Journal of Biosciences and Medicines, 2024, 12, 114-128
https://www.scirp.org/journal/jbm
ISSN Online: 2327-509X
ISSN Print: 2327-5081

Recent Research Advances in Imaging of Prostate Cancer

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How to cite this paper: Hu, Q.S., Cheng, S.P., Yuan, C.S. and Jin, C.H. (2024) Recent Research Advances in Imaging of Prostate Cancer. *Journal of Biosciences and Medicines*, **12**, 114-128.
https://doi.org/10.4236/jbm.2024.126012

Received: May 20, 2024
Accepted: June 16, 2024
Published: June 19, 2024

Abstract

Imaging study plays a crucial role in the diagnosis of prostate cancer. As early screening and management of prostate cancer has evolved over the past decade, research is now focusing on how to detect clinically significant prostate cancer and avoid overdiagnosis accurately. This article provides an overview of recent advances in imaging in prostate cancer diagnosis, including new ultrasound imaging techniques, positron emission computed tomography, multiparametric magnetic resonance imaging, and emerging areas such as imaging histology, by systematically reviewing and summarizing the existing literature.

Keywords

Prostate Cancer, Novel Ultrasound,
Positron Emission Tomography/Computed Tomography,
Multiparametric Magnetic Resonance Imaging, Imaging Histology

1. Introduction

Prostate cancer (PCa) is one of the common malignant tumors in men, and it has gradually become the second leading cause of cancer death in men [1]. In China, the incidence of prostate cancer has been increasing, which is mainly related to the introduction and promotion of prostate-specific antigen (PSA) testing, and the aging of the population is also an essential factor. Meanwhile, the mortality rate is also increasing, and most of the patients are already in the middle or late stage at the time of initial diagnosis, resulting in the overall prognosis of Chinese prostate cancer patients being much worse than that of Western developed countries [2] [3]. As a non-invasive and intuitive means of examination, imaging plays a vital role in the diagnosis of prostate cancer. The use of nonin-

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vasive imaging to detect clinically significant prostate cancer patients can further clarify the risk stratification of patients, reduce unnecessary prostate puncture biopsy, and provide a basis for prostate cancer treatment and follow-up. Currently, new imaging techniques, including novel ultrasound, positron emission tomography/computed tomography, multiparametric magnetic resonance imaging and imaging histology, provide reliable information for the diagnosis of prostate cancer.

2. New Ultrasound Imaging Techniques

Currently, transrectal ultrasound (TRUS) is often used in clinical practice to confirm the diagnosis of PCa by guiding a systematic puncture biopsy of the prostate after the detection of a PSA abnormality; however, the use of grayscale ultrasound is less effective in detecting and localizing prostate tumors. A systematic review and meta-analysis of ultrasound imaging techniques was conducted by D.A.'s team from the University of Dundee's Ninewells School of Medicine, UK to assess the accuracy of different ultrasound scanning techniques (shear-wave elastography, acoustic contrast, microscopic ultrasound) and grayscale ultrasound techniques in the diagnosis of prostate cancer. This experiment established that this new method of detecting prostate cancer was effective [4]. It has also been demonstrated that advanced ultrasound tools such as multimodal ultrasound, Microscopic ultrasonography, shear wave elastography, as well as sonography and Microscopic ultrasonography are effective imaging methods for detecting prostate cancer. Also, its availability for real-time imaging of precisely targeted biopsies provides important information for the diagnostic route of prostate cancer. Meanwhile, its availability for real-time imaging of precisely targeted biopsies provides essential information for the diagnostic route of prostate cancer. The study of Xiong Fei *et al.* from Xi'an Jiaotong University also showed that contrast-enhanced ultrasound microvascular imaging and elastography-guided prostate biopsy have better application value in the diagnosis of prostate lesions than the conventional ultrasound-targeted biopsy, while contrast-enhanced ultrasound microvascular imaging and elastography can provide semi-quantitative/quantitative parameter bases for the diagnosis of prostate cancer lesions [5]. This shows that contrast-enhanced ultrasound and elastography can more accurately detect clinically significant prostate cancer.

