6th Knowledge Series For Genitourinary Cancers Best of 2024

MRI vs PSMA-PET for Prediction of EPE in Prostate Cancer : A Prospective Nonrandomized Trial

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JU Insight

Comparing Magnetic Resonance Imaging and Prostate-Specific Membrane Antigen–Positron Emission Tomography for Prediction of Extraprostatic Extension of Prostate Cancer and Surgical Guidance: A Prospective Nonrandomized Clinical Trial

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Background & Rationale

- MRI has limited sensitivity (~60%) in predicting extraprostatic extension (EPE).
- EPE prediction is crucial for nerve-sparing radical prostatectomy.
- PSMA-PET offers high sensitivity using molecular imaging.

MRI EPE Prediction: LCC Thresholds and Scoring Systems

Scoring System / Study	LCC Threshold	Sensitivity / Specificity	Notes
Mehralivand et al. (2019)	≥10 mm	Moderate / High	Used in PI-RADS v2.1; common clinical threshold
Grivas et al. (2021)	≥11 mm	High PPV for pT3	Misses minimal LCC; good for macroscopic EPE
Rosenkrantz score	≥12 mm	High specificity	Combined with capsular bulge, irregularity
General Practice	≥6–10 mm	Higher sensitivity, lower specificity	Used with other qualitative features

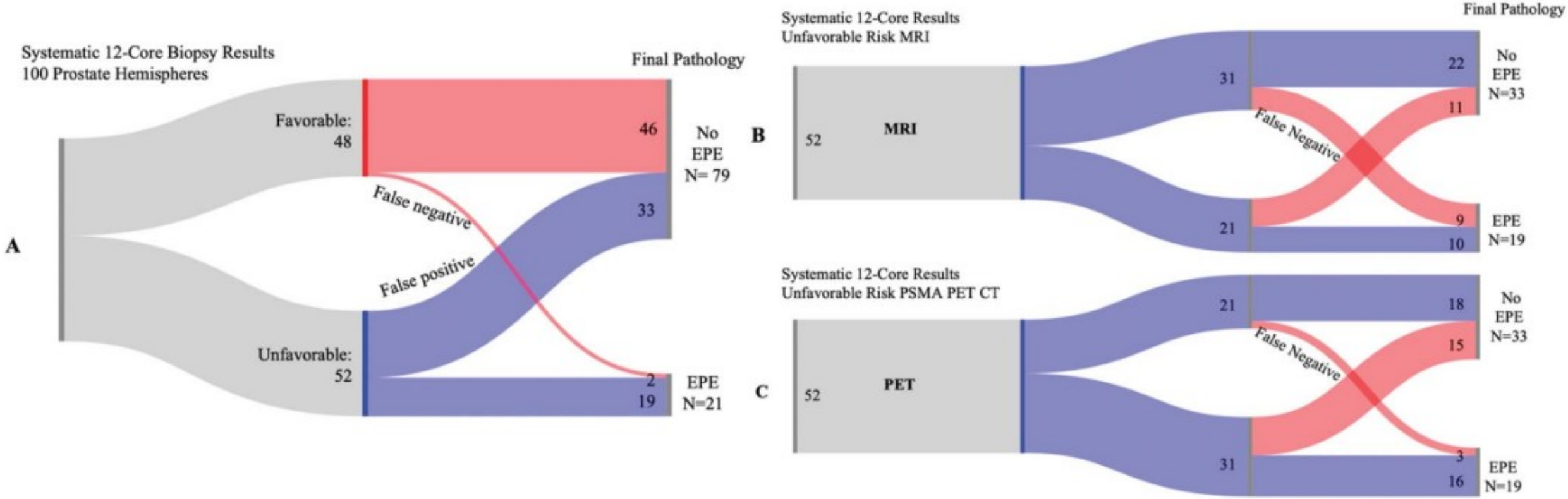
Other qualitative signs : Capsular bulge, irregularity, or neurovascular bundle asymmetry add to the assessment.

Mehralivand S, Shih JH, Harmon S, Smith C, Bloom J, Czarniecki M, Gold S, Hale G, Rayn K, Merino MJ, Wood BJ. A grading system for the assessment of risk of extraprostatic extension of prostate cancer at multiparametric MRI. Radiology. 2019 Mar;290(3):709-19.

