



# MRI Findings of Extraprostatic Extension

## Prostate Intensive MRI Education Day

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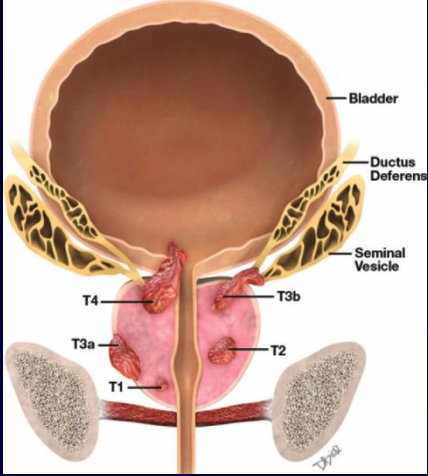
# Disclosure

- None

# Outline

- Importance of extra-prostatic extension
- MRI features of extra-prostatic extension
- MRI features of seminal vesicle invasion

# Staging - TNM



**Organ confined**

**Extra-capsular extension**

## Primary tumor

- TX Primary tumor cannot be assessed
- T0 No evidence of primary tumor
- T1 Clinically inapparent tumor
  - T1a Incidental histologic finding, < or equal to 5% of tissue
  - T1b Incidental histologic finding, > 5% of tissue
  - T1c Tumor identified by needle biopsy after detection of elevated PSA
- T2 Tumor confined within the prostate
  - T2a Tumor involves half of a single lobe or less
  - T2b Tumor involves more than half of one lobe
  - T2c Tumor involves both lobes

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- T3 Tumor extends through the prostatic capsule
  - T3a Tumor extends through capsule
  - T3b Tumor invades seminal vesicle
- T4 Tumor is fixed or invades adjacent structures other than seminal vesicle
  - T4a Tumor invades bladder neck, external sphincter, or rectum
  - T4b Tumor invades levator muscles or is fixed to pelvic wall

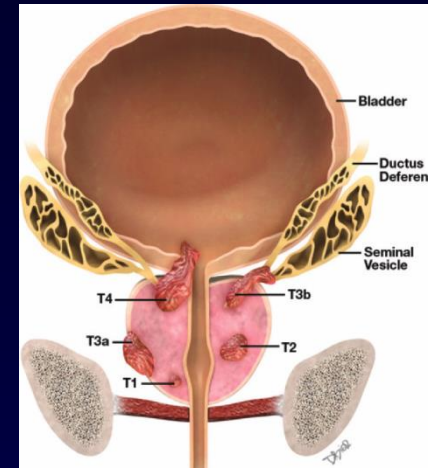
## Regional lymph nodes

- NX Regional lymph nodes cannot be assessed
- N0 No regional lymph node metastases
- N1 Metastases regional lymph node, 1

## Distant metastases

- MX Metastases cannot be assessed
- M0 No distant metastases
- M1 Distant metastases present

