Radiomics and Artificial Intelligence for Predicting PitNET Consistency: A Systematic Review and Meta Analysis

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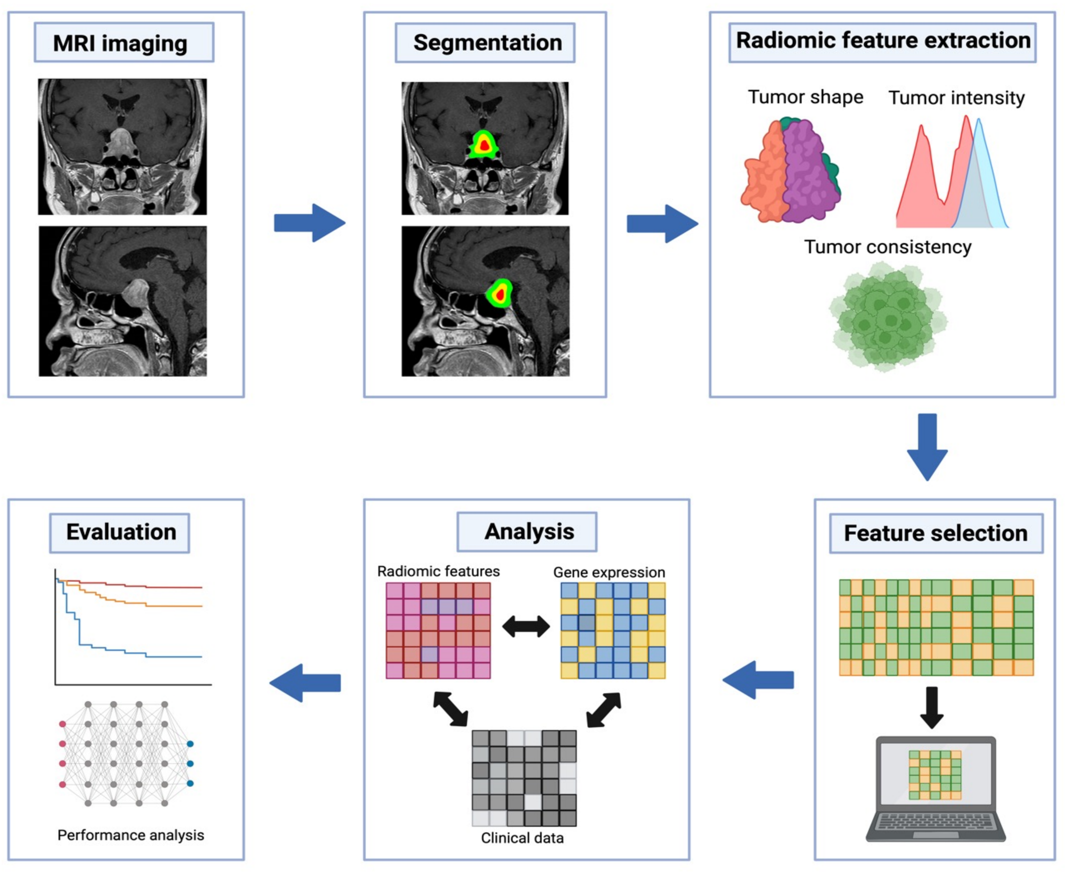
Introduction

Pituitary neuroendocrine tumors (PitNETs) represent approximately 16% of primary brain tumors. The tumor's consistency, whether soft or fibrous, significantly impacts surgical planning and outcomes. Radiomics shows potential for predicting this consistency and assessing surgical outcomes, although its predictive accuracy is still under investigation.

This article aims to conduct a systematic review of the literature and meta-analysis on the utility of artificial intelligence and radiomics to predict the consistency of PitNETs.

Figure 1. Radiomics process.



Methods and Materials

- A systematic review and meta-analysis was conducted and reported following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.
- Four databases were searched for published literature on PitNET consistency prediction using radiomics and/or artificial intelligence.
- Data extraction was carried out independently by two reviewers, and findings were synthesized through narrative analysis and comparative assessment.
- The risk of bias and applicability concerns of the included studies were assessed using the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2). The Radiomics Quality Score (RQS) for each study was calculated to assess adherence to established best practices.
- Meta-analysis was conducted using random-effects modeling and visualized using forest plots.

Figure 2. Inclusion flow diagram based on PRISMA 2020.