Study Design

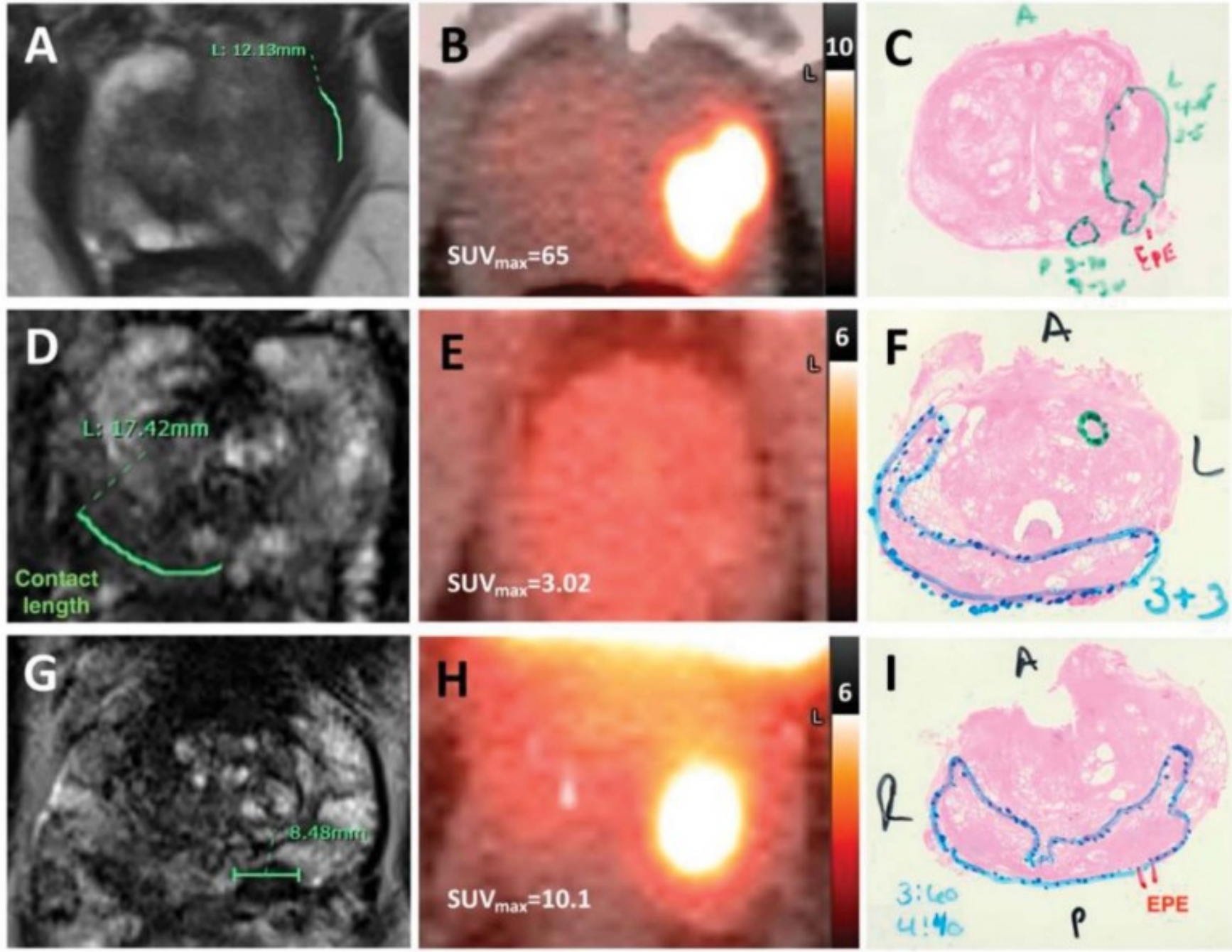
- Prospective nonrandomized trial at Indiana University.
- 50 patients with intermediate- or high-risk prostate cancer.
- Patients underwent both mpMRI and 68Ga-PSMA-11 PET-CT.
- Final whole-mount pathology used as gold standard.

Hypothesis: PSMA-PET is superior to mpMRI in detecting EPE.


