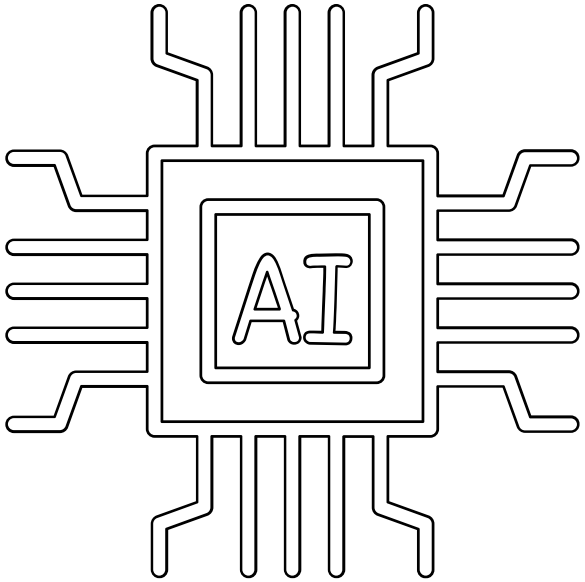


Diagnostic Accuracy of Radiomics-Based Ai Models for Detecting Tumor Deposits on MRI in Rectal Cancer

A Systematic Review and Meta-Analysis

Presented by

Maab Saleh

Medical intern, Mansoura university hospitals

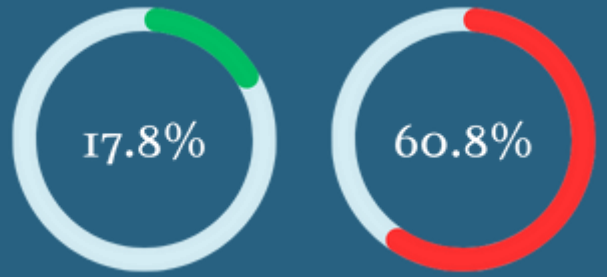
A R T S

Why Tumor Deposits Matter ?