2.1. Contrast-Enhanced Ultrasound (CEUS)

Contrast-enhanced ultrasound (CEUS) [6] is based on two-dimensional ultrasonography, in which a microbubble contrast agent is injected into the peripheral vein and circulated to the target organ via the bloodstream to improve the acoustic properties of tissue blood flow scattering and further enhance the visibility of the blood flow signal. Since the blood vessels and pathological structures in PCa lesions are different from normal tissues, especially the blood supply at the lesions is different, according to the characteristics of the phase difference

when the contrast agent reaches different tissues, CEUS can, to a large extent, more accurately identify the lesion site and improve the detection rate of PCa. Currently, domestic and international studies have focused on how to perform targeted fusion puncture biopsies using CEUS. Andreas *et al* from Germany found in a study that when performing multiparametric MRI fusion-guided puncture biopsies, CEUS intravenous contrast injection was performed and quantitative perfusions analysis software was used to study the areas with the most significant enhancement within the predefined area of magnetic resonance imaging (MRI), collect all available parameters in the quantitative perfusions analysis software and analyse PCa and further differentiate PCa aggressiveness based on histopathological findings. All available parameters in the software were collected and analysed for PCa and further differentiation of PCa aggressiveness was made on the basis of histopathological findings. It was found to be feasible to differentiate the invasiveness of PCa in fusion-guided prostate biopsies with MRI on the quantification of CEUS parameters [7]. A recent study confirmed that CEUS can be an effective complement to biparametric MRI (Bp-MRI) combining diffusion weighted imaging (DWI) and MRI T2-weighted imaging (T2WI) in the diagnosis of PCa, especially in patients with renal insufficiency or gadolinium contrast allergy [8].

It can be seen that the combined application of CEUS and Bp-MRI can improve the accuracy of prostate cancer diagnosis. Future correlation modelling by combining age, free prostate-specific antigen (F-PSA)/total prostate-specific antigen (T-PSA), time to disease progression and CEUS-BpMRI scores could lead to an optimal prediction of prostate cancer for accurate assessment of risk stratification of PCa in patients.

2.2. Ultrasonic Elastography (UE)

The principle of ultrasonic elastography in diagnosing PCa is based on the fact that the elasticity coefficient (hardness) of cancerous tissues differs from that of normal tissues, and the deformation produced by the additional external force is other to identify PCa. At present, ultrasonic elastography includes two types of modalities, namely real-time elastography (RTE) and shear-wave elastography (SWE). RTE is qualitatively reflecting the hardness of the tissue, while SWE is quantitatively reflecting the hardness of the tissue.SWE imaging has a high sensitivity in distinguishing PCa from benign tissues, and it can accurately detect cancer lesions and reveal significant differences between malignant and benign tissues [9]. In addition, the technique is more reliable in differentiating prostate cancer aggressiveness. The method also demonstrated good diagnostic performance in detecting margin status and disease staging. Further prospective and multicenter studies are needed to improve the accuracy of puncture biopsy for prostate cancer.

3. Positron Emission Tomography/Computed Tomography (PET/CT)

Although CT is safer and more convenient than MRI, it only reflects the ana-

tomical features of the lesion, but cannot assess the physiological metabolism of PCa, and since it was found that prostate-specific membrane antigen (PSMA) [10] lacks significant expression in healthy prostate tissues and is a specific target for PCa cells. Since decades of research, This technique has demonstrated excellent diagnostic accuracy in most stages of PCa. PSMA PET/CT is now becoming more and more useful in pre-treatment staging, diagnosis of patients with biochemical recurrence and efficacy assessment.

