

ASSESSING THE DIAGNOSTIC PERFORMANCE OF POSITRON EMISSION TOMOGRAPHY/MAGNETIC RESONANCE IMAGING (PET/MRI) IN PROSTATE CANCER: A SYSTEMATIC REVIEW

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ABSTRACT

Background: Prostate cancer is a leading cause of cancer-related morbidity and mortality worldwide. Accurate imaging is essential for diagnosis, staging, and treatment planning. Positron emission tomography/magnetic resonance imaging (PET/MRI) has emerged as a promising hybrid imaging modality combining functional and anatomical information.

Objective: To systematically evaluate the diagnostic performance of PET/MRI in prostate cancer detection, staging, and recurrence assessment.

Methods: A systematic review was conducted following PRISMA 2020 guidelines. Electronic databases including PubMed, Scopus, Web of Science, Embase, and Google Scholar were searched up to December 2025. Studies assessing PET/MRI in prostate cancer were included. Data on sensitivity, specificity, accuracy, and detection rates were extracted and analyzed using a narrative synthesis approach.

Results: Ten studies met the inclusion criteria. PET/MRI demonstrated superior or complementary diagnostic performance compared to mpMRI and PET/CT. Sensitivity for clinically significant prostate cancer reached up to 97% in combined imaging approaches. PET/MRI improved lesion detection, staging accuracy, and negative predictive value, particularly in high-risk and recurrent disease. However, specificity varied across studies, and performance was limited in detecting low-grade tumors.

Conclusion: PET/MRI offers significant advantages in prostate cancer imaging, particularly when using PSMA-based tracers. It enhances diagnostic accuracy and clinical decision-making, although further standardization and large-scale studies are needed to establish its role in routine practice.

KEYWORDS: Prostate cancer; PET/MRI; PSMA; multiparametric MRI; diagnostic accuracy; imaging; staging; recurrence

INTRODUCTION

Prostate cancer is one of the most frequently diagnosed malignancies among men worldwide and remains a leading cause of cancer-related morbidity and mortality. Its incidence increases markedly with age, making it a significant public health concern, particularly in aging populations. The clinical spectrum of prostate cancer ranges from indolent, slow-growing tumors to highly aggressive disease requiring prompt intervention. Early detection and accurate characterization of tumor aggressiveness are therefore essential to guide appropriate clinical management and improve patient outcomes (Mazzone et al., 2025).

The diagnostic pathway for prostate cancer has evolved considerably over the past decades, with increasing reliance on advanced imaging techniques to complement clinical and biochemical assessment. Traditionally, prostate-specific antigen (PSA) testing and digital rectal examination have been used for initial screening, followed by biopsy for definitive diagnosis. However, these approaches have limitations, including overdiagnosis and the detection of clinically insignificant disease, highlighting the need for more precise imaging strategies that can better differentiate between significant and indolent tumors (Kasivisvanathan et al., 2018).

Multiparametric magnetic resonance imaging (mpMRI) has emerged as a cornerstone in the evaluation of prostate cancer due to its superior soft tissue contrast and ability to provide both anatomical and functional information. MpMRI incorporates sequences such as T2-weighted imaging, diffusion-weighted imaging, and dynamic contrast-enhanced imaging, enabling improved lesion detection and risk stratification. Despite these advantages, mpMRI is not without limitations, including variability in interpretation, moderate specificity, and reduced sensitivity in certain clinical scenarios such as small or low-grade lesions (Westphalen et al., 2020).

In recent years, molecular imaging techniques have gained increasing attention in prostate cancer diagnostics, particularly positron emission tomography (PET) using prostate-specific membrane antigen (PSMA)-targeted radiotracers. PSMA is highly expressed in prostate cancer cells, especially in higher-grade tumors, making it an ideal target for imaging. PSMA PET imaging has demonstrated high sensitivity and specificity in detecting both primary and recurrent disease, as well as metastatic spread, thereby improving staging accuracy and clinical decision-making (Zhang & Ma, 2024).

The integration of PET with magnetic resonance imaging in the form of PET/MRI represents a significant advancement in hybrid imaging technology. PET/MRI combines the metabolic and molecular information provided by PET with the excellent anatomical resolution and soft tissue contrast of MRI. This combination allows for simultaneous acquisition of functional and structural data, potentially improving lesion localization, tumor characterization, and overall diagnostic performance compared to standalone imaging modalities (Lindenberg et al., 2016).