Tumor Deposits in Non-Metastatic Colorectal Cancer

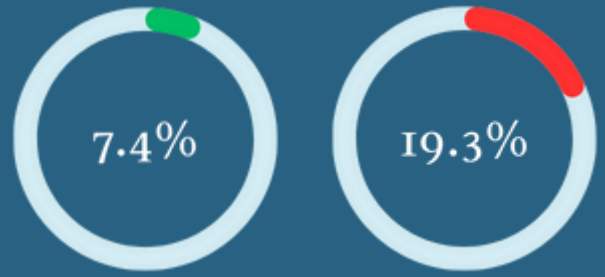
Tabanera et al., 2025

TDs -ve TDs +ve



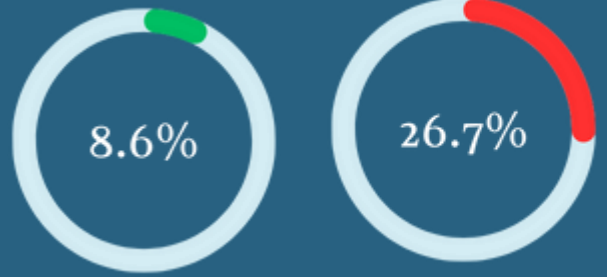
Global recurrence rate

TDs -ve TDs +ve



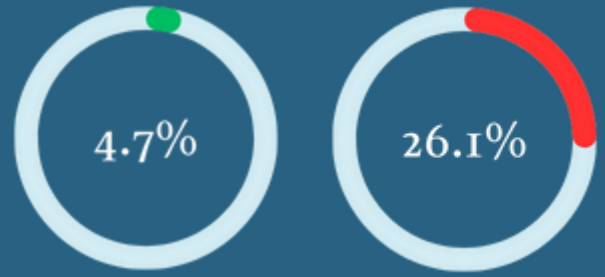
Lung Metastasis

TDs -ve TDs +ve



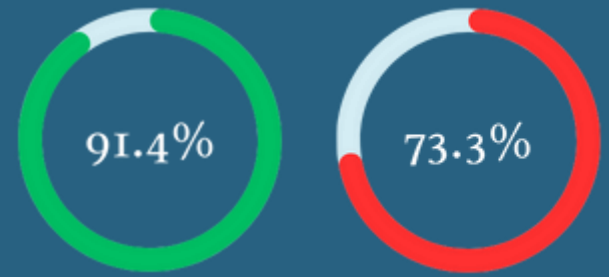
Liver Metastasis

TDs-+ve TDs +ve

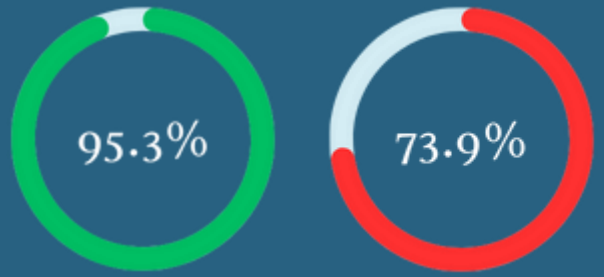


Peritoneal Metastasis

TDs -ve TDs +ve

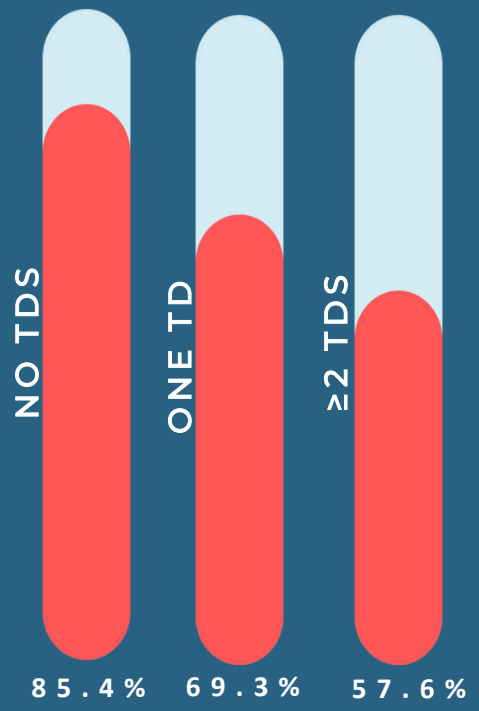


5 years recurrence free survival (RFS) for liver dissemination



5 years recurrence free survival (RFS) for peritoneal dissemination

Tumor Deposits and Extramural vascular invasion are main predictors of survival outcomes in rectal cancer



5-year cancer-specific survival (CSS)

Bhutiani et al., 2024

TDs/EMVI +ve

DFS: HR= 2.95; 95% CI [1.61,5.42]

TDs/EMVI +ve

OS: HR= 1.69; 95% CI [1.01,2.84]

Di Fabio et al., 2024

- **On a multivariate logistic regression TDs were risk factor of:**
- **Post operative distant metastasis OR= 10.15; 95% CI [2.40-42.88]**
- **Pathologically confirmed LNs OR= 5.50; 95% CI [1.85- 16.38]**

Lv et al., 2023

DWI 5 POINTS LIKERT SCALE FOR DETECTION OF PATHOLOGICALLY PROVEN VIABLE EXTRAMURAL VENOUS INVASION OR TUMOR DEPOSIT

Kim et al., 2023

38 %
False negative rate

7 %
False positive rate

In a Radiology 2023 whole-mount–validated cohort of 117 post-nCRT rectal cancers, a 5-point Likert read of DW-MRI for viable EMVI/tumor deposits achieved per-patient **Sensitivity** 62% (95% CI 42–79) and **Specificity** 93% (86–98)

REFERENCE: KIM TH, FIRAT C, THOMPSON HM, GANGAI N, ZHENG J, CAPANU M, BATES DDB, PARODER V, GARCÍA-AGUILAR J, SHIA J, GOLLUB MJ, HORVAT N. EXTRAMURAL VENOUS INVASION AND TUMOR DEPOSIT AT DIFFUSION-WEIGHTED MRI IN PATIENTS AFTER NEOADJUVANT TREATMENT FOR RECTAL CANCER. RADIOLOGY. 2023 AUG;308(2):E230079. DOI: 10.1148/RADIOL.230079. PMID: 37581503; PMCID: PMC10478788.

Radiomics

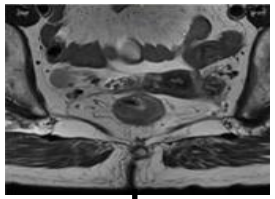
From pixels to the scalpel: MRI-radiomics in rectal cancer is already predicting pre-op nodal staging, local metastasis and pathologic complete response after chemoradiation.