A
Systematic 12-Core Biopsy Results
100 Prostate Hemispheres
Final Pathology
Favorable:
48
Unfavorable:
52
46
33
2
19
False negative
False positive
No
EPE
N= 79
EPE
N=21
B
Systematic 12-Core Results
Unfavorable Risk MRI
Final Pathology
52
MRI
31
21
22
11
9
10
False Negative
No
EPE
N=33
EPE
N=19
C
Systematic 12-Core Results
Unfavorable Risk PSMA PET CT
52
PET
21
31
18
15
3
16
False Negative
No
EPE
N=33
EPE
N=19

Imaging & Analysis

- mpMRI interpreted using PIRADS and EPE risk factors.
- PSMA-PET positive for EPE if capsule contact length >5mm.
- 4 key EPE zones: bladder neck, bilateral NVB, anterior apex.
- Radiologists blinded to clinical data and other modality.


A
L: 12.13mm
B
10
L
SUVmax=65
C
A
L
EPE
D
L: 17.42mm
Contact
length
E
6
L
SUVmax=3.02
F
A
L
3+3
G
8.48mm
H
6
L
SUVmax=10.1
I
A
R
3:60
4:40
EPE
P

Primary & Secondary Outcomes

- Primary: Sensitivity and specificity for EPE prediction at NVBs.
- Secondary: Accuracy for SVI and lymph node involvement.
- Surgeon questionnaire responses before and after PSMA-PET.

Results

Table 2. *Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value of MRI and ^{68}Ga–Prostate-Specific Membrane Antigen–11 Positron Emission Tomography CT in Preoperative Disease Staging*

Outcome	Imaging modality	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	AUC (95% CI)
EPE at neurovascular bundle region, left and right (N = 100)	MRI	0.57 (0.36-0.78)	0.77 (0.68-0.86)	0.40 (0.22-0.58)	0.87 (0.79-0.95)	0.67 (0.55-0.79)
	PET	0.86 (0.71-1.00)	0.73 (0.64-0.83)	0.46 (0.31-0.62)	0.95 (0.90-1.00)	0.80 (0.70-0.89)
Difference (95% CI)		−0.29 (−0.54 to −0.03)	0.04 (−0.10 to 0.17)			−0.12 (−0.26 to 0.01)
P value[a]		**.03**	.49			.07
Seminal vesicle invasion	MRI	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
	PET	0.50 (0.19-0.81)	0.93 (0.84-1.00)	0.63 (0.29-0.96)	0.88 (0.78-0.98)	0.71 (0.54-0.88)
Difference (95% CI)		0.50 (0.19-0.81)	0.07 (−0.01 to 0.16)			0.29 (0.12-0.46)
P value[a]		**.03**	.25			**< .01**
Lymph node involvement	MRI	0.00 (0.00-0.00)	0.98 (0.93-1.00)	0.00 (0.00-0.00)	0.82 (0.71-0.92)	0.51 (0.49-0.54)
	PET	0.44 (0.12-0.77)	0.98 (0.93-1.00)	0.80 (0.45-1.00)	0.89 (0.80-0.98)	0.71 (0.54-0.88)
Difference (95% CI)		−0.44 (−0.77to −0.12)	0.00 (−0.07 to 0.07)			−0.20 (−0.37 to −0.02)
P value[a]		**.05**	1.00			**.03**

Results – Imaging Accuracy

EPE

- Sensitivity: PSMA-PET 86% vs mpMRI 57% (p=0.03).
- Specificity: PSMA-PET 73% vs mpMRI 77% (NS).
- AUC: 0.80 (PSMA-PET) vs 0.67 (mpMRI).
- NPV: 95% (PET) vs 87% (MRI); PPV: 46% (PET) vs 40% (MRI).

Impact on Surgical Planning

- Correct nerve-sparing plan: 77% (with PET) vs 65% (MRI only).
- In 27 discordant cases,
    - PET led to correct plan in 20 vs 7 for MRI.
    - 40% underwent surgery with altered plan based on PET.
- Positive margins not increased despite increased nerve-sparing.

Subgroup & Additional Findings

- PSMA-PET useful in unfavorable intermediate/high-risk disease.
- MRI superior for detecting SVI (100% vs 50% sensitivity).
- PSMA-PET detected lymph node metastasis in 44% (MRI = 0%).
- PET SUV correlated with higher Gleason scores.

Limitations

- Single-center study with expert radiologists.
- Small sample size (n=50).
- PET and MRI reader variability not tested.
- Standardization needed across institutions and imaging platforms.