3.1. PSMA PET/CT Applied to Pre-Treatment Staging

PCa staging is essential for the correct choice of clinical treatment. Conventional imaging techniques (i.e., computed tomography, magnetic resonance imaging, and radionuclide bone scanning) perform poorly in diagnosing early recurrent or metastatic PCa. Novel positron emission tomography agents, including radiolabeled prostate-specific membrane antigen and choline, have shown greater sensitivity and specificity in initial staging and early biochemical recurrence (BCR). Wondergem *et al.* demonstrated the potential of 18F-DCFPyL PET/CT by applying it to 160 patients with high-risk The preliminary results of 18F-DCFPyL PET/CT in 160 patients with high-risk prostate cancer in terms of primary staging, metastasis detection rate, and impact on clinical management and outcomes showed that 18F-DCFPyL PET/CT can be used as a first-line imaging modality for treatment selection in patients with primary high-risk prostate cancer, and that the majority of patients do not require further diagnostic imaging [11]. However, in a subsequent prospective study led by Ulaner *et al.*, 18F-DCFPyL PET/CT had a high positive predictive value for distant metastases (74%) and biochemical recurrence sites (89%) in newly diagnosed prostate cancer. However, there were false-positive findings of significant DCFPyL concentrations at some sites, particularly in the ribs and pelvic bone, and these sites should not be presumed to be malignant due to their isolated affinity for DCFPyL [12]. A biopsy may still be required before a treatment decision is made. Jansen *et al.* also found in a study that 18F-DCFPyL PET/CT showed high specificity (94.4%) and limited sensitivity (41.2%) in detecting pelvic lymph node metastases in primary PCa [13]. This implies that current PSMA PET/CT imaging cannot replace diagnostic extended pelvic lymph node dissection (ePLND). Further studies are needed to determine the exact place of PSMA PET/CT imaging in the primary staging of PCa. In a survey by Alshalalfa *et al.*, they found that the combination of PSMA PET/CT and sentinel lymph node (SLN) biopsy was 94% accurate in staging lymph nodes in diagnosing intermediate to high risk primary PCa. The addition of SLN biopsy in patients with negative PSMA PET/CT results increased the combined sensitivity of detecting ePLND lymph node metastases to 100% [14]. This diagnostic accuracy may provide valuable information to guide further treatment of patients with PCa, such as using PSMA PET/CT and SLN biopsy rather than ePLND as the preferred method of pre-radiotherapy staging. In addition to the 18F-DCFPyL contrast

agent, some studies have found that 18F-PSMA-1007 PET/CT is also capable of reliably detecting malignant lymph nodes, with a specificity of more than 99% for lymph node metastasis [15]. Although various types of imaging agents have been developed to further improve the diagnostic performance of PET/CT, the biopsy is still required before local treatment to avoid misjudgment of prostate cancer staging. When necessary, the combination of imaging agents is also a more effective method. For example, the combination of PSMA PET and GRP-R PET can better classify prostate lesions [16], while 18F-rhPSMA-7.3 has an excellent safety profile and provides clinically useful information about the presence of diseases other than the prostate, which can be used to accurately diagnose prostate cancer at the initial diagnosis. Disease burdens and selecting the most appropriate treatment for prostate cancer patients [17].