# Staging and Treatment



**I/II** (T1/2N0M0)  
organ confined

Prostatectomy, radiotherapy  
focal therapy

**III** (T3N0M0)  
EPE, SVI

Radiotherapy

**IV** (T4 or N1)  
Local invasion or  
lymphadenopathy

Hormone therapy

**IV** (M1)  
distant spread

Hormone therapy

# Extraprostatic Extension

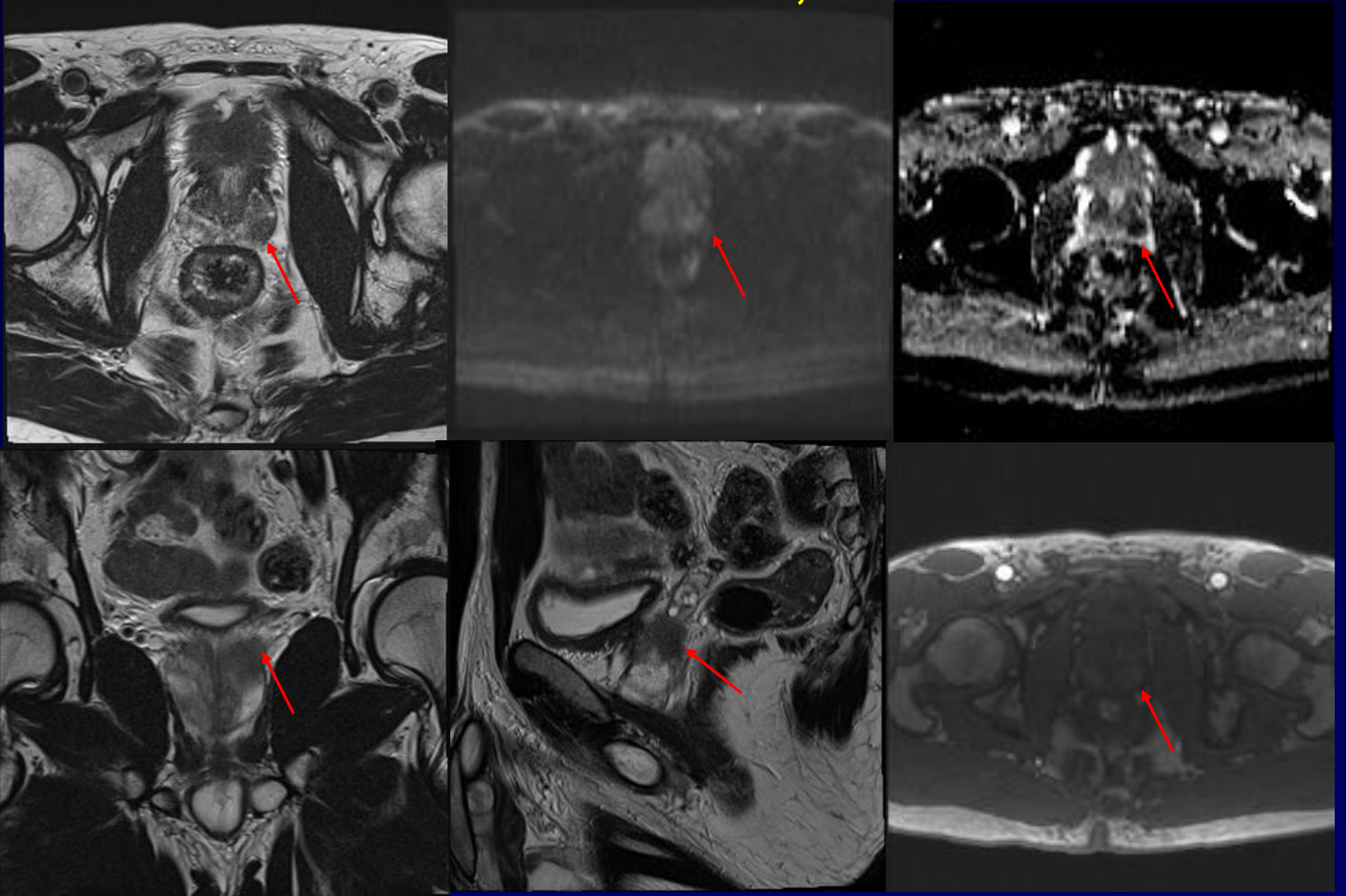
- Clinical T2 disease: 52.4% pT3 at radical prostatectomy
- PSA, DRE, Gleason score, # of +Bx cores
- Predictors of a positive MRI:
  - $3 \geq$  sextants biopsy positive
  - Positive DRE
  - $PSA > 10$

O'Dowd J Urol 1997;158:687-698.

Cornud F et al. Radiology 2002;224(1):203-210.