Several systematic reviews and meta-analyses have suggested that PET/MRI may offer superior diagnostic accuracy compared to mpMRI alone in the detection of primary prostate cancer. For instance, pooled analyses have demonstrated improved sensitivity and overall diagnostic performance when PET data are combined with MRI findings, particularly when PSMA-targeted tracers are used. These findings highlight the potential of PET/MRI to enhance the detection of clinically significant disease while reducing unnecessary biopsies (Li et al., 2019; Evangelista et al., 2021).

Moreover, PET/MRI has shown promise in specific clinical scenarios such as biochemical recurrence, where early and accurate localization of recurrent disease is critical for guiding salvage therapy. Compared to conventional imaging modalities such as CT and bone scintigraphy, PET-based techniques—especially when integrated with MRI—provide superior detection of small-volume disease and improved characterization of local versus distant recurrence. This capability is particularly important in tailoring individualized treatment strategies (Torri et al., 2024).

Despite these promising findings, the clinical utility of PET/MRI in prostate cancer remains an area of ongoing investigation. Variability in study designs, patient populations, imaging protocols, and interpretation criteria has resulted in heterogeneous findings across the literature. Therefore, a comprehensive evaluation of the available evidence is necessary to better understand the diagnostic performance, strengths, and limitations of PET/MRI in prostate cancer. Accordingly, this systematic review aims to assess the effectiveness of PET/MRI in lesion detection, staging, and overall diagnostic accuracy in patients with prostate cancer (Mazzone et al., 2025; Evangelista et al., 2021).

METHODOLOGY

Study Design

This study employed a systematic review methodology following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure methodological rigor, transparency, and reproducibility. The primary objective of this review was to systematically evaluate and synthesize the available evidence regarding the diagnostic performance of positron emission tomography/magnetic resonance imaging (PET/MRI) in prostate cancer. The review focused on assessing the effectiveness of PET/MRI in lesion detection, local staging, identification of clinically significant prostate cancer, and detection of recurrence.

The review included peer-reviewed studies investigating PET/MRI either as a standalone imaging modality or in comparison with other established imaging techniques such as multiparametric magnetic resonance imaging (mpMRI), positron emission tomography/computed tomography (PET/CT), or PET alone. Both prospective and retrospective studies were considered to capture a comprehensive range of clinical evidence across different patient populations and clinical settings.

Eligibility Criteria

Studies were selected according to predefined inclusion and exclusion criteria:

Inclusion Criteria:

- **Population:** Adult male patients with suspected, newly diagnosed, or recurrent prostate cancer.
- **Interventions/Exposures:** Imaging with PET/MRI, including PSMA-based PET/MRI or choline PET/MRI.
- **Comparators:** mpMRI, PET/CT, PET alone, or combined imaging approaches (e.g., PET + MRI).
- **Outcomes:** Diagnostic performance measures including sensitivity, specificity, accuracy, detection rate, negative predictive value (NPV), positive predictive value (PPV), and area under the curve (AUC).
- **Study Designs:** Prospective studies, retrospective studies, comparative diagnostic studies, and randomized controlled trials.
- **Language:** English-language publications only.

- **Publication Period:** Studies published between 2010 and 2025 to reflect modern imaging techniques and PSMA-based advancements.

Exclusion Criteria:

- Non-empirical publications (e.g., reviews, editorials, commentaries).
- Studies not involving PET/MRI or lacking relevant diagnostic performance data.
- Animal studies or preclinical research.
- Conference abstracts without full-text availability.
- Duplicate studies or overlapping datasets.

A total of **10 studies** met all inclusion criteria and were included in the final analysis.

Search Strategy

A comprehensive literature search was conducted across multiple electronic databases, including **PubMed, Scopus, Web of Science, Embase, and Google Scholar**, covering publications from database inception to December 2025. The search strategy was developed using Boolean operators and combinations of relevant keywords and Medical Subject Headings (MeSH) terms.