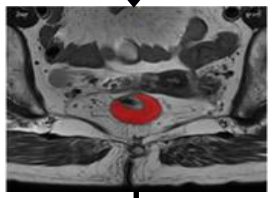
Radiomics Process

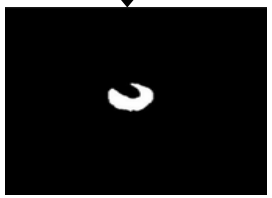
1 → 2 → 3 → 4 → 5

IMAGE ACQUISITION

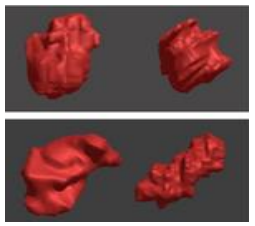
IMAGE SEGMENTATION



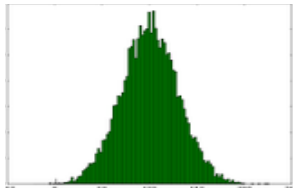




FEATURE EXTRACTION



SHAPE

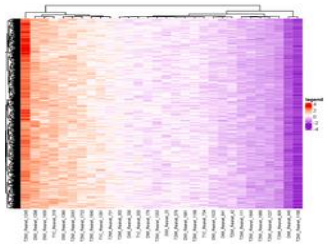


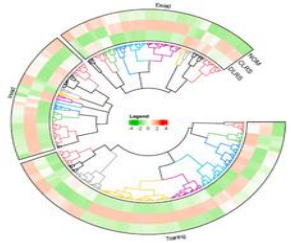
TUMOR INTENSITY

2	1	3	2	4	1
4	3	2	1	2	3
1	2	4	1	3	2
	1	4	2	4	3
2		3	1	1	2

TEXTURE

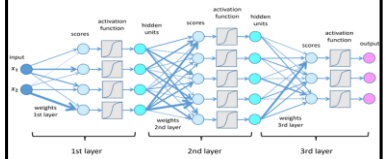
FEATURE SELECTION



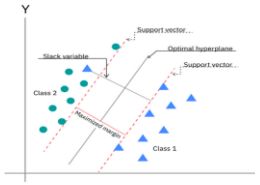


LR,LASSO, ..ETC.

AI MODEL



NEURAL NETWORKS



SUPPORT VECTOR MACHINES

RANDOM FOREST

Methods

- We followed PRISMA statement guidelines and Cochrane handbook of systematic review of diagnostic test accuracy studies.

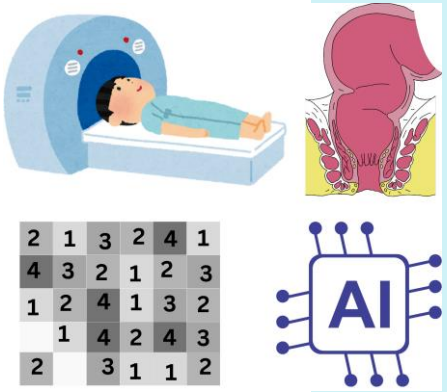
Search strategy

- Systematic literature search conducted in PubMed, Scopus, Web of Science, and Cochrane Library up to February 2025.
- Search terms combined keywords: radiomics, artificial intelligence, tumor deposits, rectal cancer, MRI.

PubMed.gov Scopus® Clarivate Web of Science™ Cochrane

Eligibility Criteria

- Inclusion: studies using **MRI-based radiomics models** for detecting tumor deposits in rectal cancer.
- Exclusion: non-radiomics studies, non-MRI imaging, other cancer types, reviews, editorials.



Study selection

- Screening conducted in **two steps**:
  I. **Title/abstract screening**
  II. **Full-text review**
- Used **Rayyan software** for **independent, blinded screening** by two reviewers.

Quality Assessment

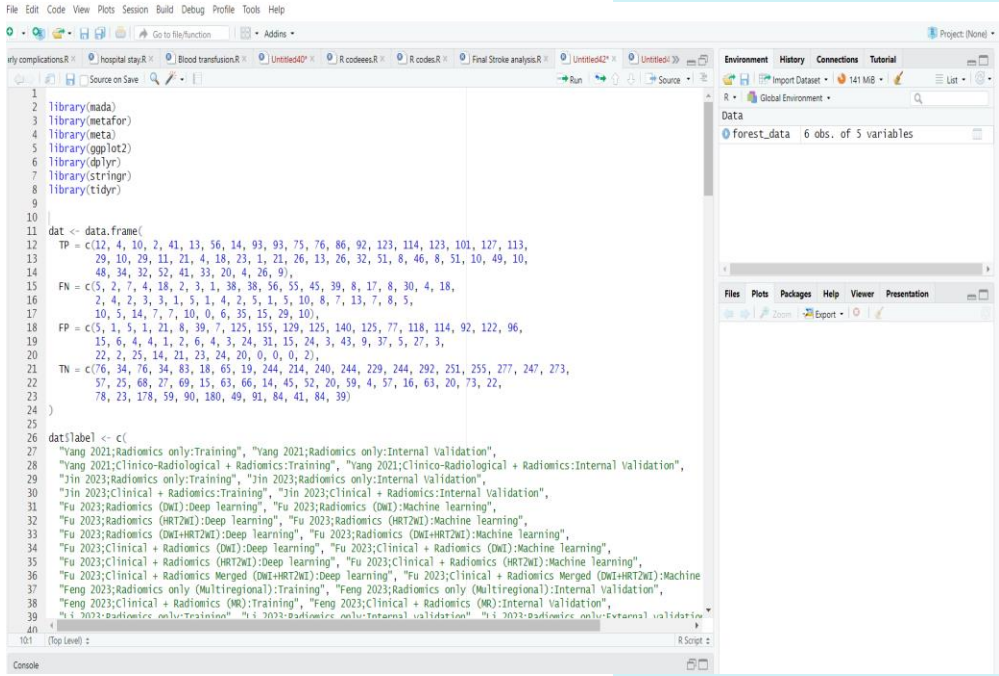
- Assessed risk of bias using **QUADAS-2 tool**.

Data Extraction

- Extracted study characteristics, MRI sequences, radiomics features, modeling methods, validation strategies.
- Constructed **2×2 tables (TP, FP, TN, FN)** for diagnostic meta-analysis.