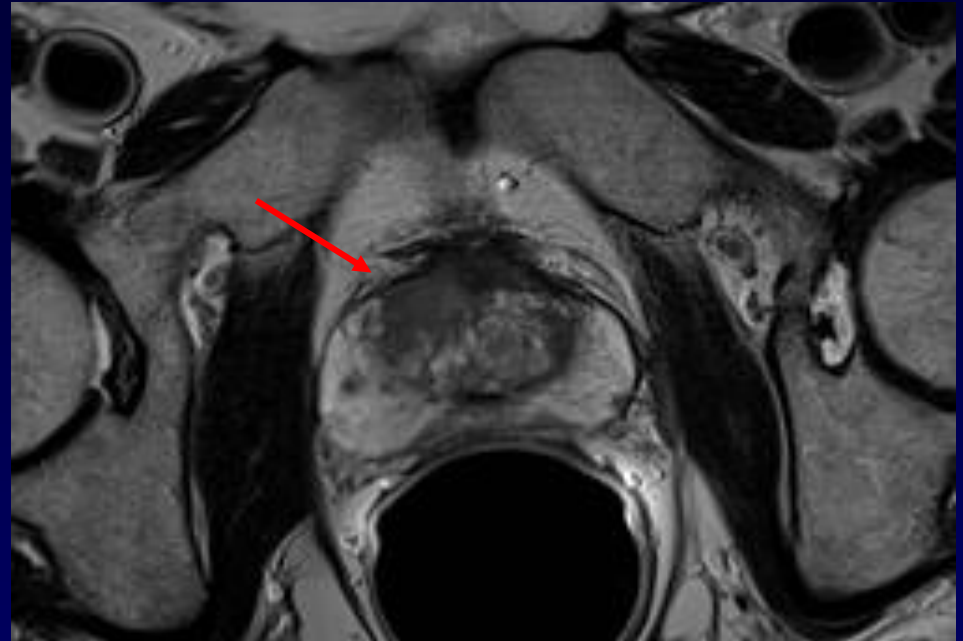


# PIRADS 5 PZ, with EPE



# MRI Extraprostatic Extension

1. Broad tumour contact (>12mm)
2. Smooth capsular bulge
3. Irregular capsular bulge
4. Obliteration of rectoprostatic angle
5. Asymmetry or invasion of neurovascular bundle



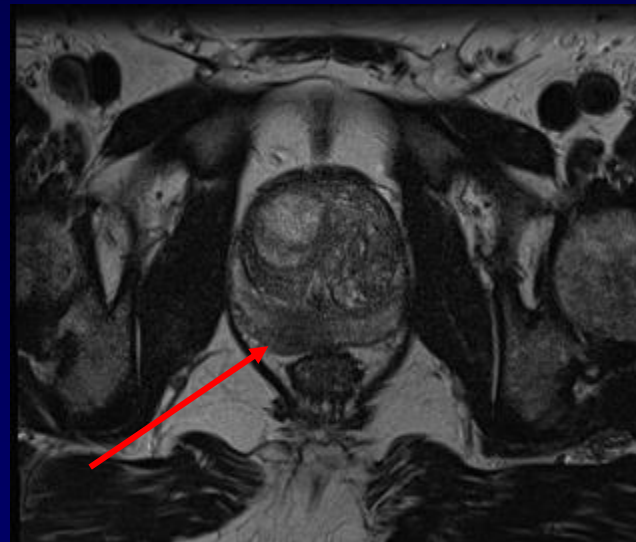
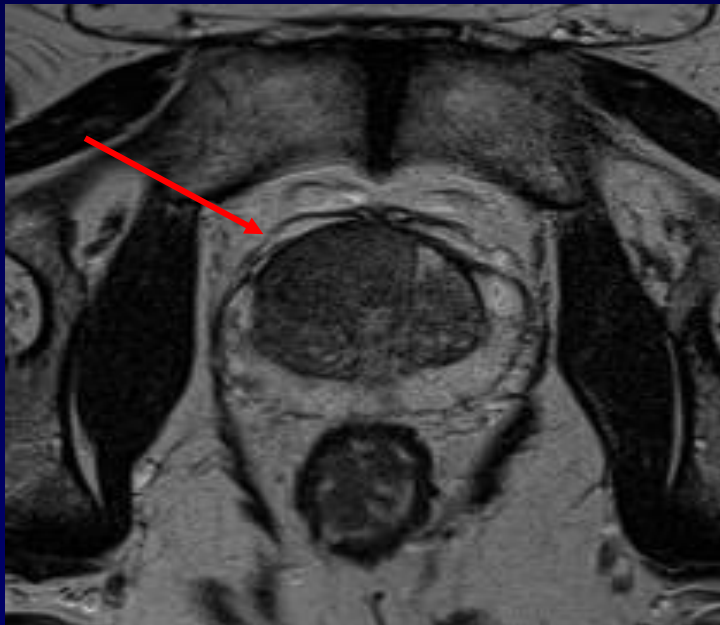
Sensitivity 55%, Specificity 44%

Quinn SF et al. Radiology 1994;190:323-327.  
Outwater EK et al. Radiology 1994;193:333-339.



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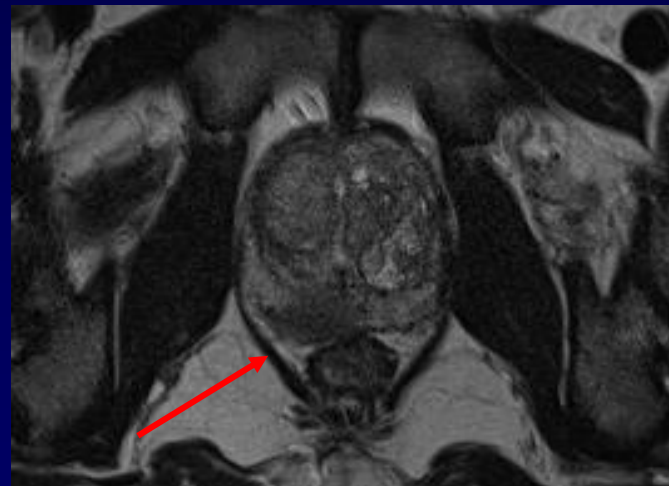


PPV 25%

Schieber ML et al. Radiology 1993;189:339-352.  
Harris RD et al. RadioGraphics 1995;15:813-829.

