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Diagnostic Accuracy of Magnetic Resonance Imaging in Assessing Myometrial Invasion in Endometrial Carcinoma: A Retrospective Single Centre Study

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Abstract

Background: Endometrial carcinoma is the most common gynecologic malignancy in developed nations. Accurate preoperative assessment of myometrial invasion is critical for staging and guiding surgical management. This study aimed to evaluate the diagnostic accuracy of 1.5 Tesla plain magnetic resonance imaging (MRI) in determining the depth of myometrial invasion compared with postoperative histopathology. ***Materials and Methods:*** A retrospective analysis was conducted on 189 patients with histologically confirmed endometrial carcinoma who underwent preoperative 1.5 T plain MRI using T1- and T2-weighted sequences. MRI findings were correlated with histopathological staging, and diagnostic indices, including sensitivity, specificity, predictive values, and area under the curve (AUC), were calculated across FIGO stages. ***Results:*** The mean patient age was 56.3 years, predominantly postmenopausal. MRI accuracy for detecting myometrial invasion was 85.8 % for Stage IA, 63.8 % for Stage IB, and 66.6 % for Stage II disease. Overall, MRI demonstrated 27.8 % sensitivity, 81.8 % specificity, 71.4 % PPV, and 40.9 % NPV, with an AUC of 0.562. ***Conclusion:*** Plain 1.5 T MRI showed moderate diagnostic accuracy with high specificity for early-stage endometrial carcinoma but limited sensitivity for advanced invasion. The study underscores MRI's role as a practical preoperative tool, particularly in resource-limited settings lacking contrast or diffusion-weighted imaging.

Keywords: ***Diagnostic accuracy, Endometrial carcinoma, Magnetic Resonance Imaging, Myometrial invasion.***

Introduction

Endometrial carcinoma is the most common gynecologic malignancy in developed countries and constitutes a major cause of cancer-related morbidity among women worldwide. The average age at diagnosis is approximately 63 years, and most patients present with disease confined to the uterine corpus at the time of diagnosis. In contrast, developing nations such as India have traditionally shown a four- to fivefold lower incidence, but recent trends indicate an increase in prevalence, likely due to changing dietary habits, obesity, and physical inactivity (Mahdy *et al*., 2025; Tang *et al*., 2025).

Histologically, endometrial carcinoma is classified into Type I (endometrioid) and Type II (non-endometrioid) tumors. Type I cancers, which are estrogen-dependent, account for the majority and typically exhibit microsatellite instability and PTEN, PIK3CA, or KRAS mutations. Type II tumors, including serous and clear-cell subtypes, are p53-mutated and display a more aggressive clinical course (Okuda *et al*., 2010).

The Cancer Genome Atlas (TCGA) has further refined this framework by delineating four molecular subtypes POLE ultra mutated, microsatellite instability high, copy number–low, and copy number high groups each associated with distinct prognostic implications (Espinosa *et al*., 2024).

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Among prognostic factors, the depth of myometrial invasion remains one of the most powerful predictors of recurrence, lymphovascular invasion, and lymph node metastasis. Deep invasion beyond the inner half of the myometrium correlates strongly with pelvic lymph node metastasis rates of up to 34% and distant metastasis rates approaching 40%, compared with <5% in tumors confined to the endometrium (Maheshwari *et al*., 2022; Jin *et al*., 2022).

Accurate preoperative assessment of invasion depth is therefore crucial for risk stratification, surgical planning, and fertility-sparing decision-making. Magnetic Resonance Imaging (MRI) has emerged as the imaging modality of choice for local staging of endometrial carcinoma (Pinto. 2025). T2-weighted MRI provides excellent anatomic detail, while dynamic contrast-enhanced (DCE) MRI and diffusion-weighted imaging (DWI) significantly enhance sensitivity for distinguishing superficial from deep myometrial invasion and for detecting cervical stromal extension (Jin *et al*., 2022; Nougaret *et al*., 2025).

Despite these strengths, the diagnostic performance of MRI may vary across centers, especially in settings where only non-contrast (plain) MRI is routinely available. Given the emerging burden of endometrial carcinoma in India and the need for cost-effective diagnostic accuracy in resource-limited environments, this study was undertaken to to evaluate the diagnostic accuracy of plain 1.5T MRI in assessing the depth of myometrial invasion compared to histopathology in patients with endometrial carcinoma.

Methods

Study design and setting

This retrospective observational study was conducted at the Government Arignar Anna Memorial Cancer Hospital, Karapettai, Kanchipuram, Tamil Nadu, India, a tertiary regional oncology center. The study period spanned July 2017 to July 2023. The study was approved by the Institutional ethics committee of Chengalpattu Medical College (Registration No: ECR/774/Inst/TN/2015; Ref.No.: CMCH -22-PR-173).

The institutional database was reviewed to identify all patients with a histopathologically confirmed diagnosis of carcinoma endometrium who underwent definitive surgical management during the study period. The institutional multidisciplinary tumor board approved treatment planning for all cases according to standard guidelines.

