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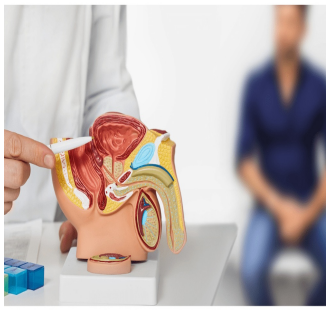
Advancing MRI Utility in PSA Gray Zone for Prostate Cancer Management



Prostate cancer (PCa) is highly prevalent globally among men, necessitating improved diagnostic accuracy, especially for clinically significant cases (csPCa) requiring aggressive treatment to reduce mortality. While prostate-specific antigen (PSA) is commonly used for screening, its reliance leads to over-diagnosis concerns due to lack of cancer specificity. PSA levels > 10 ng/mL typically prompt biopsy, but the 4–10 ng/mL range (the "gray zone") remains contentious for biopsy necessity due to risks of over-diagnosis and adverse effects.

Multiparametric magnetic resonance imaging (mpMRI) is increasingly used for PCa detection, localization, and staging, potentially reducing unnecessary biopsies by accurately identifying csPCa. Studies indicate mpMRI's ability to lower detection of low-risk PCa while enhancing csPCa diagnosis, supported by high negative predictive values (NPVs) ranging from 86.8% to 97.1%. However, its effectiveness within the PSA gray zone remains unclear despite recent research variability among different centers.

Consequently, a meta-analysis was conducted to evaluate mpMRI performance specifically in patients with PSA levels of 4–10 ng/mL, exploring its potential role in managing the PSA gray zone.

Meta-Analysis of MRI Performance in Prostate Cancer Detection: Variations in Clinical Utility

This meta-analysis included 19 studies involving 3,879 participants meeting inclusion criteria. Ten studies (2,205 patients) evaluated MRI's performance for clinically significant prostate cancer (csPCa), and 13 studies (2,965 patients) assessed its performance for detecting any prostate cancer (PCa). Patient ages ranged from 64 to 74 years, with csPCa prevalence varying from 18% to 67% based on pathological or biopsy results.

MRI sensitivity for csPCa detection was pooled at 0.84 (95% CI, 0.79–0.88) with specificity at 0.76 (95% CI, 0.65–0.84). Summary positive predictive value (PPV) was 0.62 (95% CI, 0.51–0.71), and negative predictive value (NPV) was 0.91 (95% CI, 0.87–0.93). The area under the hierarchical summary receiver operating characteristic (HSROC) curve was 0.88 (95% CI, 0.85–0.90), indicating good overall diagnostic accuracy despite substantial heterogeneity in sensitivity (I2 = 90%) and specificity (I2 = 71%).

Subgroup analyses highlighted differences in MRI performance between biparametric MRI (bpMRI) and multiparametric MRI (mpMRI), as well as between different versions of the PI-RADS scoring system and types of reference standards used. Prospective studies generally showed lower sensitivity compared to retrospective ones (0.83 vs. 0.85, p = 0.01).

For PCa detection, pooled sensitivity was 0.82 (95% CI, 0.75–0.87) and specificity was 0.74 (95% CI, 0.65–0.82), with an area under the HSROC curve of 0.85 (95% CI, 0.82–0.88). Subgroup analyses based on PI-RADS versions further elucidated the diagnostic performance variations across studies.

Overall, despite variations in study methodologies and imaging protocols, MRI demonstrates promising utility in detecting and characterizing prostate cancer, particularly csPCa, contributing valuable insights for clinical decision-making.

Insights into Diagnostic Accuracy and Clinical Implications

MRI demonstrated robust diagnostic performance for csPCa detection, achieving an area under the hierarchical summary receiver operating characteristic (HSROC) curve of 0.88 (95% CI, 0.85–0.90), indicating overall good accuracy. The pooled sensitivity for csPCa detection was 0.84 (95% CI, 0.79–0.88), highlighting MRI's ability to correctly identify significant prostate cancers. Specificity was 0.76 (95% CI, 0.65–0.84), indicating its capability to avoid unnecessary biopsies when MRI results are negative. The pooled negative predictive value (NPV) for csPCa detection was notably high at 0.91 (95% CI, 0.87–0.93), indicating that a negative MRI result effectively rules out non-csPCa cases.

For overall PCa detection, MRI showed a pooled sensitivity of 0.82 (95% CI, 0.75–0.87) and specificity of 0.74 (95% CI, 0.65–0.82). However,

the pooled positive predictive value (PPV) was lower at 0.66 (95% CI, 0.54–0.76), suggesting caution in interpreting positive MRI findings and the need for additional clinical context before proceeding to biopsy. Subgroup analyses revealed significant variability influenced by MRI protocol variations (e.g., biparametric MRI [bpMRI] vs. multiparametric MRI [mpMRI]), different versions of the Prostate Imaging Reporting and Data System (PI-RADS), and choice of standard reference (e.g., targeted biopsy methods). Notably, studies comparing bpMRI with mpMRI suggested comparable performance in detecting csPCa, advocating for standardized acquisition protocols and quality assessments to optimize diagnostic accuracy.

Valuable tool identified despite study limitations

Limitations of the meta-analysis included predominantly retrospective study designs and considerable heterogeneity among included studies, which may affect the generalizability of findings. Despite these challenges, MRI emerges as a valuable tool in clinical decision-making for men with PSA levels in the gray zone (4–10 ng/mL), aiding in personalized biopsy decisions and potentially reducing unnecessary procedures. Further efforts in standardization and validation are crucial to refine MRI's role in optimizing prostate cancer detection and management.

MRI could be considered a reliable and satisfactory tool to instruct clinical decisions for patients with PSA in the “gray zone,” particularly for csPCa detection. Furthermore, the high NPV of prostate MRI for csPCa detection indicates that negative MRI can reliably rule out the non-csPCa, sparing patients unnecessary biopsy.

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