# MRI Extraprostatic Extension

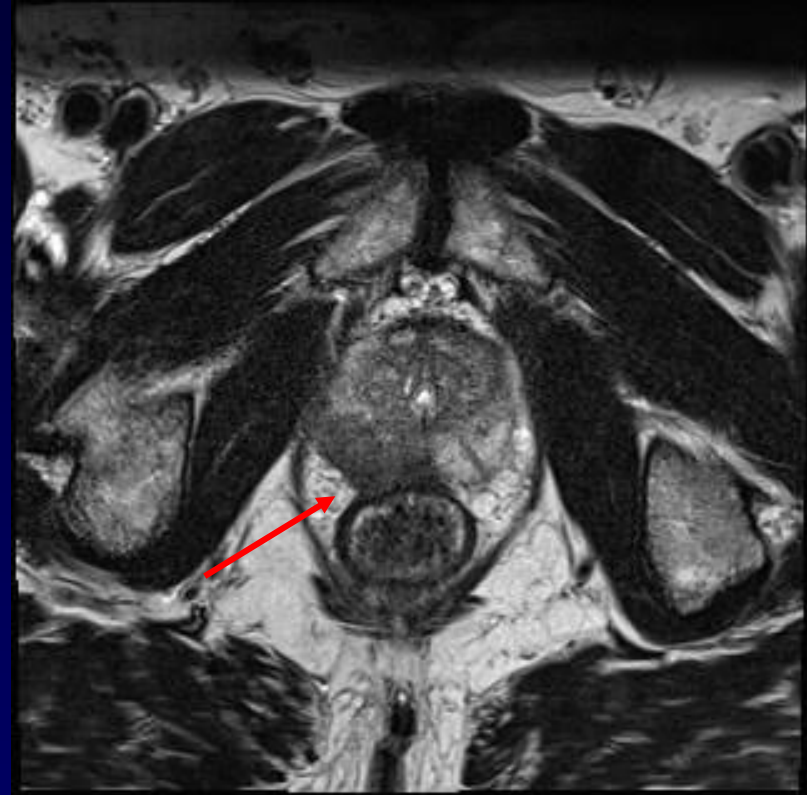
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Schieber ML et al. Radiology 1993;189:339-352  
Chelsky MJ et al. J Urol 1993;150:391-395.

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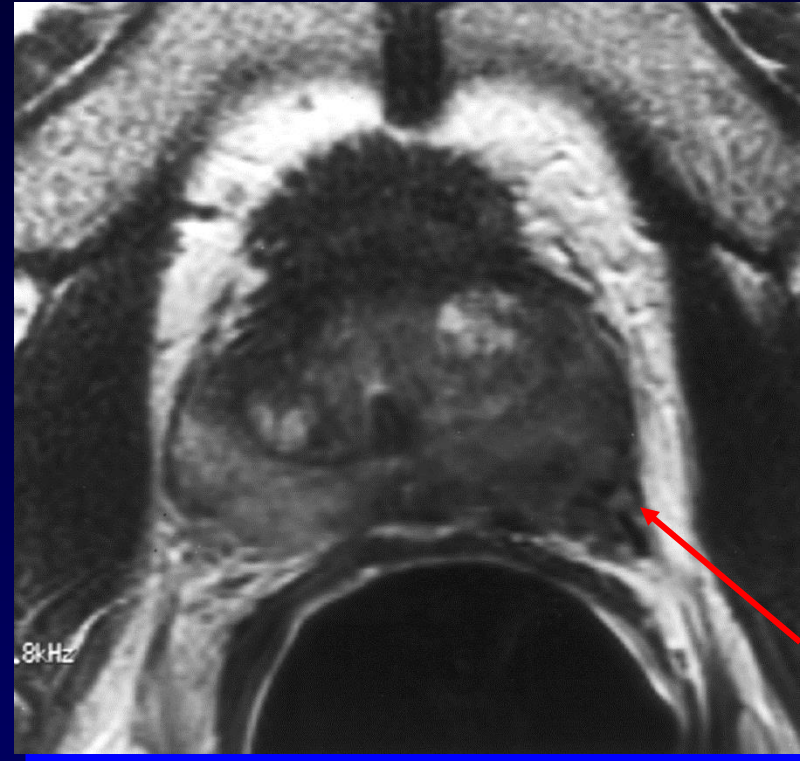
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Tempany C et al. Radiology 1991;181:107-112.  
Bezzi M et al. Radiology 1988;169:339-346.