3.2. PSMA PET/CT Applied to the Diagnosis of Patients with Biochemical Recurrence

PET/CT not only has better diagnostic efficacy for initial primary PCa, but also has a significant advantage in the detection of early microscopic primary foci and metastatic foci, which can be used for detecting biochemical recurrent PCa in addition to tumor staging. Nina-Sophie *et al.* found in a retrospective study that, compared with conventional CT, 68Ga-PSMA PET/CT had a significant impact on the method of radiation therapy, especially for postoperative patients [18]. Numerous studies have demonstrated that 68Ga-PSMA PET/CT is a reliable test for biochemical recurrence in patients with persistently elevated PSA, and this finding has been recognized in several cancer guidelines [18] [19]. Meanwhile, Farolfi *et al.* found that 68Ga-PSMA-11 PET/CT has high sensitivity and specificity compared with the existing tests, and it is recommended to be used in patients with early biochemical recurrence after RP [20]. It was also rapidly incorporated into the EAU-EANM-ESTRO-ESUR-SIOG guidelines [21]. However, Ga-PSMA PET/CT has become a very promising diagnostic method for prostate cancer. However, it is also increasingly recognized that its specificity results are unreliable, and the data of false negative prostate cases are underestimated. Yakar *et al.* identified three false negative cases of locally recurrent prostate cancer using multiparametric MRI and histopathology as the reference standard. Artifacts of prostate metal markers used for external radiation radiotherapy, low levels of PSMA uptake, and bladder overflow were identified as potential reasons for misdiagnosis after the study [22]. Understanding these diagnostic pitfalls may improve the understanding of Ga-PSMA PET/CT. In addition to this, the role of other contrast agents is also significant, such as F-PSMA-1007, which is one of the most promising radiographic agents for PET imaging of recurrent prostate cancer. The lower limit of urinary clearance is probably its most valuable and prominent feature. In patients with early biochemical recurrence, the detection rate of F-PSMA-1007 was higher than that of F-FCH PET/CT and better than that of radiocholine. The former also showed more suggestive lesions

and fewer ambiguous lesions overall [23] [24]. [89Zr]Zr-PSMA-617 PET/CT imaging is also a promising new diagnostic tool for prostate cancer patients with less radiation exposure, especially when the recurrent disease is not detected by [68Ga]Ga-PSMA-11 PET/CT imaging. The long half-life of 89Zr enables late time-point imaging (up to 72 hours in relevant studies) to identify prostate cancer tissue by increasing tracer uptake in the tumor lesion to improve the contrast between tumor and normal tissue [25].

3.3. Application of PSMA PET/CT to Assess the Efficacy of Therapy

PSMA PET/CT can be used not only for diagnosing PCa, but also plays a significant role in assessing the response of a lesion to therapy after systemic or localized treatment. Fanti *et al.* agreed on all the statements made in a consensus statement on the criteria for assessing response to PSMA PET/CT in prostate cancer. Ideally, patients can be categorized as responders or non-responders based on PSMA PET/CT imaging criteria: categories of responders include stable disease on PSMA PET/CT imaging, partial response, and complete response. PSMA PET/CT evaluation may also be considered in specific clinical situations, such as oligometastatic or multi-metastatic disease, but the results have not been established [26]. Although PSMA PET/CT has determined that it can be used to assess post-treatment response, it should still be implemented in the context of clinical trials, and its criteria should be progressively refined.

Although most of the current evaluations of PET-CT for various tracers are single-center, small-sample studies, more extensive studies with homogeneous patient populations and cost-effectiveness evaluations are still needed to explore the value of their application

more fully. However, the value of PET/CT for early and accurate diagnosis of PCa, pre-treatment staging, diagnosis of biochemical recurrence, and efficacy evaluation is undoubted.

4. Multiparametric MRI (mpMRI)

Multiparametric MRI (mpMRI) is one of the most essential means of prostate cancer diagnosis. mpMRI is mainly used for PCa diagnosis and active surveillance (AS). mpMRI consists of high-resolution T2WI, DWI, and dynamic contrast enhancement (DCE) sequences, which in turn are based on prostate imaging reports and reports. mpMRI consists of high-resolution T2WI, DWI, and dynamic contrast enhancement (DCE) sequences, which in turn are the basis for structured reporting using the prostate imaging report and data system (PI-RADS) classification. With the rapid development of mpMRI technology, the accuracy of mpMRI diagnosis and localization of PCa has been improved, and the prostate imaging report and data system have been continuously updated. Currently, the commonly used one is PI-RADS version 2.1. The high quality of mpMRI performance and reporting cannot be ensured because many believe that the performance of mpMRI may vary depending on the perfor-

mance of the MRI itself, the experience of the radiologist, whether other biomarkers are taken into account, and whether the mpMRI-targeted biopsy is performed alone or in conjunction with a systematic biopsy. Still, there is no denying the high diagnostic value of mpMRI for PCa.