Statistical Analysis

- Performed in R (version 4.4.2) using appropriate diagnostic accuracy meta-analysis packages.
- Applied **bivariate random-effects model** to pool sensitivity, specificity, AUC and Youden balanced accuracy.
- Heterogeneity assessed with **Zhou and Dendukuri approach I^2 statistic** adapted for diagnostic test accuracy studies.
- Subgroup analyses by **MRI sequence** and **feature set (radiomics-only vs radiomics + clinical/radiologic)**.



```
library(mada)
library(metafor)
library(meta)
library(ggplot2)
library(dplyr)
library(stringr)
library(tidyr)

dat <- data.frame(
  TP = c(12, 4, 10, 2, 41, 13, 56, 14, 93, 93, 75, 76, 86, 92, 123, 114, 123, 101, 127, 113,
         29, 10, 29, 11, 21, 4, 18, 23, 1, 21, 26, 13, 26, 32, 51, 8, 46, 8, 51, 10, 49, 10,
         48, 34, 32, 52, 41, 33, 20, 4, 26, 9),
  FN = c(5, 2, 7, 4, 18, 2, 3, 1, 38, 38, 56, 55, 45, 39, 8, 17, 8, 30, 4, 18,
         2, 4, 2, 3, 3, 1, 5, 1, 4, 2, 5, 1, 5, 10, 8, 7, 13, 7, 8, 5,
         10, 5, 14, 7, 7, 10, 0, 6, 35, 15, 29, 10),
  FP = c(5, 1, 5, 1, 21, 8, 39, 7, 125, 155, 129, 125, 140, 125, 77, 118, 114, 92, 122, 96,
         15, 6, 4, 4, 1, 2, 6, 4, 3, 24, 31, 15, 24, 3, 43, 9, 37, 5, 27, 3,
         22, 2, 25, 14, 21, 23, 24, 20, 0, 0, 0, 2),
  TN = c(76, 34, 76, 34, 83, 18, 65, 19, 244, 214, 240, 244, 229, 244, 292, 251, 255, 277, 247, 273,
         57, 25, 68, 27, 69, 15, 63, 66, 14, 45, 52, 20, 59, 4, 57, 16, 63, 20, 73, 22,
         78, 23, 178, 59, 90, 180, 49, 91, 84, 41, 84, 39)
)

dat$label <- c(
  "Yang 2021;Radiomics only:Training", "Yang 2021;Radiomics only:Internal Validation",
  "Yang 2021;Clinico-Radiological + Radiomics:Training", "Yang 2021;Clinico-Radiological + Radiomics:Internal Validation",
  "Jin 2023;Radiomics only:Training", "Jin 2023;Radiomics only:Internal Validation",
  "Jin 2023;Clinical + Radiomics:Training", "Jin 2023;Clinical + Radiomics:Internal Validation",
  "Fu 2023;Radiomics (DWI):Deep learning", "Fu 2023;Radiomics (DWI):Machine learning",
  "Fu 2023;Radiomics (HRT2WI):Deep learning", "Fu 2023;Radiomics (HRT2WI):Machine learning",
  "Fu 2023;Radiomics (DWI+HRT2WI):Deep learning", "Fu 2023;Radiomics (DWI+HRT2WI):Machine learning",
  "Fu 2023;Clinical + Radiomics (DWI):Deep learning", "Fu 2023;Clinical + Radiomics (DWI):Machine learning",
  "Fu 2023;Clinical + Radiomics (HRT2WI):Deep learning", "Fu 2023;Clinical + Radiomics (HRT2WI):Machine learning",
  "Fu 2023;Clinical + Radiomics Merged (DWI+HRT2WI):Deep learning", "Fu 2023;Clinical + Radiomics Merged (DWI+HRT2WI):Machine
  "Feng 2023;Radiomics only (Multiregional):Training", "Feng 2023;Radiomics only (Multiregional):Internal Validation",
  "Feng 2023;Clinical + Radiomics (MR):Training", "Feng 2023;Clinical + Radiomics (MR):Internal Validation",
```