Study Conclusion

- PSMA-PET improves sensitivity for EPE prediction.
- Enables more accurate nerve-sparing decisions.
- Especially valuable in higher-risk prostate cancer.
- Further multicenter validation warranted.

Critical analysis

- Power justification : designed to estimate sensitivity (expected 90%) and specificity (expected 75%) of PSMA Pet

    - Calculations assumed **prevalence of EPE = 35%**, with **confidence interval width ≤0.23 (sensitivity)** and **≤0.25 (specificity)**.

    - **Planned N=80**, but only 50 patients enrolled → **underpowered**, particularly for subgroup or side-specific analyses.

- **Surgeon decisions were influenced in real-time**, not blinded → potential **confirmation bias**.

Critical analysis

Strength :

- **NPV CIs**
  - PSMA-PET NPV: **0.95 (0.90–1.00)**
    → **Tight and high** → reliable for **ruling out EPE** (very useful clinically).

- In 27 discordant cases:
  - PSMA-PET led to correct decisions in 20 cases vs 7 for MRI (**P < .01**).
  - Shifted 22 patients from nonnerve-sparing to nerve-sparing without increasing margin rates.
  - This is a **strong practical finding** with direct surgical implications

Context from Existing Literature

Meta-Analysis > Eur Urol. 2016 Aug;70(2):233-45. doi: 10.1016/j.eururo.2015.07.029.
Epub 2015 Jul 26.

Accuracy of Magnetic Resonance Imaging for Local Staging of Prostate Cancer: A Diagnostic Meta-analysis

Maarten de Rooij [1], Esther H J Hamoen [2], J Alfred Witjes [2], Jelle O Barentsz [2], Maroeska M Rovers

MRI sensitivity for EPE ~57%, specificity ~91% (meta-analysis of 75 studies).

SYSTEMATIC REVIEW article

Front. Oncol., 01 November 2024

Sec. Cancer Imaging and Image-directed Interventions

Volume 14 - 2024 | https://doi.org/10.3389/fonc.2024.1410229

Comparison of ^{68}Ga-PSMA PET and mpMRI for prostate cancer local staging: a comprehensive review and direct meta-analysis

Xinyu Jin[1] Yijie Cai[2] Xiaolu Ren[3*]

Comparable diagnostic performance in detecting ECE and SVI

PROSTAGE Trial

Eur J Nucl Med Mol Imaging. 2025 Mar 31. doi: 10.1007/s00259-025-07208-z.
Online ahead of print.

Prospective comparison of ^{18}F-PSMA-1007 PET/CT and MRI with histopathology as the reference standard for intraprostatic tumour detection and T-staging of high-risk prostate cancer

Aino Kivikallio [1 2], Simona Malaspina [2 3], Irena Saarinen [1 2], Marko Seppänen [2 3], Mikael Anttinen [2 4], Ivan Jambor [5 6], Janne Verho [2 5], Jukka Kemppainen [2 3], Hannu J Aronen [2 5], Peter J Boström [2 4], Otto Ettala [# 2 4], Pekka Taimen [# 7 8]

Lesion Detection Rates:
- **PSMA PET/CT**: 84.6% and 82.1% (two independent readers)
- **MRI**: 74.4% and 46.2%

AUC for EPE Detection:
- **PSMA PET/CT**: 0.500–0.591
- **MRI**: 0.648–0.682

PSMA PET/CT demonstrated high sensitivity in localizing intraprostatic lesions, it appeared inferior to WBMRI in detecting EPE

Comparison with Existing Literature

Study	Modality Compared	EPE Detection Sensitivity	Key Takeaway
Bahler et al. (2024)	PSMA PET/CT vs. mpMRI	86% vs. 57%	PSMA PET/CT improved EPE detection and surgical planning.
Kivikallio et al. (2025)	PSMA PET/CT vs. WBMRI	Lower than MRI	MRI outperformed PSMA PET/CT in EPE detection.
Hui et al. (2023)	PSMA PET/CT vs. mpMRI	Higher accuracy in T-staging	PSMA PET/CT showed greater accuracy in detecting EPE.

Take-Home Message

- PSMA-PET consistently shows higher sensitivity than MRI for EPE detection.
- High negative predictive value of PSMA-PET (>90%) supports nerve-sparing when negative.
- Combined MRI + PSMA-PET may improve surgical precision and reduce positive margins.
- Best utility in unfavorable intermediate- or high-risk prostate cancer cases.

Thankyou