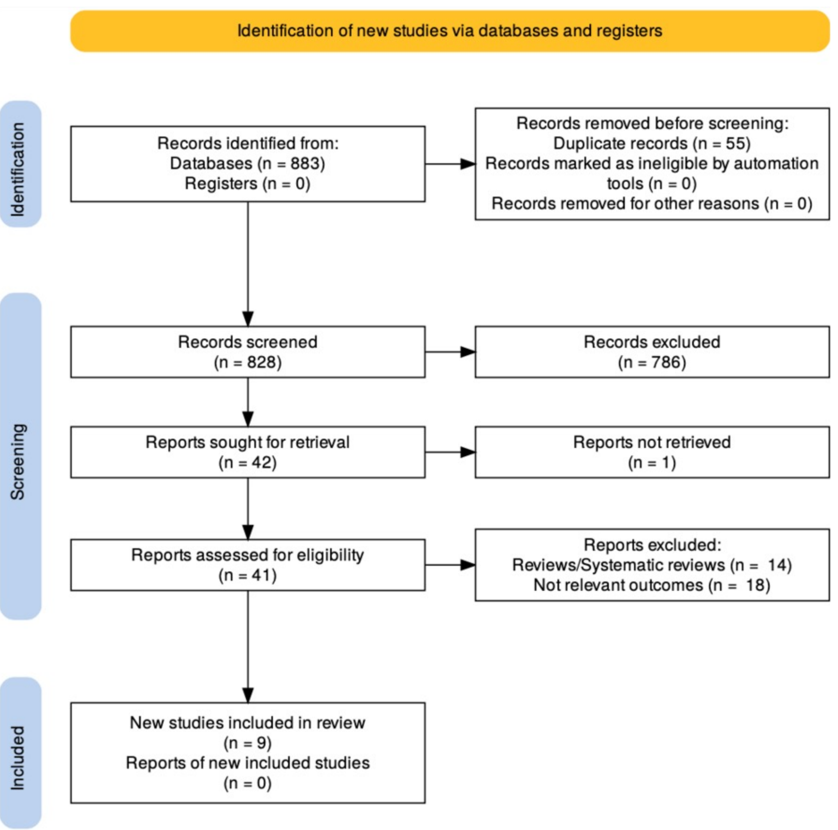
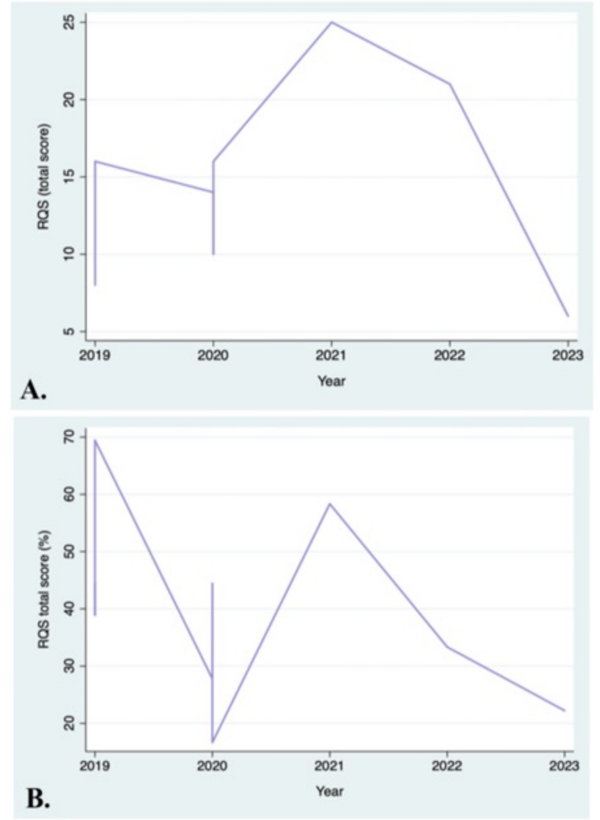