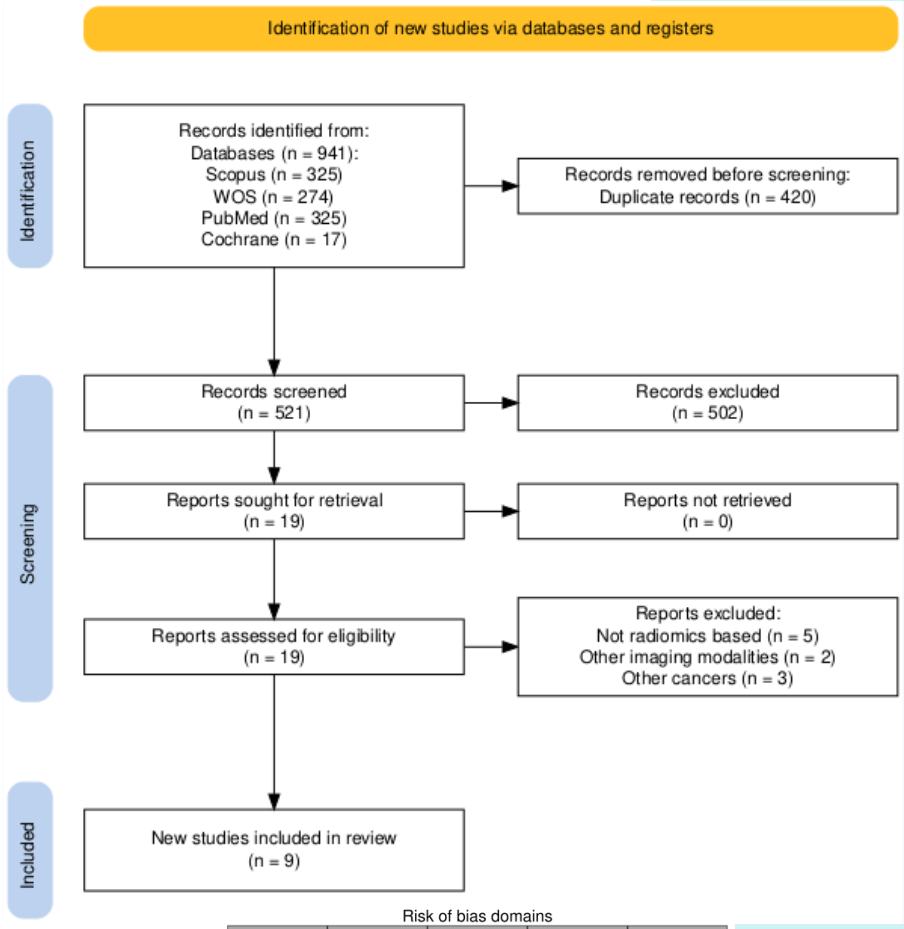
Results

Study Inclusion

- **9 studies** included (2021–2025) after Rayyan two-step screening.
- Cohorts ranged from **retrospective single-center to multi-center** validations.