In PI-RADS version 2.1, not only the revised specifications for the technical parameters of image acquisition of mpMRI data are pointed out in detail, but also detailed explanations for the assessment of lesions in each region are provided [27]. Numerous studies have shown that using PI-RADS v2.1 improves the consistency of lesion detection by radiologists with different experiences [28]. However, the need for a biopsy of lesions with a PI-RADS v2.1 score of 3 needs to be further explored. Current evidence suggests that imaging and clinical indicators can be used for risk stratification of PI-RADS v2.1 score 3 lesions. For example, in a prospective multicenter study, the combination of mpMRI+ PET/CT reduced the number of false negatives for clinically substantial PCa compared with MRI, thus potentially reducing the number of prostate biopsies required for clinically significant PCa [29]. In contrast, age, previous biopsy status and prostate specific antigen density (PSAD) were found to be independent predictors of clinically significant PCa that could not be determined by prostate mpMRI [30]. In particular, PSAD, in a systematic review, was quantitatively evaluated for its diagnostic performance in combination with prostate MRI for clinically significant PCa. It showed complementary performance and predictive value to imaging, especially in patients with negative MRI PI-RADS v2.1 score 3 lesions [31]. Incorporating PSAD into prostate biopsy decisions may help improve risk stratification. This includes actively monitored patients for whom serial prostate MRI alone is not accurate enough to exclude prostate cancer progression reliably. Other clinical factors and biomarkers as well as serial MRI are needed to adjust the intensity of subsequent biopsies safely [32]. However, with the development of imaging PET/MRI and other emerging imaging techniques are gradually improving the accuracy of PCa diagnosis, in a study by Mengxia Chen *et al.*, a total of 90 lesions from 54 patients were analyzed, of which 66 lesions represented clinically significant PCa. The analysis showed that PET/MRI was superior to mpMRI in detecting clinically significant PCa, with improved sensitivity without compromising specificity [33]. This shows that PET/MRI can improve the detection of PCa with clinical significance in PI-RADS2.1 score 3. Therefore, based on factors such as PSAD, age, prostate and lesion size, and previous biopsy pathology, 68 Ga-PSMA PET/CT and PET/MRI will help develop management strategies for PI-RADS 3 lesions. Overall, although the use of mpMRI during active surveillance of prostate cancer may result in a slight increase in the cost of patient care, clinicians may still consider applying mpMRI if its use in combination with other metrics allows physicians to monitor prostate cancer more accurately.

For prostate cancer, systematic biopsy remains the gold standard for its diagnosis. However, in a population-based screening trial of targeted and standard

biopsies in men with mpMRI results suggestive of prostate cancer, mpMRI was found to be noninferior to standard biopsy for the detection of clinically significant prostate cancers, but less likely to detect clinically insignificant cancers [34]. Although omitting systematic prostate sampling during MRI-targeted biopsy may reduce the detection rate of detecting non-clinically significant PCa and reduce patient discomfort, it also reduces the ability to predict pathologic features accurately [35]. It is thus clear that clinicians should not pursue a reduction in the number of biopsy puncture needles, but should choose biopsy protocols rationally based on ensuring diagnostic accuracy. Michael Ahdoot *et al.* study investigated an optimized strategy for diagnosing aggressive prostate cancer with abnormal prostate mpMRI scans while minimizing the risk of the over-biopsy. The results showed that MRI-targeted biopsy alone could be used in men with a PI-RADS2.1 score of 5. In contrast, men with a PI-RADS2.1 score of 3 or 4 would benefit from a combination of MRI-targeted biopsy and systematic biopsy [36]. This study may provide a reference for clinicians' biopsy strategies.

Although the efficacy of mpMRI, PET/MRI or combined PET/CT needs to be further validated in prospective trials, it is believed that future studies will clarify their role in the diagnosis of PCa and identify more valuable imaging agents.