# MRI Extraprostatic Extension

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Tempany C et al. Radiology 1991;181:107-112.



# MRI Extraprostatic Extension

Kyle K. Yu, MD • Hedvig Hricak, MD, PhD • Ravi Alagappan, MD  
Daniel M. Chernoff, MD, PhD • Peter Bacchetti, PhD • Charles J. Zaloudek, MD

## **Detection of Extracapsular Extension of Prostate Carcinoma with Endorectal and Phased-Array Coil MR Imaging: Multivariate Feature Analysis<sup>1</sup>**

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# MRI Extraprostatic Extension

Table 2  
Descriptive Statistical Features for Each Reader

Test Statistic	Reader		
	1	2	3
Sensitivity	28/34 (82)*	16/34 (47)	20/34 (59)
Specificity	31/43 (72)	32/43 (74)	29/43 (67)
PPV	28/40 (70)	16/27 (59)	20/34 (59)
NPV	31/37 (84)	32/50 (64)	29/43 (67)
Accuracy	59/77 (77)†	48/77 (62)	49/77 (64)

Note.—NPV = negative predictive value, PPV = positive predictive value. Numbers in parentheses are percentages.

\*  $P < .05$  for comparison of reader 1 with readers 2 and 3.

†  $P = .06$  for comparison of reader 1 with readers 2 and 3.

Sensitivity: 80-88%; 23-90%

Specificity: 96-100%; 30-95%

Yu, KK et al. Radiology 1997;202:697

Futterer JJ et al. Radiology 2006;238:184

Hricak H et al. Radiology 2007;243(1):28

Hedge JV et al. Int J Radiat Oncol Biol Phys 2013;85(2):e101

Brajtford JS et al. BJU Int 2001;107(9):1419

Engelbrecht, M et al Eur Radiol 2002;12:2294

# mpMRI Extraprostatic Extension

- ESUR PIRADS
- Sensitivity of 77%, Specificity 64%
- NPV 77%, PPV 64%

	AUC
T2	0.72
DWI	0.67
DCE	0.64
Sum of PIRADS	0.74

# Added value of DWI for ECE

- T2 scores and ADCs were independently associated with ECE.
- ADC had incremental value in patients without a high suspicion of ECE on T2
- Whole lesion ADC histogram analysis

# Objective Assessment for ECE

- Length of capsular contact
- Size of lesion (18.8 vs 13.3 mm)
- Whole lesion ADC histogram/texture analysis
  - Kurtosis (histogram flatness)
  - Skewness (histogram asymmetry)
  - Entropy (histogram irregularity)

Krishna S et al. JMRI 2017;202:697-702.

Rosenkrantz AB et al. J Magn Reson Imaging 2016;43(4):990-997

# MRI Extra-prostatic Extension

- Meta-analysis 2000-2014
- 75 studies, 9796 pts

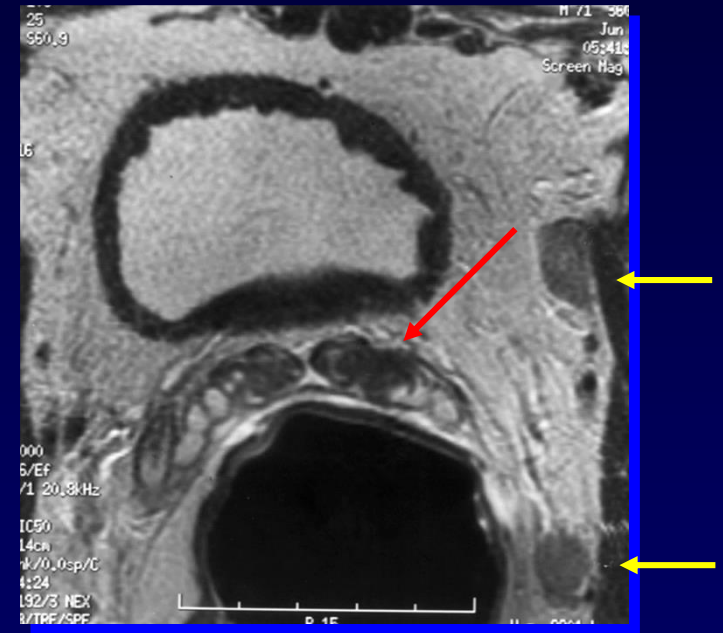
	Sensitivity	Specificity
ECE	0.57	0.91
SVI	0.58	0.96
Overall T3 detection	0.61	0.88