The primary search terms included:

- (“prostate cancer” OR “prostatic neoplasms”)
- AND (“PET/MRI” OR “positron emission tomography magnetic resonance imaging”)
- AND (“PSMA” OR “prostate-specific membrane antigen” OR “choline PET”)
- AND (“diagnostic performance” OR “sensitivity” OR “specificity” OR “accuracy” OR “detection rate”)

Additional manual searches of reference lists from relevant systematic reviews and included articles were performed to ensure completeness. Duplicate records were identified and removed prior to screening.

Study Selection Process

The study selection process was conducted independently by two reviewers. All retrieved records were imported into a reference management software (e.g., Zotero or EndNote) for organization and de-duplication. Initial screening was performed based on titles and abstracts to identify potentially relevant studies. Full-text articles were then assessed for eligibility based on the predefined inclusion and exclusion criteria.

Discrepancies between reviewers were resolved through discussion and consensus. In cases where disagreement persisted, a third reviewer was consulted to make the final decision. The study selection process followed the PRISMA framework, including identification, screening, eligibility, and inclusion stages, and is summarized in a PRISMA flow diagram.

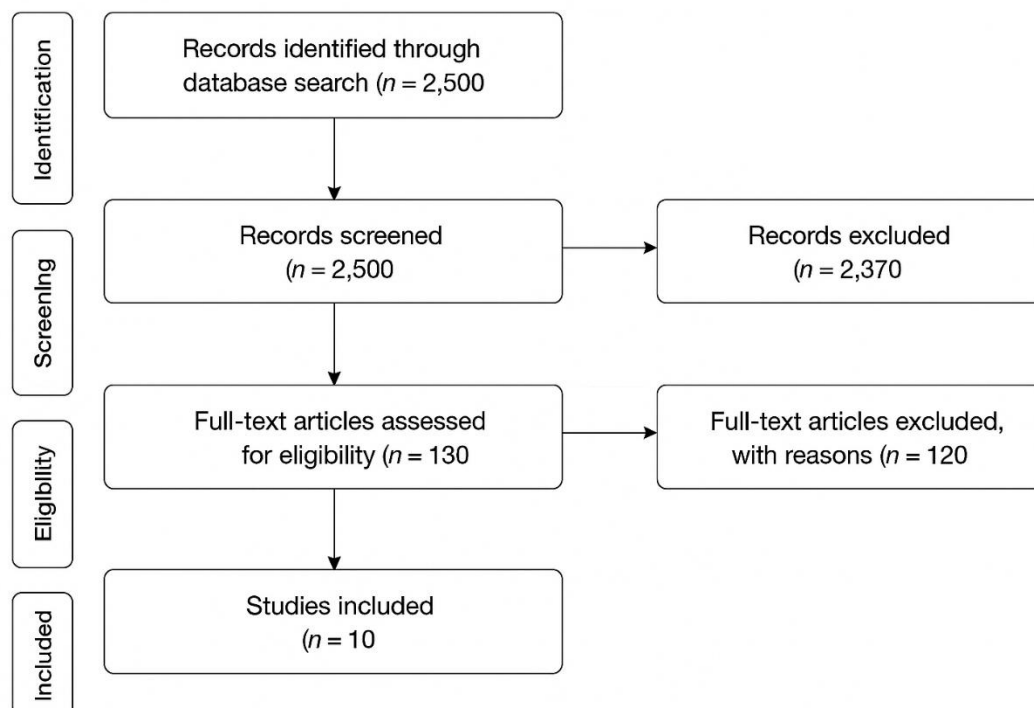


Figure 1 PRISMA Flow Diagram

Data Extraction

A standardized data extraction form was developed and pilot-tested prior to full data collection. The following information was extracted from each included study:

- Author(s), publication year, and journal.
- Study design and clinical setting (primary diagnosis or recurrence).
- Sample size and patient characteristics.
- Type of imaging modality used (e.g., PSMA PET/MRI, choline PET/MRI).

- Comparator imaging modalities (mpMRI, PET/CT, PET alone).
- Reference standard (e.g., histopathology, biopsy, clinical follow-up).
- Diagnostic performance metrics (sensitivity, specificity, accuracy, PPV, NPV, AUC).
- Key findings related to lesion detection, staging, or recurrence.

Data extraction was performed independently by two reviewers, with cross-checking to ensure accuracy and completeness.