Study population

All women aged >18 years who underwent elective surgical staging for endometrial carcinoma and had preoperative magnetic resonance imaging (MRI) performed at the same institution were included.

Inclusion criteria

(1) Histologically confirmed primary endometrial carcinoma. (2) Patients who underwent definitive surgical staging including hysterectomy and bilateral salpingo-oophorectomy. (3) Availability of preoperative MRI scan performed within four weeks prior to surgery. (4) Complete postoperative histopathological examination (HPE) report available.

Exclusion criteria

(1) Recurrent endometrial carcinoma or patients undergoing pelvic exenteration. (2) Patients who received neoadjuvant chemotherapy or radiotherapy before surgery. (3) Patients who underwent fertility-sparing procedures without uterine removal. (4) Postoperative histopathological diagnosis other than carcinoma endometrium (e.g., uterine sarcoma). (5) Evidence of metastatic disease on preoperative imaging.

DOMI classification

The DOMI (Degree of Myometrial Invasion) was calculated based on MRI findings assessing the extent of myometrial invasion. All MRI scans were interpreted by an experienced radiologistand was blinded to histopathological findings, and surgical outcomes at the time of image interpretation. The MRI finding variables was created by categorizing patients into two groups.

DOMI >50: Myometrial invasion greater than 50% of the myometrial thickness.

DOMI <50: Myometrial invasion less than 50% of the myometrial thickness.

This binary classification was used to assess its predictive ability in distinguishing between Stage 1 (early-stage) and Stage 2+ (advanced-stage) disease.

Histopathological analysis

Postoperative specimens were examined by senior pathologists specializing in gynecologic oncology. The following parameters were documented: (1) Histologic type and grade (FIGO 2020 grading), (2) Depth of myometrial invasion (inner vs outer half), (3) Cervical stromal, serosal, and adnexal involvement, (4) Lymphovascular space invasion (LVSI) and nodal status where available. HPE staging was considered the reference standard (gold standard) against which MRI findings were compared.

Data collection and variables

Data extracted from institutional records included: (1) Demographic details (age, menopausal status), (2) Clinical presentation and comorbidities, (3) Tumor grade and histologic subtype, (4) MRI-based preoperative stage, (5) final postoperative HPE stage. All data were anonymized before analysis.

Statistical analysis

Descriptive statistics were performed for continuous variables (e.g., age, tumor grade) and categorical variables (e.g., Stage 1 vs. Stage 2+, DOMI >50 vs. DOMI <50). Binomial logistic regression was used to assess the relationship between DOMI (DOMI >50 vs. DOMI <50) and STAGE (Stage 2+ vs. Stage 1). The odds ratio (OR) and 95% confidence intervals (CIs) were computed for the predictor variable (DOMI).

The Receiver Operating Characteristic (ROC) curve was generated to evaluate the diagnostic accuracy of MRI in distinguishing between Stage 1 and Stage 2+. The area under the curve (AUC), sensitivity, specificity, and predictive values were calculated. Statistical significance was set at $p < 0.05$ for all tests. All statistical analyses were performed using Jamovi (Version 2.6.44) software.

Results

A total of 189 patients who underwent surgical management for carcinoma endometrium between July 2017 and July 2023 were included in the study. The mean age of the patients was 56.3 years (median: 55; SD: ±9.23) with a range from 33 to 70 years, reflecting the predominance of peri- and postmenopausal women in this malignancy group. All patients underwent either laparoscopic or open surgical staging, including total hysterectomy with bilateral salpingo-oophorectomy, peritoneal washings, and bilateral pelvic lymph node dissection. Omentectomy was performed selectively in

cases of Grade III tumors or non-endometrioid histology (serous or clear cell types) (**See Table 1**). The majority of patients were postmenopausal. The distribution of comorbidities was as 36.5 % (n:36.5) diabetes mellitus, 38.7% (n:73) hypertension, 6.3% (n:12) heart disease and 10.6% (n:20) for others (Asthma, Kidney Disease, Seizures).

Tumor characteristics

The histopathological grading of tumors showed a predominance of Grade I (70.9%) endometrioid adenocarcinomas, followed by Grade II (15.3%) and Grade III (13.8%) lesions (**See Table 1**).

MRI Staging and pathological staging concordance

The concordance between preoperative MRI staging and postoperative histopathology (HPE) staging is summarized table 2.

The highest MRI accuracy was observed in Stage IA, with 85.8% concordance with HPE. Stage IB showed 63.8% accuracy, with 27.6% of patients downstaged postoperatively, while Stage II showed 66.6% accuracy, with 14% of patients upstaged due to unrecognized serosal or bowel involvement.

Diagnostic performance of MRI

ROC analysis was conducted to assess the diagnostic performance of MRI in detecting myometrial invasion. The AUC for MRI was 0.562, indicating moderate performance. The AUC of 0.562 suggests that MRI provides moderate accuracy, but its high specificity (100%) and zero sensitivity indicate that the model is biased towards predicting Stage 1 (**See Table 3 and Figure 1**).