- Addition of functional imaging and 3T improved sensitivity
- No additional benefit with endorectal coil



# MRI Seminal Vesicle Invasion

- Disruption or loss of normal architecture of the SV
- Focal or diffuse low T2 SI
- Asymmetric thickening or irregularity of the SV wall
- Direct tumour extension into or around SV
- Obliteration of vesicoprostatic angle
- Restricted diffusion
- Focal enhancement



Hricak H et al. Radiology 1994;193(3):703-709.  
Sala E et al. Radiology 2006;238(3):929-937.

# mpMRI Seminal Vesicle Invasion

**Per-Patient Diagnostic Performance Indexes for Detecting SVI on Endorectal Multiparametric MR Images**

Parameter	T2-weighted MR Imaging	Incremental Difference (%)	T2-weighted and DW MR Imaging	Incremental Difference (%)	T2-weighted, DW, and DCE MR Imaging
<b>Sensitivity</b>					
Radiologist A	65 (15/23) [45.5, 84.6]	0.0, 28.6	78 (18/23) [60.0, 94.4]	0.0, 0.0	78 (18/23) [60.0, 94.4]
Radiologist B	56.5 (13/23) [35.3, 76.9]	-15.0, 23.8	61 (14/23) [40.0, 80.8]	-12.0, 12.5	61 (14/23) [40.0, 80.0]
<b>Specificity</b>					
Radiologist A	90.7 (98/108) [84.8, 96.0]	0.9, 10.8	96.3 (104/108) [92.3, 99.1]	-2.8, 2.8	96.3 (104/108) [92.4, 99.1]
Radiologist B	88.9 (96/108) [82.7, 94.3]	2.8, 14.2	97.2 (105/108) [93.6, 100.0]	0.0, 2.9	98.2 (106/108) [95.2, 100.0]
<b>Positive predictive value</b>					
Radiologist A	60 [15/25] [40.0, 79.3]	5.6, 39.5	82 (18/22) [64.0, 95.8]	-10.7, 11.5	82 (18/22) [64.7, 95.8]
Radiologist B	52 (13/25) [32.0, 71.4]	11.2, 51.1	82 (14/17) [61.5, 100.0]	-1.9, 18.2	88 (14/16) [68.8, 100.0]
<b>Negative predictive value</b>					
Radiologist A	92.5 (98/106) [87.4, 97.1]	0.3, 6.3	95.4 (104/109) [91.2, 99.1]	-0.1, 0.1	95.4 (104/109) [91.2, 99.1]
Radiologist B	90.6 (96/106) [84.8, 95.4]	-2.1, 5.4	92.1 (105/114) [87.0, 96.5]	-2.3, 2.5	92.2 (106/115) [87.1, 96.6]

Note.—Data are performance indexes as percentages, with numbers of SVs in parentheses and 95% confidence intervals as percentages in brackets.

- Addition of DWI or DCE did not improve sensitivity
- Addition of DWI improves specificity
- DCE did not provide additional incremental value

# Scoring of Extraprostatic Extension

Criteria	Findings	Score
Extra-capsular extension	Abutment	1
	Irregularity	3
	Neurovascular bundle thickening	4
	Bulge, loss of capsule	4
	Measurable extra-capsular disease	5
Seminal vesicles	Expansion	1
	Low T2 signal	2
	Filling in of angle	3
	Enhancement and impeded diffusion	4

# Scoring of Extraprostatic Extension

Criteria	Findings	Score
Distal sphincter	Adjacent tumour	3
	Effacement of low signal sphincter	3
	Abnormal enhancement extending into sphincter	4
Bladder neck	Adjacent tumour	2
	Loss of low T2 signal in bladder muscle	3
	Abnormal enhancement extending into bladder neck	4

# Conclusion

- Detection for the presence or absence of extra-prostatic extension is important for management
- Overall moderate accuracy with mpMRI
  - Low sensitivity with improvements with functional imaging
  - High specificity
- Important to mention location-encroaching: NVB, distal sphincter, bladder neck



# Thank you

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<https://survey.ubc.ca/s/challenges-mri-prostate>