Quality Assessment

The methodological quality of the included studies was assessed using standardized appraisal tools appropriate to study design:

- **Newcastle–Ottawa Scale (NOS)** for observational and retrospective studies.
- **QUADAS-2 (Quality Assessment of Diagnostic Accuracy Studies)** tool for diagnostic accuracy studies.

Each study was evaluated for risk of bias across domains including patient selection, index test (PET/MRI), reference standard, and flow and timing. Studies were categorized as having low, moderate, or high risk of bias.

Overall, most studies demonstrated **moderate methodological quality**, primarily due to small sample sizes, retrospective designs, and variability in imaging protocols and interpretation criteria.

Data Synthesis

Due to heterogeneity in study designs, imaging techniques, and reported outcomes, a **narrative synthesis approach** was adopted. Quantitative pooling (meta-analysis) was not performed because of variability in outcome definitions, imaging protocols, and reporting metrics across studies.

Findings were synthesized and organized into key thematic domains:

1. Diagnostic performance of PET/MRI in primary prostate cancer detection.
2. Comparative performance of PET/MRI versus mpMRI, PET/CT, or PET alone.
3. Performance of PET/MRI in detecting clinically significant prostate cancer.
4. Role of PET/MRI in recurrence detection and staging.

Where available, quantitative data such as sensitivity, specificity, detection rates, and AUC values were reported descriptively. Comparative trends across studies were highlighted to identify consistent patterns in diagnostic performance.

Ethical Considerations

As this study was based on the analysis of previously published data, ethical approval and informed consent were not required. All included studies were published in peer-reviewed journals and were assumed to have obtained appropriate ethical clearance prior to data collection. The review was conducted in accordance with PRISMA 2020 guidelines, ensuring transparency, accuracy, and academic integrity in data reporting and synthesis.

RESULTS

Summary and Interpretation of Included Studies on PET/MRI in Prostate Cancer

The included studies evaluating the diagnostic performance of PET/MRI in prostate cancer encompass a range of prospective trials, retrospective analyses, and comparative imaging studies involving both primary and recurrent disease settings. Sample sizes varied from 20 to 296 patients, reflecting both early feasibility studies and larger multicenter trials. Patient populations included men with suspected prostate cancer, biopsy-proven intermediate- to high-risk disease, and individuals with biochemical recurrence following radical prostatectomy. Most studies used histopathology, particularly whole-mount prostatectomy specimens, as the reference standard, ensuring robust validation of imaging findings.

Grefve et al. (2025) evaluated the performance of PSMA-PET/mpMRI in 55 patients with intermediate- to high-risk prostate cancer and demonstrated improved detection of clinically significant prostate cancer (csPCa), with detection rates of 85% for PET/MRI compared to 75% for mpMRI and 70% for PSMA-PET alone. For overall lesion detection, PET/MRI also showed superior performance (38%) compared to both mpMRI and PET alone (32% each), without an increase in false-positive findings, indicating improved diagnostic consistency.

Phillipi et al. (2025) investigated imaging performance in the post-prostatectomy recurrence setting and found that mpMRI alone achieved higher sensitivity (73.0%) than PSMA PET/CT (65.2%), with similar specificity (77.1% vs. 75.7%). However, combining both modalities improved overall diagnostic accuracy to 77.8% and significantly increased specificity to 90.0% ($p = 0.026$), along with better inter-rater reliability, highlighting the complementary value of hybrid or combined imaging approaches.

Hartenbach et al. (2014) demonstrated that combined FEC-PET/MRI achieved a sensitivity of 95% for detecting dominant prostate cancer lesions. For lesions greater than 5 mm, PET/MRI achieved sensitivity and specificity of 84% and 80%, respectively, compared to 67% and 35% for MRI alone and 85% and 45% for PET alone. These results underscore the marked improvement in diagnostic accuracy when functional and anatomical imaging are combined.

Emmett et al. (2021), in a large prospective multicenter trial of 296 patients, showed that adding PSMA PET/CT to mpMRI significantly improved sensitivity from 83% to 97% and negative predictive value from 72% to 91% ($p < 0.001$), although specificity decreased from 53% to 40% ($p = 0.011$). Importantly, the combined imaging approach allowed approximately 19% of patients to potentially avoid unnecessary biopsy, demonstrating clinical utility beyond diagnostic accuracy alone.