Quality Assessment

- **5 studies**: low risk of bias.
- **4 studies**: some concerns



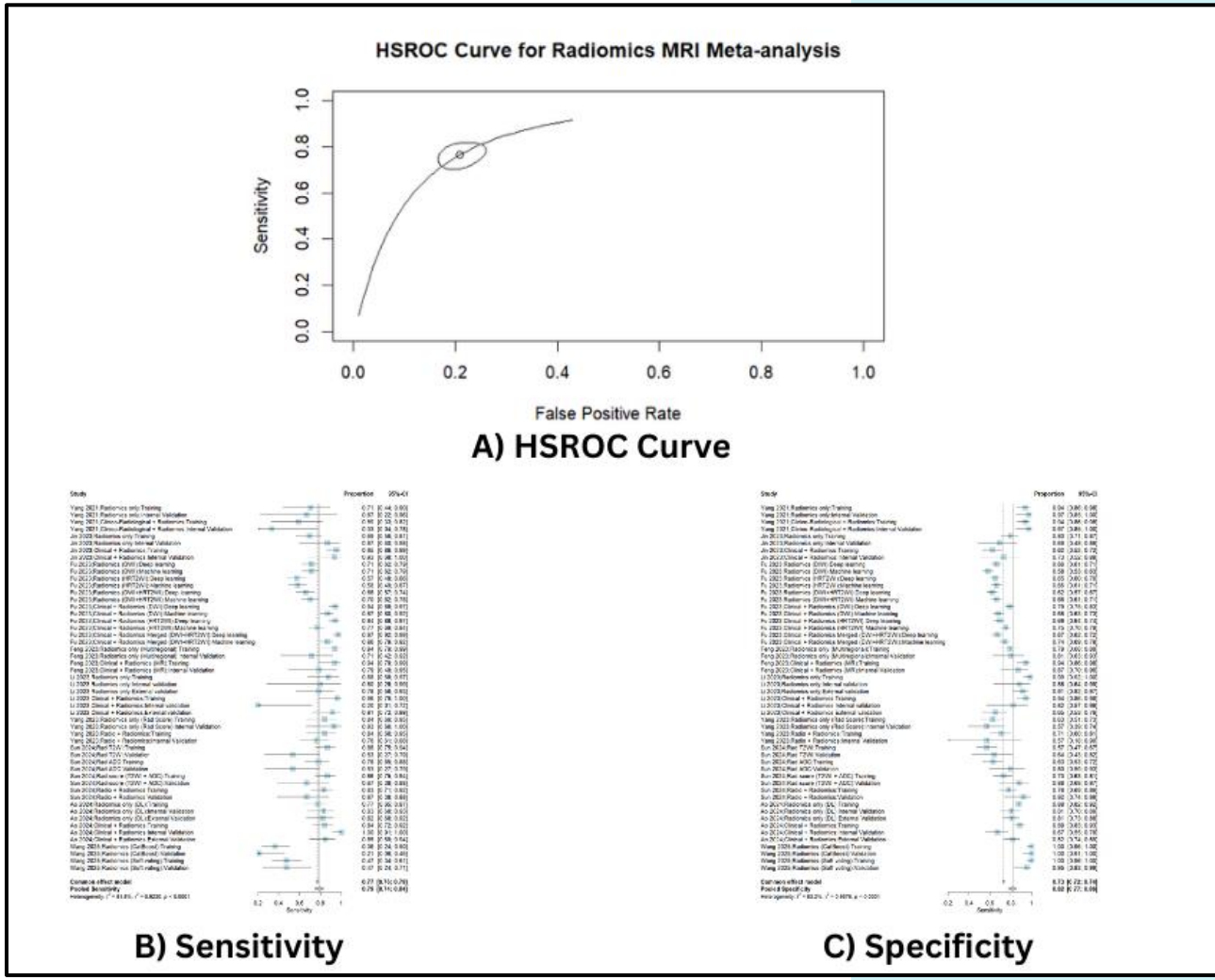
Pooled Diagnostic test accuracy

All cohorts

Pooled Diagnostic Performance

(All cohorts)

- **Sensitivity:** 76.5% (95% CI [71.4%-80.9%])
- **Specificity:** 79% (95% CI [82.5%-75%])
- **AUC:** 0.845
- **Heterogeneity:** I^2 = 7.3% (very low).