5. Imaging Omics and Artificial Intelligence

The concept of imaging omics was first proposed by Dutch scholar Lambin in 2012, which refers to extracting high-throughput features from medical images (high-throughput features means extracting millions of image features at one time), and further adopting diversified statistical analysis and data mining methods to extract and strip critical information from massive information, which can ultimately be used for assisting in the diagnosis, classification or prediction of diseases. Prediction. In recent years, artificial intelligence (AI) has been tried and researched to varying degrees in the diagnostic models of various organ diseases, and AI-based imaging histology applications have already covered the clinical phases of lesion detection, pathological diagnosis, radiotherapy planning, and postoperative prediction.

For example, AI has the potential to standardize the detection of lesions suspected of PCa on MRI. Yafei Qi *et al* A combined model combining a multi-imaging fusion model, age, PSAD, and PI-RADS v2.1 scores performed better in both the primary cohort and validation cohort when compared to a clinicopathologic model. In addition, using the combined model to predict PCa identified more patients with negative PCa than the clinicopathologic model. This study developed and validated the combined model to provide a preoperative prediction of PCa in men with PSA levels of 4 - 10 ng/mL and may help in making treatment decisions and reducing unnecessary biopsies [37]. Later, Yangbai Lu *et al.* also found that dual-parametric MRI-based imaging group line drawings also had the potential to accurately and noninvasively identify PCa in patients with

PI-RADS ≤3 lesions and PSA of 4 - 10 ng/mL, which could reduce unnecessary biopsies [38]. A recent study [39] showed that the combined [18F]-DCFPyL PET/MRI imaging histology model (a combination of PET+ADC+T2WI radiomic features) was the best performing model, outperforming the clinical model in terms of pathology grading group prediction, suggesting that the hybrid PET/MRI model is of complementary value for non-invasive risk stratification of PCa. However, further prospective studies are needed to confirm the reproducibility and clinical utility of this approach. As for prostate cancer requiring biopsy, systems capable of fusing MRI and US to guide robotic prostate biopsy are needed [39]. This application of precise segmentation of preoperative MRI images is essential for accurate image alignment and automatic localization of biopsy targets. Therefore, in a research work led by Weirong Wang *et al.*, a parallel dual pyramid network that combines a convolutional neural network (CNN) and a labeled multilayer perceptron (MLP) was developed for MRI automatic segmentation of PCa and clinically significant PCa in MRI. The proposed network consists of two stages. The first stage focuses on prostate segmentation, while the second stage uses the previous segmentation from the previous stage to detect cancerous regions. These two phases share a similar network architecture, using CNNs and labeled MLPs as the feature extraction backbone to create a pyramid-structured network for feature encoding and decoding. By employing CNN layers at different scales, the network generates scale-aware local semantic features that are integrated into the feature map and fed into the MLP layer from a global perspective. This promotes complementarity between local and global information, capturing richer semantic features. In addition, the network integrates an interactive hybrid attention module to enhance the perception of the target region. Experimental results show that their proposed network outperforms other state-of-the-art image segmentation methods in segmenting PCa and csPCa tissues in MRI images [40]. Continuous MRI is an important assessment tool for PCa patients undergoing active monitoring. However, its sensitivity in predicting histopathological tumor progression at follow-up is only moderate, partly due to the subjective nature of its clinical reporting and the differences between centers and reviewers. Nikita Sushentsev *et al.* used a long short-term memory (LSTM) recurrent neural network (RNN) in a study. recurrent neural network, RNN) to develop a time-series imaging histology prediction model that analyzed the longitudinal changes in tumor-derived imaging histological features in 297 scans of 76 AS patients, of which 28 patients suffered from histopathological PCa progression, and 48 had stable disease. The LSTM-based model combining time-series imaging histology and sequential PSAD was found to significantly outperform a model combining conventional delta imaging histology and delta-PSA density, and to perform comparably to sequential MRI analyses performed by experts using sequential assessment of change in prostate cancer. Thus, the proposed time-series imaging histology framework provides a viable quantitative tool for the standardization of serial MRI assessment in PCa active