Scheltema et al. (2019) reported high diagnostic performance for PSMA-PET in detecting intermediate-grade prostate cancer, with per-patient sensitivity of 100% compared to 97% for mpMRI. In segment-based analysis, PSMA-PET achieved superior accuracy (AUC = 0.91) compared to mpMRI (AUC = 0.79). The combined PET + mpMRI approach further improved sensitivity to 92%, specificity to 90%, and negative predictive value to 96%. However, detection rates for low-grade tumors were poor for both modalities (18% for PET and 10% for mpMRI), indicating limitations in indolent disease.

Lee et al. (2017) evaluated integrated PET/MRI in 31 patients and demonstrated higher sensitivity compared to mpMRI alone across all patient groups, including high Gleason score patients (77.0% vs. 66.2%, $p = 0.011$), low Gleason score patients (66.7% vs. 47.4%, $p = 0.007$), and overall (72.5% vs. 58.0%, $p = 0.008$). Diagnostic odds ratios were also significantly higher for PET/MRI, particularly in high-grade disease (15.143), confirming improved diagnostic discrimination.

Westphalen et al. (2020) provided important contextual data on mpMRI performance, showing that the positive predictive value (PPV) of PI-RADS scoring varied widely across 26 centers. PPV for PI-RADS ≥ 3 was 35% (95% CI: 27–43%), and for PI-RADS ≥ 4 was 49% (95% CI: 40–58%), with substantial inter-center variability. These findings highlight limitations of mpMRI alone and support the need for adjunct modalities such as PET.

Kasivisvanathan et al. (2018), in a randomized trial of 500 patients, demonstrated that MRI-targeted biopsy detected more clinically significant cancer than standard biopsy (38% vs. 26%, $p = 0.005$) while reducing detection of clinically insignificant cancer by 13 percentage points ($p < 0.001$). Additionally, 28% of patients avoided biopsy altogether due to negative MRI findings, emphasizing the role of imaging in reducing overtreatment.

Jena et al. (2018) showed that combining PSMA PET/MRI with clinical parameters significantly improved diagnostic accuracy, achieving a mean AUC of 0.94 ± 0.03 compared to individual AUCs of 0.77 (PSA), 0.70 (digital rectal examination), 0.82 (mpMRI), and 0.88 (PSMA uptake). This demonstrates the added value of multimodal integration in lesion characterization.

Finally, Afshar-Oromieh et al. (2014) demonstrated that ^{68}Ga -PSMA PET/MRI improved lesion detection and characterization compared to PET/CT in recurrent prostate cancer. PET/MRI provided better lesion contrast and clarified four indeterminate findings seen on PET/CT. However, technical limitations such as reduced standardized uptake values in certain regions were noted, indicating the need for careful interpretation.

Overall, the findings across all included studies consistently demonstrate that PET/MRI, particularly when combined with PSMA-based imaging, improves sensitivity, diagnostic accuracy, and negative predictive value in prostate cancer detection and staging. While specificity may vary depending on the study and clinical context, the integration of PET and MRI provides complementary anatomical and functional information that enhances clinical decision-making, especially in clinically significant disease.

Table (1): General Characteristics of Included Studies

Study	Design	Sample	Setting	Modalities	Reference Standard	Key Results
Grefve et al. (2025)	Prospective	55	Primary PCa	PET/MRI vs mpMRI vs PET	Histopathology	csPCa: 85% vs 75% vs 70%
Phillipi et al. (2025)	Retrospective	37	Recurrence	mpMRI, PET/CT	Follow-up	Accuracy 77.8%, specificity 90%
Hartenbach et al. (2014)	Prospective	NR	Primary	PET/MRI vs MRI vs PET	Histology	Sensitivity 95%
Emmett et al. (2021)	Prospective	296	Suspected PCa	PET/CT + MRI	Biopsy	Sensitivity 97%, NPV 91%
Scheltema et al. (2019)	Prospective	56	Primary	PET + mpMRI	Histology	AUC 0.91, sensitivity 92%
Lee et al. (2017)	Comparative	31	Primary	PET/MRI vs MRI vs PET/CT	Histology	Sensitivity 72.5%
Westphalen et al. (2020)	Multicenter	3449	Diagnostic	mpMRI (PI-RADS)	Biopsy	PPV 35–49%
Kasivisvanathan et al. (2018)	RCT	500	Suspected PCa	MRI-targeted biopsy	Histology	38% vs 26% detection
Jena et al. (2018)	Retrospective	82	Primary	PET/MRI + clinical	Histology	AUC 0.94

