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Artificial Intelligence Imaging for Distinguishing True Tumor Progression from Treatment-Related Change in Treated Glioma: Systematic Review and Meta-Analysis

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Introduction

Distinguishing true tumor progression from treatment-related imaging change including pseudoprogression, radiation necrosis, or treatment injury after glioma therapy is a common, high-stakes diagnostic dilemma.

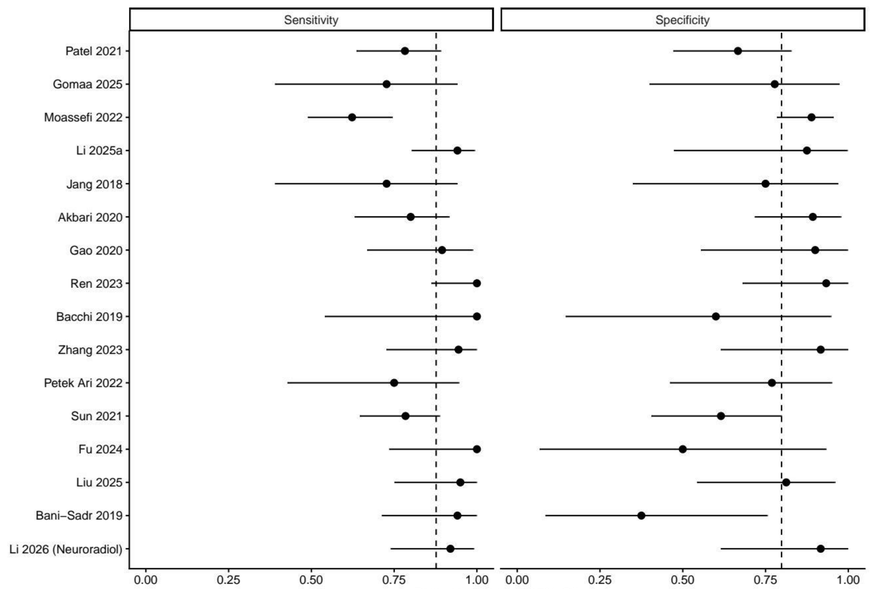
Conventional MRI and RANO criteria often resolve it only in retrospect, and misclassification risks stopping effective therapy or prompting unnecessary surgery.

We systematically reviewed and quantified the diagnostic accuracy of AI-based imaging models for this distinction.

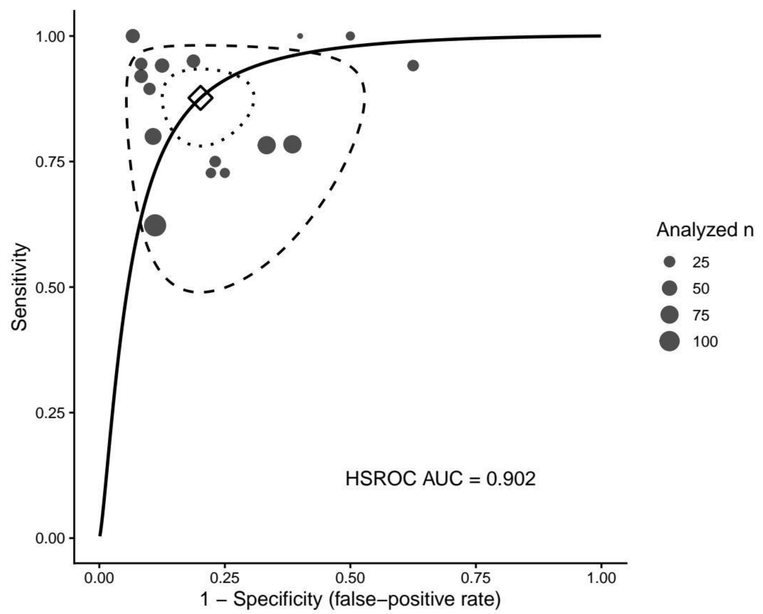
Methods

- PubMed, Scopus, and Web of Science searched through Aug 25, 2026; PRISMA 2020; prospectively registered (PROSPERO).
- 27 studies in the qualitative review; 16 with patient-level 2×2 data (670 patients) in the meta-analysis.
- Sensitivity and specificity pooled with a bivariate random-effects generalized linear mixed model (exact binomial) and hierarchical summary ROC.
- Robustness confirmed with Reitsma and Bayesian models and leave-one-out analysis; risk of bias assessed with QUADAS-2.

Results



Study-level sensitivity and specificity across 16 studies (exact 95% CI).



Summary ROC: pooled operating point with 95% confidence (dotted) and prediction (dashed) regions; AUC 0.902.

Conclusions

- AI-based imaging showed moderate-to-good accuracy — pooled sensitivity 0.877, specificity 0.798, summary AUC 0.902 — robust across frequentist and Bayesian frameworks.
- A negative AI result lowers a 40% pre-test probability of true progression to ~9% (negative LR 0.15); a positive result (positive LR 4.35) is not sufficient to rule in.
- Substantial heterogeneity, wide prediction intervals, and reliance on internally validated single-center models temper readiness.
- These tools are best used as adjunctive decision support — not standalone diagnosis — pending prospective, external, multicenter validation.

References

1. Palavani LB, et al. Neurosurg Rev 2025.
2. Kocak B, et al. Eur Radiol 2025.
3. Wen PY, et al. RANO 2.0. J Clin Oncol 2023.

Full reference list in the manuscript.

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