surveillance. It also presents a new methodology for sequential image analysis that can support clinical decision-making in a wide range of situations, from continuous disease surveillance to treatment response assessment. Time-series image-omics can also be applied to other clinical scenarios involving sequential imaging, opening up a new frontier for AI-driven radiology research [41]. In addition to the above, AI-assisted deep survival networks using high-throughput MRI can accurately predict PCa biochemical recurrence and provide an alternative to traditional PCa risk stratification methods [42]. Fuzzy radio-mics have been recognized as a potential method to deal with voxel membership uncertainty relying on non-binary probabilistic masks [43]. Fuzzy imaging radio-mics can potentially improve predictive performance compared to conventional binary imaging radiomics in PET, especially in small lesions. We hypothesize that this effect is due to the ability of fuzzy image-omics to mimic partial volume effects and depiction uncertainty at small lesion boundaries. In addition, some studies suggest that the low redundancy of fuzzy imaging omics features supports the recognition of imaging biomarkers in future research [44]. Future studies should consider using fuzzy and binary image-omics to analyze lesions and their surroundings systematically.

This paper explores the current status of artificial intelligence for automated PCa detection on MRI, however, the existing literature has many limitations, including bias in model validation, heterogeneity in reporting performance metrics, and lack of sufficient clinical translational evidence, and thus the credibility of AI for clinical use is currently subject to some skepticism. Future research, which needs to include large and diverse multi-institutional training and testing datasets, is expected to enable the development of more powerful AI models that may in the future eliminate prostate puncture biopsy as the gold standard for confirming the diagnosis of PCa.

6. Summary

New imaging techniques (ultrasound, PET/CT, mpMRI, PET/MRI, and imaging histology) provide reliable information for the diagnosis of prostate cancer, but each has its advantages and disadvantages. Ultrasound can be used for puncture biopsy of prostate cancer, but it lacks diagnostic specificity and is easily affected by subjective factors, the integration of the targeted biopsy can further improve the diagnostic accuracy, such as the joint application of CEUS and Bp-MRI can improve the accuracy of prostate cancer diagnosis.PET/CT is mainly used for diagnosis, staging and biochemical recurrence of prostate cancer, and has significant advantages in the judgment of lymph node metastasis and bone metastasis, but it will increase the economic burden of patients and is difficult to promote, so clinicians often use mpMRI and bone scan to replace its initial assessment, clinicians can choose according to the patient's situation. Undoubtedly, mpMRI can significantly improve the diagnostic performance of prostate cancer and has been widely used in clinical practice. In the future, it can be further studied in

depth, such as the integration of the targeted biopsy and the establishment of related diagnostic models, which can further improve the diagnostic accuracy of prostate cancer. AI-based imaging genomics can obtain high-throughput and quantitative image information from medical imaging images, and extract information that cannot be obtained from traditional imaging images, but there is a lack of prospective studies and clinical applications. It is believed that it will be further improved in future research and applications.

In addition, the conventional imaging modality of PCa cannot fully characterize the disease burden. Novel PET tracers combined with CT and MRI can provide superior anatomical localization and explore the biological relevance of the tumor site, thus guiding clinicians to make better treatment decisions. Future imaging studies should further explore and develop existing and new imaging technologies to provide more individualized and precise medical services to patients, reduce unnecessary prostate biopsies, and lower the risk of complications to patients. With the development of imaging techniques, they will not only be used for the diagnosis of PCa, but also adjuvant therapy. Although the use of imaging technology in PCa treatment is still immature and needs to be verified by a large number of prospective multicenter studies, it provides a new way of thinking for the treatment of PCa and is more minimally invasive, which has a wide research prospect and important clinical significance.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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