Afshar-Oromieh et al. (2014)	Prospective	20	Recurrence	PET/MRI vs PET/CT	Imaging	Better lesion detection
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DISCUSSION

Prostate cancer remains a major global health burden, necessitating continuous advancements in diagnostic strategies to improve early detection and accurate staging. Imaging plays a central role in this process, particularly in distinguishing clinically significant disease from indolent tumors. The present systematic review highlights the growing importance of hybrid imaging, specifically PET/MRI, in enhancing diagnostic performance compared to conventional modalities. These findings align with the increasing demand for precise imaging tools in prostate cancer management, as emphasized in epidemiological and clinical reports (American Cancer Society; Mazzone et al., 2025).

The results of this review demonstrate that PET/MRI provides superior diagnostic performance compared to standalone imaging modalities such as mpMRI or PET/CT. This is largely attributed to its ability to combine functional and anatomical imaging into a single modality. The integration of metabolic activity from PET with the high-resolution soft tissue imaging of MRI enhances lesion detection and localization, supporting previous findings that hybrid imaging offers significant advantages over individual techniques (Lindenberg et al., 2016; Li et al., 2019).

Multiparametric MRI has long been considered the standard imaging modality for prostate cancer due to its high soft tissue contrast and ability to characterize lesions. However, its limitations, including variability in interpretation and moderate specificity, have been well documented. Studies have shown that mpMRI alone may miss certain clinically significant lesions or produce variable predictive values across institutions, highlighting the need for complementary imaging approaches (Guo et al., 2024; Westphalen et al., 2020).

The addition of PET imaging, particularly using PSMA-targeted tracers, significantly enhances diagnostic accuracy. PSMA PET imaging has demonstrated high sensitivity for prostate cancer detection, especially in high-grade tumors and recurrent disease. The present review supports these findings, showing that PET/MRI consistently improves sensitivity and detection rates for clinically significant prostate cancer, reinforcing the established role of PSMA imaging in modern oncologic diagnostics (Liu et al., 2025; Mazzone et al., 2025).

Several included studies, such as Grefve et al. (2025) and Scheltema et al. (2019), demonstrated that combining PET with MRI improves detection rates for clinically significant prostate cancer compared to either modality alone. These findings are consistent with previous meta-analyses indicating that combined imaging approaches yield higher sensitivity and negative predictive value, thereby improving diagnostic confidence and reducing the likelihood of missed significant disease (Evangelista et al., 2020; Evangelista et al., 2021).

The improved performance of PET/MRI is particularly evident in primary tumor localization and local staging. Studies such as Eiber et al. (2016) and Hartenbach et al. (2014) demonstrated that PET/MRI enhances lesion localization accuracy and provides superior sensitivity compared to mpMRI alone. This improvement is crucial for treatment planning, particularly in surgical and radiotherapy settings where precise tumor localization is essential.

In addition to primary diagnosis, PET/MRI has shown significant utility in the detection of recurrent prostate cancer. The findings of Phillipi et al. (2025) and Afshar-Oromieh et al. (2014) indicate that PET-based imaging improves the detection of local recurrence and metastatic disease, particularly in patients with biochemical recurrence. These results are supported by systematic reviews demonstrating the superiority of PSMA PET imaging over conventional modalities in recurrence detection (Zhang & Ma, 2024).

Another important advantage of PET/MRI is its ability to improve staging accuracy, particularly for lymph node and bone metastases. Studies such as Freitag et al. (2016) demonstrated that PSMA PET/MRI provides improved detection of metastatic lesions compared to PET/CT, which can significantly impact treatment decisions. Accurate staging is essential for determining appropriate therapeutic strategies and improving patient outcomes.

