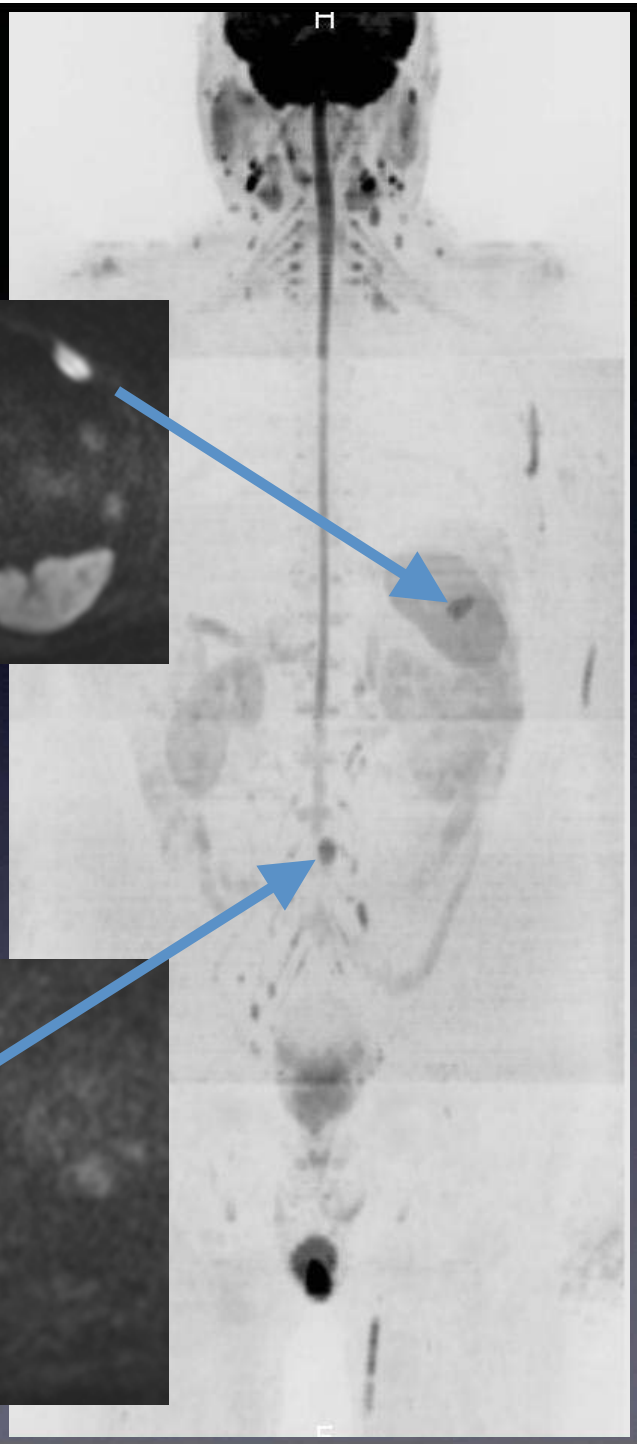
Kazuhiro Kitajima et al. , J Nucl Med 55 (2014) 223–232

Case (A.B.)

- No local relapse
- 2 lesions on MIP images
  - Nodal metastasis
    - Aortic bifurcation
  - Bone metastasis
    - left rib