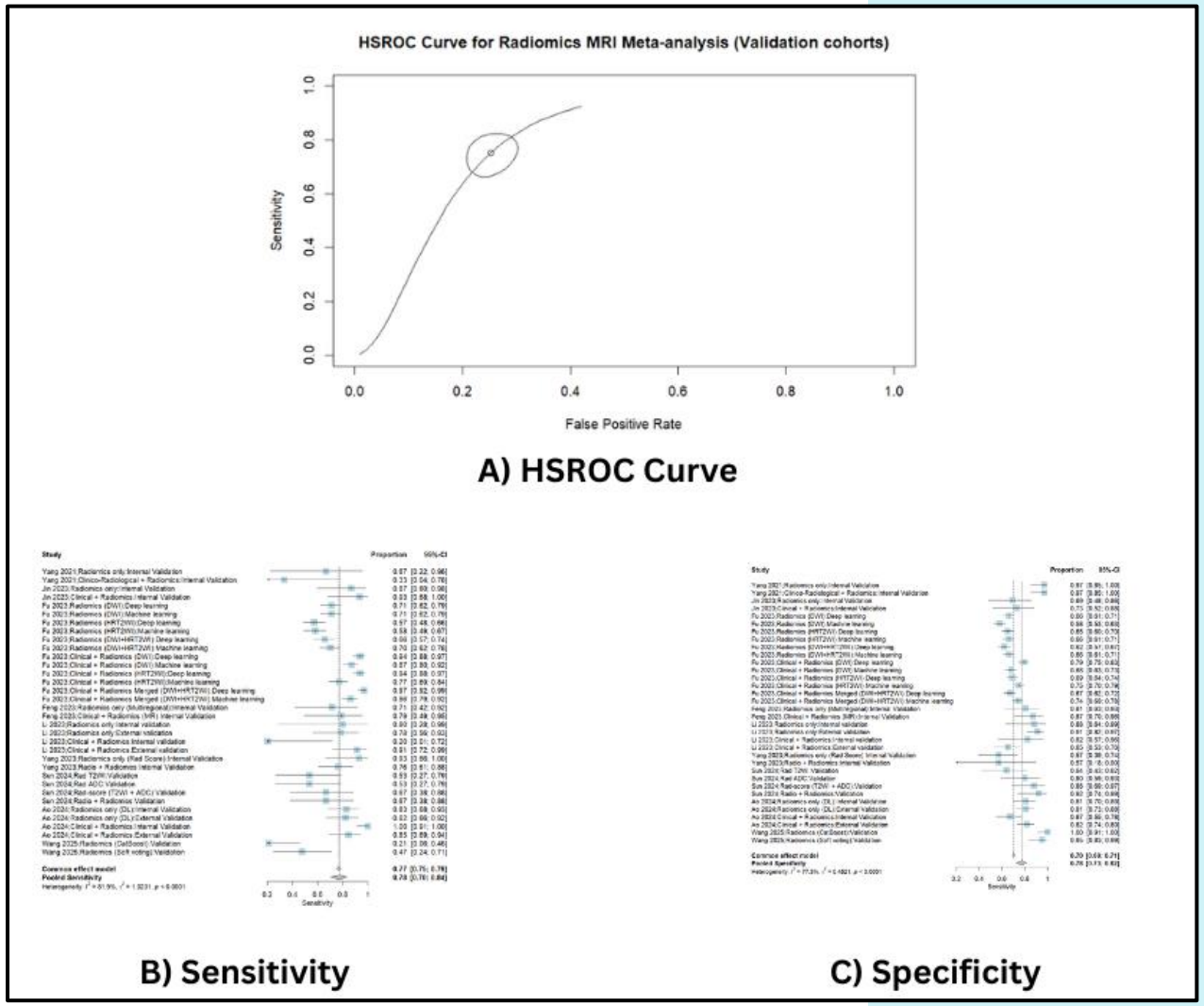
Pooled Diagnostic test accuracy

Validation cohorts only

Pooled Diagnostic Performance

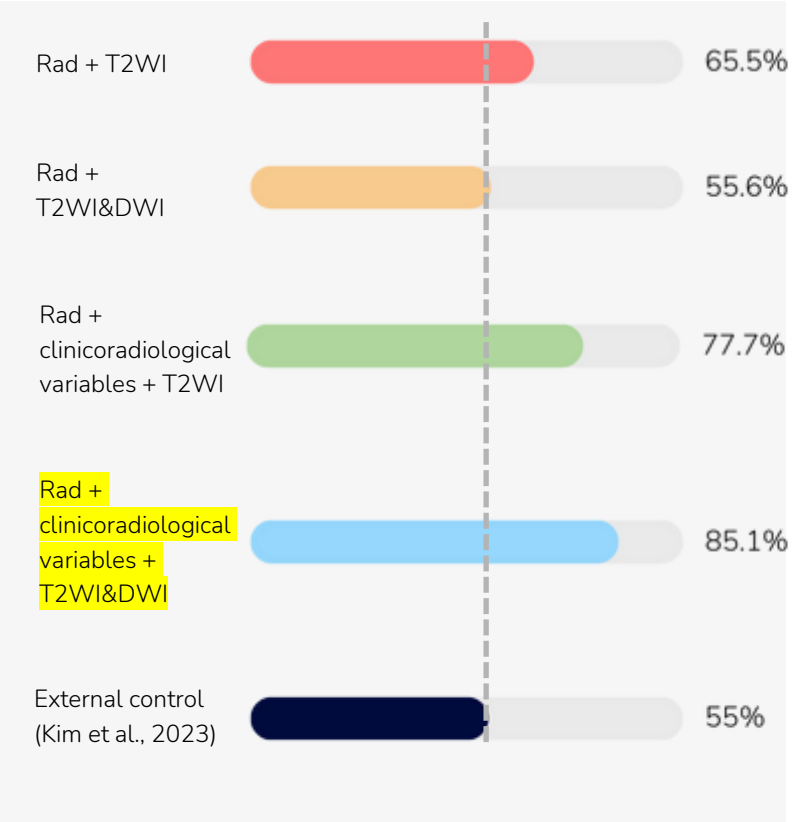
(Validation cohorts only)

- **Sensitivity:** 75.1% (95% CI [68.1%-80.9%])
- **Specificity:** 74.8% (95% CI [70.8%-78.4%])
- **AUC:** 0.806
- **Heterogeneity:** I^2 = 7.9% (very low).