The combination of PET/MRI with clinical parameters further enhances diagnostic performance. Jena et al. (2018) demonstrated that integrating imaging findings with clinical data such as PSA levels and Gleason score significantly improves diagnostic accuracy. This multimodal approach reflects the trend toward personalized medicine, where imaging is used in conjunction with clinical and pathological data to guide decision-making.

Despite its advantages, PET/MRI is not without limitations. One of the main challenges is the variability in specificity observed across studies. While sensitivity is generally high, specificity may be reduced in certain cases, potentially leading to false-positive findings. This variability underscores the need for standardized imaging protocols and interpretation criteria to ensure consistent diagnostic performance (Torri et al., 2024).

Additionally, PET/MRI demonstrates limited sensitivity for low-grade prostate cancer. Studies such as Scheltema et al. (2019) and Lee et al. (2017) have shown that both PET and MRI may have reduced detection rates for indolent tumors. While this may be advantageous in reducing overdiagnosis, it also highlights the need for careful patient selection and interpretation of imaging results.

The findings of the PRIMARY study (Emmett et al., 2021) further support the role of combined imaging approaches in improving diagnostic pathways. The study demonstrated that adding PET imaging to MRI significantly improves sensitivity and negative predictive value, potentially allowing some patients to avoid unnecessary biopsy. These findings align with the broader literature supporting the use of advanced imaging to refine diagnostic algorithms (Kasivisvanathan et al., 2018).

From a clinical perspective, the integration of PET/MRI into routine practice has the potential to significantly improve patient management. By providing more accurate detection and staging, PET/MRI can support more precise treatment planning, reduce unnecessary interventions, and improve overall outcomes. However, practical considerations such as cost, availability, and the need for specialized expertise may limit its widespread adoption (Lindenberg et al., 2016).

Overall, the findings of this review are consistent with existing literature demonstrating the added value of PET/MRI in prostate cancer imaging. Multiple systematic reviews and meta-analyses have confirmed its superior diagnostic performance compared to conventional imaging modalities, particularly when PSMA-based tracers are used. However, further large-scale studies are needed to standardize its use and fully establish its role in clinical guidelines (Evangelista et al., 2021; Torri et al., 2024).

In conclusion, PET/MRI represents a significant advancement in prostate cancer imaging, offering improved diagnostic accuracy through the integration of functional and anatomical data. While challenges remain, its potential to enhance detection, staging, and treatment planning makes it a valuable tool in modern prostate cancer management.

CONCLUSION

The findings of this systematic review demonstrate that PET/MRI represents a highly promising imaging modality in the diagnosis and staging of prostate cancer. Across the included studies, PET/MRI consistently showed improved sensitivity, diagnostic accuracy, and lesion localization compared to standalone imaging modalities such as mpMRI or PET/CT. The integration of metabolic information from PET—particularly using PSMA-targeted tracers—with the superior soft tissue resolution of MRI enhances the detection of clinically significant prostate cancer and improves staging precision. These advantages are especially evident in high-risk patients and in cases of biochemical recurrence, where early and accurate localization of disease is critical for guiding treatment decisions.

Despite these benefits, PET/MRI is not without limitations, including variability in specificity, reduced performance in detecting low-grade tumors, and technical challenges related to image interpretation and standardization. Additionally, accessibility, cost, and the need for specialized expertise may limit its widespread implementation in routine clinical practice. Overall, PET/MRI should be considered a valuable complementary tool rather than a replacement for existing imaging modalities, with its greatest utility in complex or high-risk clinical scenarios. Further large-scale, standardized studies are required to define its role in clinical guidelines and optimize its integration into prostate cancer diagnostic pathways.

LIMITATIONS

This systematic review has several limitations that should be acknowledged. First, the included studies demonstrated heterogeneity in study design, patient populations, imaging protocols, and outcome measures, which limited direct comparison and precluded quantitative meta-analysis. Second, several studies had relatively small sample sizes or retrospective designs, which may introduce selection bias and affect the generalizability of findings. Third, variability in reference standards, including the use of histopathology versus clinical follow-up, may have influenced reported diagnostic performance metrics. Additionally, differences in radiotracers (e.g., PSMA vs. choline) and imaging interpretation criteria may have contributed to inconsistencies across studies. Finally, publication bias cannot be excluded, as studies reporting positive findings are more likely to be published.

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