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Advancements in Molecular Imaging Probes for Precision Diagnosis and Treatment of Prostate Cancer

Key words: Molecular imaging; Prostate cancer; Nuclear medicine; Prostate-specific membrane antigen (PSMA); Nanoparticle

Research Summary

- Prostate cancer is the second most commonly diagnosed cancer in men. It accounted for 14.1% of newly diagnosed cancer cases among males worldwide in 2020.
- This review mainly provides a comprehensive review of the current and emerging roles of molecular probes in the diagnosis and treatment of prostate cancer. Also focuses on various imaging modalities, including PET, SPECT, MRI, optical imaging, and ultrasound imaging, highlighting their advantages and drawbacks. In addition, it identifies Prostate-specific membrane antigen (PSMA) as a key biomarker for prostate cancer, playing a vital role in assessing tumor cells and their response to treatment

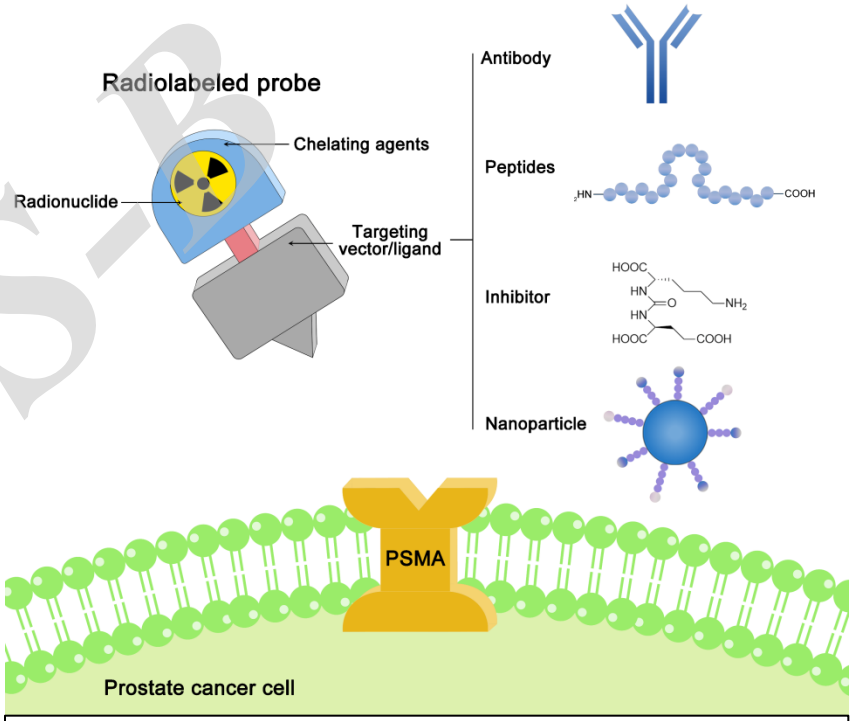

Fig. 1. PSMA-targeted radiolabeled probes for prostate cancer.

Innovation points

- The use of novel molecular probes has improved the detection rate, specificity, and accuracy of prostate cancer detection.
- PSMA is one of the most important molecular biomarkers of prostate cancer.
- ^{18}F-PSMA-1007 PET/CT and ^{68}Ga-PSMA PET/CT show greater diagnostic efficacy in prostate cancer compared to ^{18}F-FDG PET/CT, which is more widely used.
- ^{68}Ga-PSMA PET/CT exhibits a slightly higher sensitivity in diagnosing prostate cancer, while ^{18}F-PSMA-1007 PET/CT may offer higher specificity and confirmed positive rates.
- AR, GRPR, and uPAR biology offer promising targets for prostate cancer imaging.

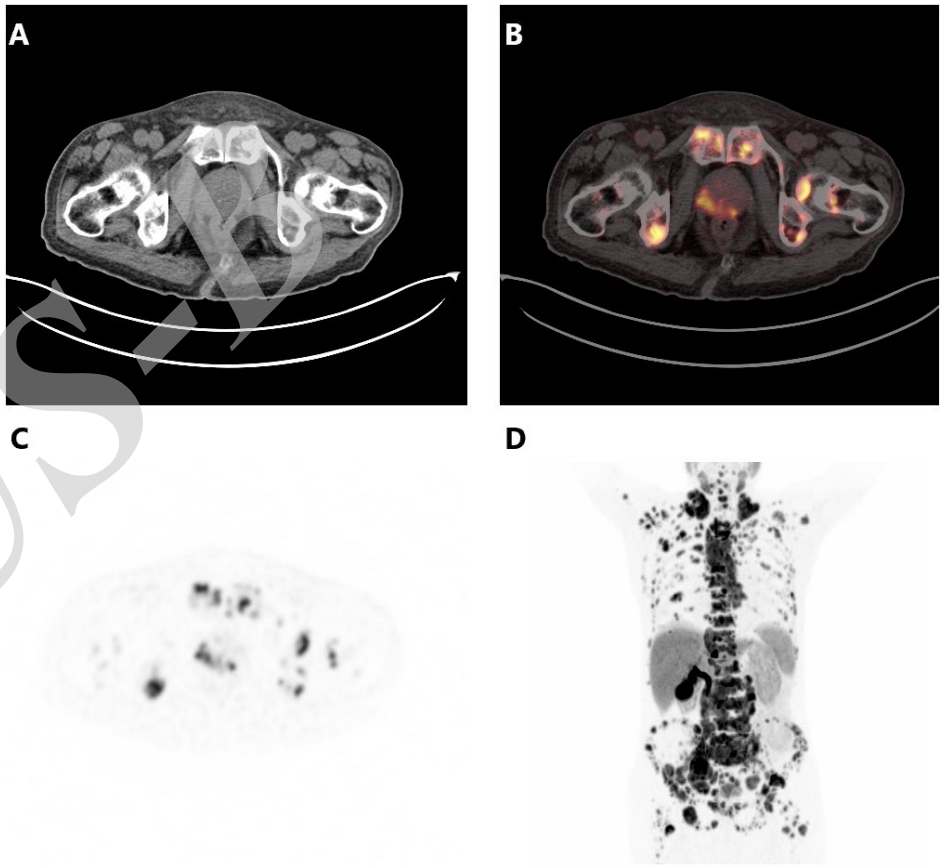

Fig 2. ^{18}F-PSMA PET/CT findings in a 72-year-old patient. (A, B) Irregular low-density foci observed in the right peripheral area, exhibiting notable uptake of ^{18}F-PSMA, suggesting potential malignant changes. (C) Multiple bone mineral density foci with slightly higher ^{18}F-PSMA uptake which indicate multiple bone metastatic lesions. (D) MIP showed increased ^{18}F-PSMA -1007 uptake in multiple bones and lymph nodes throughout the body, suggesting metastatic lesions

Figure 4

Innovation points

A series of comprehensive tables were generated to summarize the latest knowledge about Molecular Imaging Probes for Diagnosis and Treatment of Prostate Cancer.

- **Table 1** | PSMA-targeting imaging radiopharmaceuticals under clinical investigation in prostate cancer
- **Table 2** | An exploration of PSMA-targeted probes used in clinical practice for prostate cancer, including an assessment of their respective advantages and limitations.
- **Table 3** | General summary of the molecular probes for PET in prostate cancer.
- **Table 4** | Overview of some molecular probes used for SPECT imaging in prostate cancer
- **Table 5** | Summarizing the key characteristics and applications of microbubble-based probes and photoacoustic imaging probes.
- **Table 6** | Key features and applications of nanobody-based molecular probes and ferritin-based probes