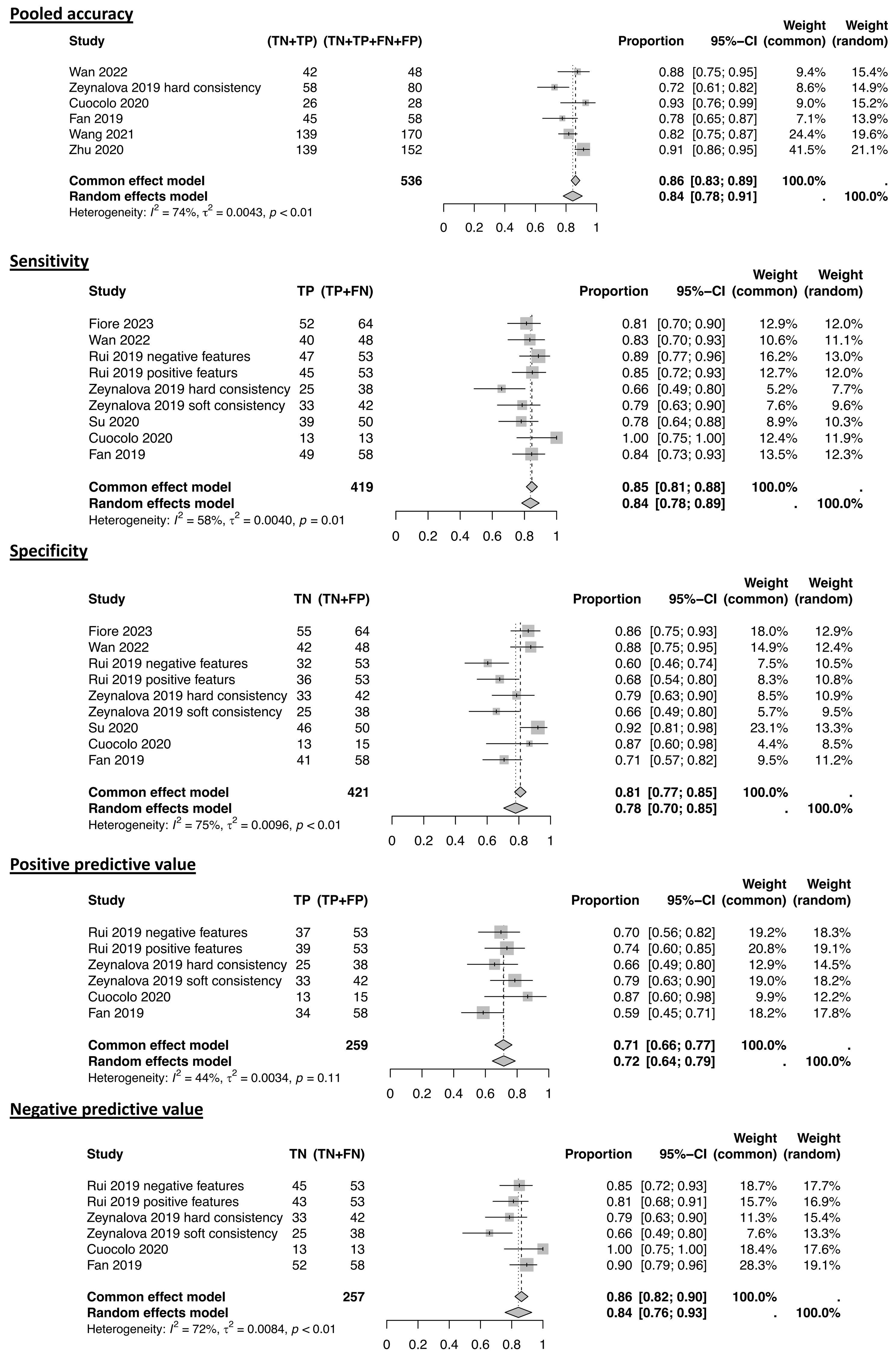
Figure 3. Radiomics Quality Score.



Results

- Nine studies were included, covering 947 patients with PitNETs who underwent tumor consistency prediction using radiomics.
- 66.8% had soft tumors and 33.2% had firm tumors.
- MRI machines with varying magnetic field strengths (1.5T and 3T) and different regions of interest (2D and 3D) were used across studies, with manual segmentation being the most common method.
- Prediction models demonstrated AUC values ranging from 0.71 to 0.99.
- The RQS averaged 14.2 (39.5%), and the QUADAS-2 tool revealed a varied risk of bias, mainly in patient selection and flow/timing domains, though applicability concerns were minimal.
- Meta-analysis showed that algorithms had an overall accuracy of 84% in predicting tumor consistency, with a pooled sensitivity of 84%, specificity of 78%, and an AUC of 0.89, despite significant heterogeneity among studies.

Figure 4. Meta-analysis forest plot graphics.



Limitations

The evolving nature of radiomics technology necessitates further research, particularly studies with larger populations and rigorous internal validation, to refine and validate predictive models. Significant heterogeneity in reporting outcomes.

Conclusions

This study demonstrates the promising potential of radiomics, particularly when combined with artificial intelligence, in the study of neurological tumors, with a focus on predicting the consistency of PitNETs. By distinguishing between soft and firm tumors, radiomics can significantly enhance preoperative planning, influence surgical approaches, and reduce complications, ultimately leading to better surgical outcomes.

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Access QR code for: complete references list, tables and figures.

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