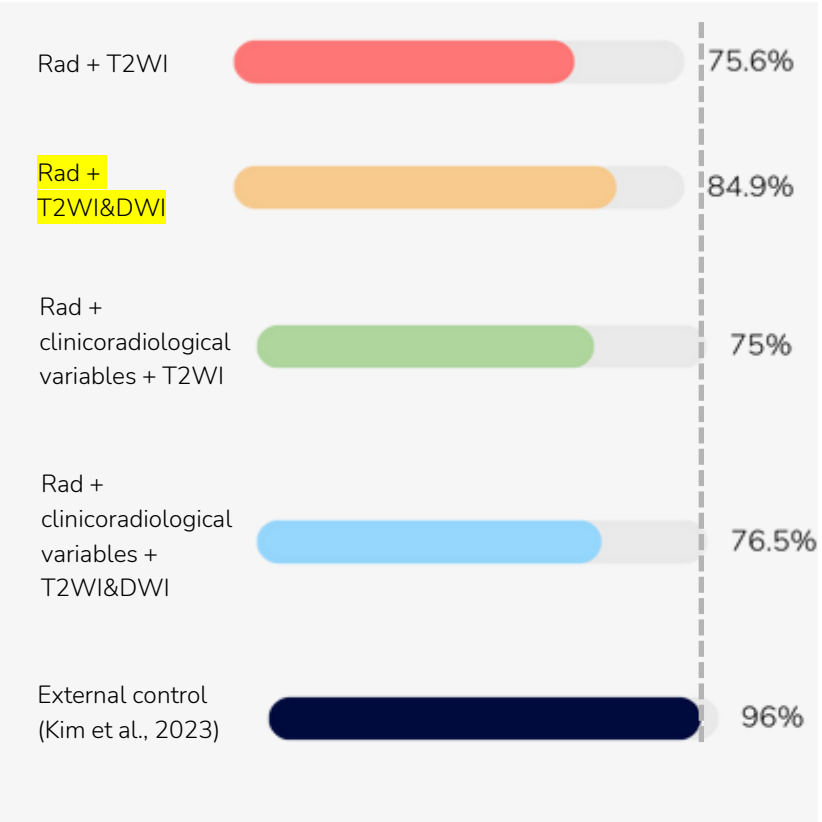


Sub-groups

Sensitivity

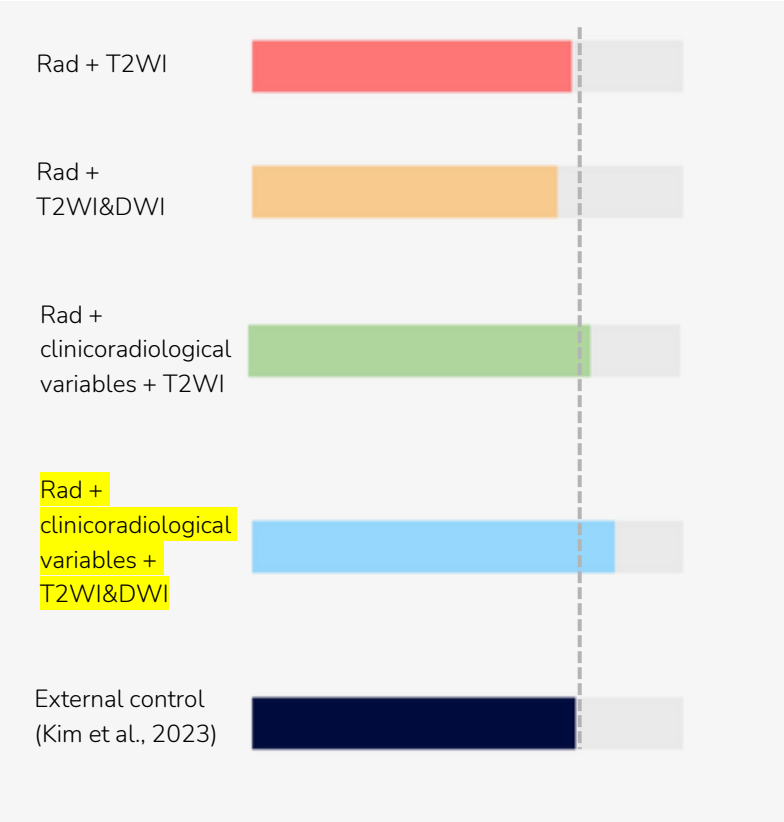


Specificity

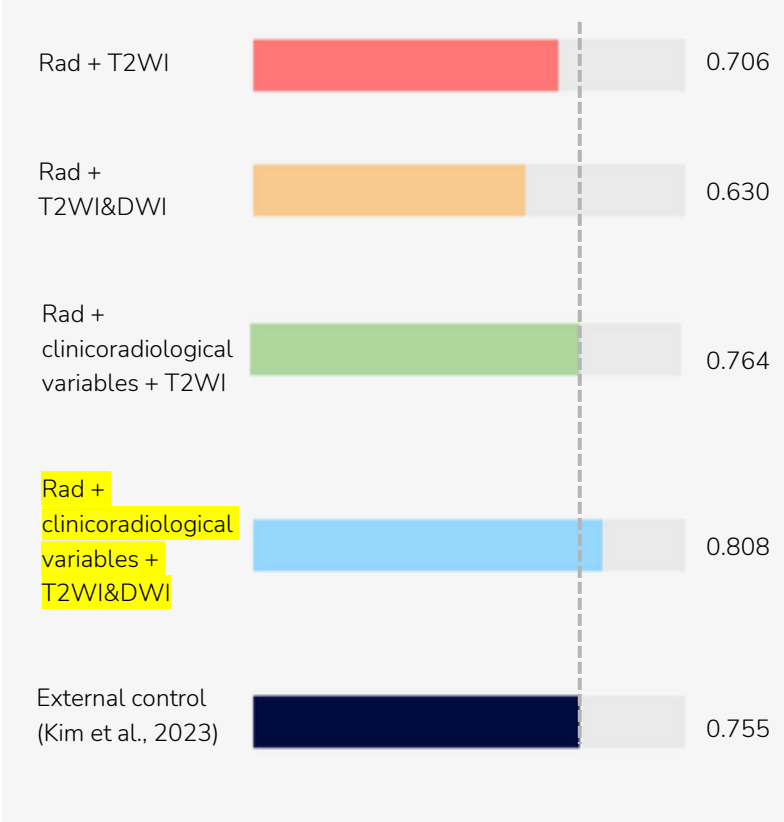


Sub-groups

AUC



Youden Balanced accuracy



Take Home message

Radiomics-based MRI models demonstrate promising diagnostic accuracy for detecting tumor deposits in rectal cancer, with pooled AUC around **0.85** and balanced sensitivity and specificity.

Validation-only cohorts confirm generalizability, showing slightly lower but consistent performance (AUC ~0.81)

Take Home message

Take Home message

Combining radiomics with clinical/radiologic variables significantly improves sensitivity without compromising specificity, highlighting the value of multimodal integration.

Take Home message

MRI sequence matters: T2WI+DWI yields the highest specificity, while DWI alone shows variable results with higher heterogeneity.

Take Home message

Time to move from **promising papers** to **clinic-ready tools** that sharpen surgical triage

Thanks a lot

It’s a privilege to present here. As intern doctors, we’re deeply grateful for the opportunity and the warm welcome.

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