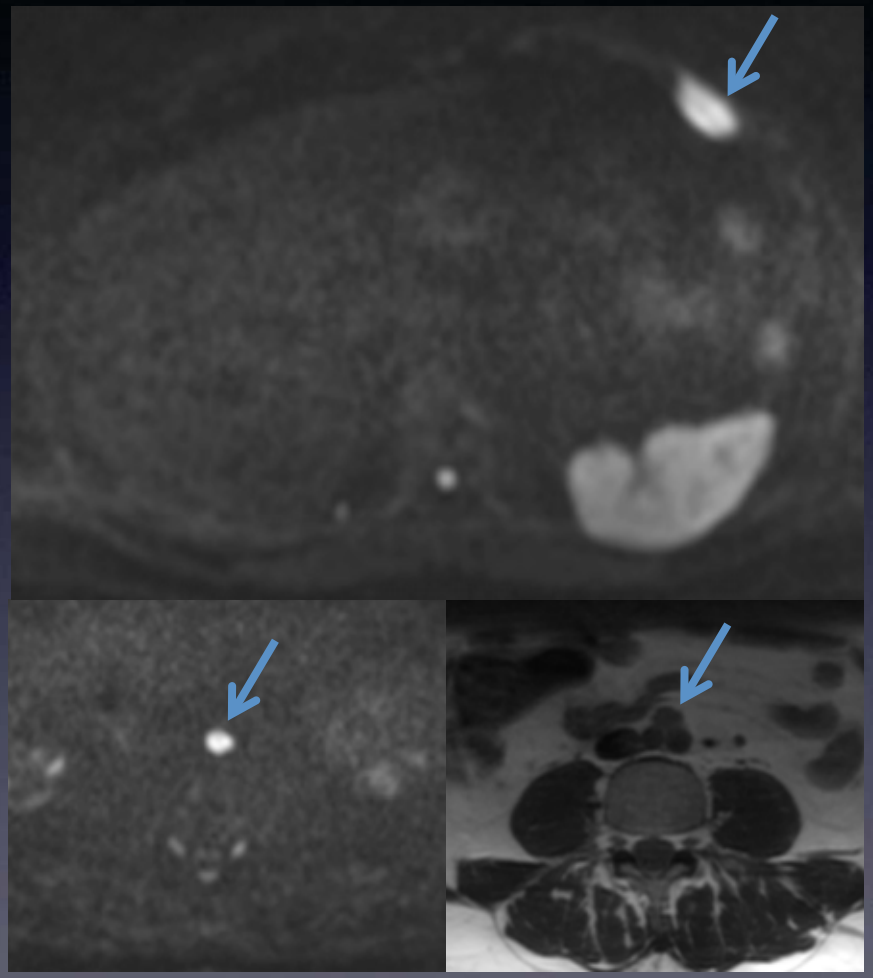






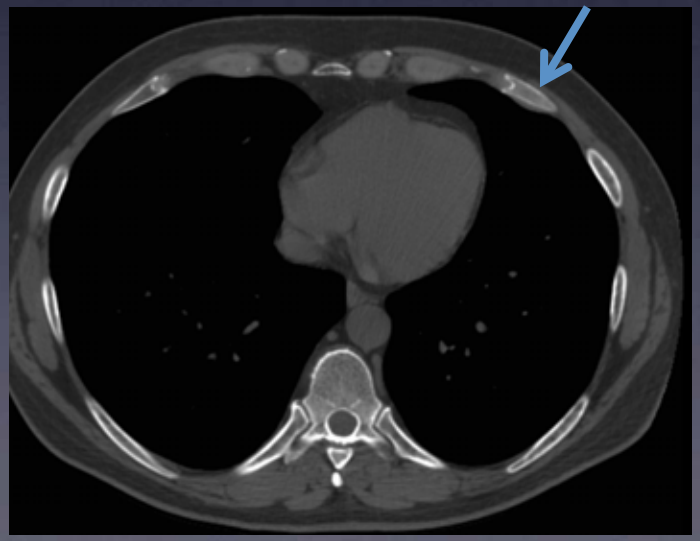
Distant relapse

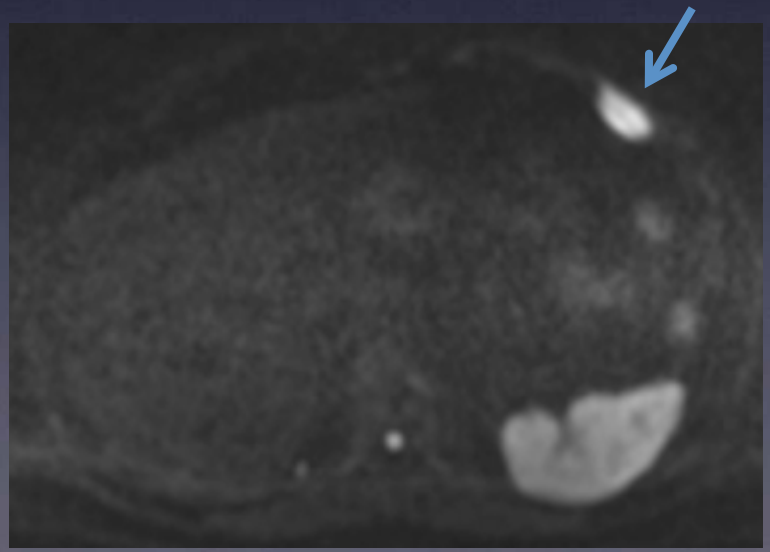
- N+ : common iliac lymph node
- M+: left rib
  - BS was negative
    - Less sensitive than MRI



Distant relapse

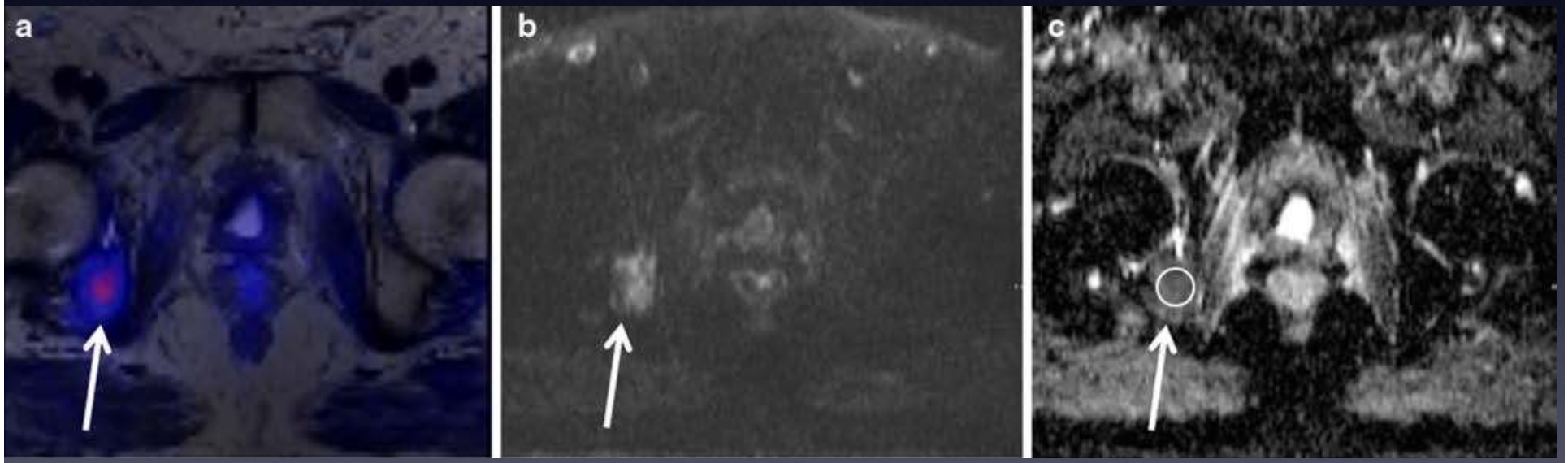
- "all-in-one" MRI (mpMRI+WB-MRI) may contribute to the best treatment selection
  - In this patient, bone & nodal M+ were missed by CT and BS, and only visualised on the "all-in-one" MRI





Future developments: MRI-PET

- With ligands of PSMA, it is surely the most promising technique that could have a major impact on clinical management of PCa patients.



MRI-PET DWI (b=1000) ADC map

Patient with a bone metastasis from prostate cancer in the right ischium

CONCLUSIONS

- Mp-MRI is considered to be the state of the art in detecting and localizing PCa relapse after RP and definitive RT

- WB-MRI (+mpMRI): promising all-in-one exam for local recurrence and distant mets (bone and node)

THANK YOU
Ευχαριστώ

Acknowledgements:
G. Petralia, MD
D.V. Matei, MD