Logistic regression for STAGE prediction

A binomial logistic regression was performed to evaluate the role of DOMI (DOMI >50 vs. DOMI <50) in predicting STAGE (Stage 2+ vs. Stage 1) (**See Table 4**).

Final diagnostic accuracy

The final diagnostic accuracy for Stage 2+ prediction based on DOMI was assessed (**See Table 5**).

These findings highlight that while the model shows high specificity, it is poor at predicting Stage 2+ (27.78% sensitivity). The PPV is moderate at 71.43%, but the accuracy remains 48.28%, indicating the model's limited effectiveness.

Table I: Distribution of tumor grades

Tumor Grade	Number of Cases (n=189)	Percentage (%)
Grade I	134	70.9
Grade II	29	15.3
Grade III	26	13.8

Table II: Table compares preoperative MRI staging with postoperative histopathology (HPE) staging for endometrial carcinoma

Preoperative MRI stage	Postoperative HPE stage	Number of cases (n)	Percentage (%)
Stage IA (N=127)	Stage IA	109	85.8%
	Stage IB	11	8.7%
	Stage II	6	4.7%
	Stage IIIA	1	0.8%
Stage IB (N=47)	Stage IA	13	27.6%
	Stage IB	30	63.8%
	Stage II	-	-
	Stage IIIA	4	8.5%
Stage II (N=15)	Stage II	10	66.6%
	Stage IIIA	4	26.7%
	Stage IVA	1	6.7%

Table III: Table summarizes the sensitivity, specificity, accuracy, and predictive values for MRI in detecting myometrial invasion in endometrial carcinoma.

Metric	Value
AUC	0.562
Sensitivity	0%
Specificity	100%
Accuracy	75.9%
Positive Predictive Value (PPV)	27.8%
Negative Predictive Value (NPV)	81.8%

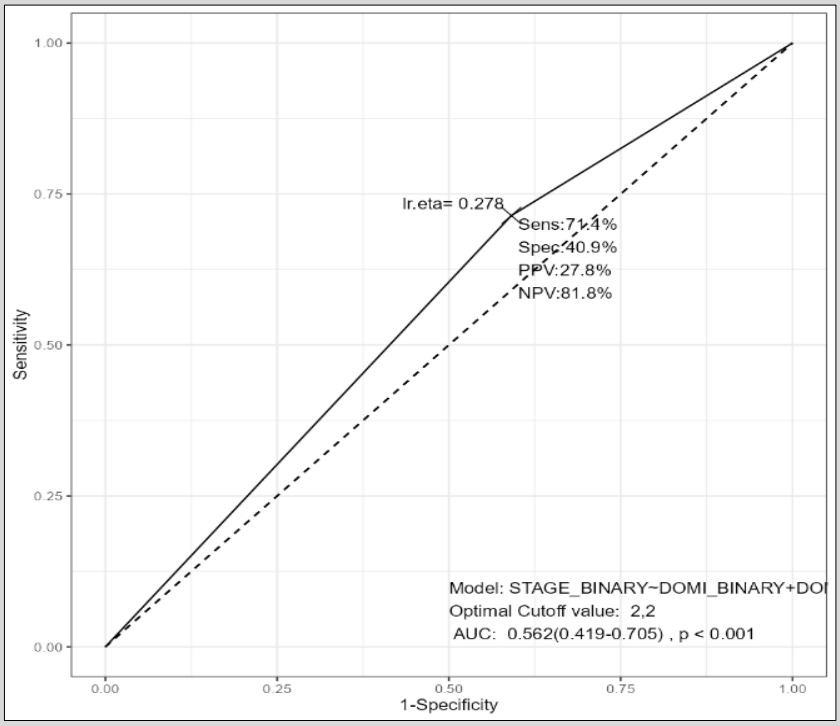

Fig. 1: ROC curve for MRI diagnostic performance

Table IV: Logistic regression results for predicting stage (Stage 2+ vs. Stage 1).

Predictor	Estimate	95% CI	SE	Z	p-value	Odds Ratio
Intercept	-1.504	(-2.587, -0.421)	0.553	-2.721	0.007	0.222
DOMI_BINARY (>50 vs <50)	0.549	(-0.757, 1.855)	0.666	0.823	0.410	1.731

Table V: Table summarizes the diagnostic performance metrics for the prediction of Stage 2+ versus Stage 1 using DOMI >50 vs. DOMI <50.

Metric	Value
Sensitivity	27.78%
Specificity	81.82%
Accuracy	48.28%
Positive Predictive Value (PPV)	71.43%
Negative Predictive Value (NPV)	40.91%

Discussion

The present study, conducted at a regional cancer center, demonstrated an overall diagnostic accuracy of 63–85% for assessing myometrial invasion using plain 1.5 T MRI, with the highest concordance for Stage IA disease. These findings align closely with global data while underscoring MRI's value even in resource-limited settings where contrast or diffusion-weighted imaging (DWI) is not routinely available.

In the landmark study by Takeuchi *et al*. the use of T2-weighted, diffusion-weighted, and dynamic contrast-enhanced (DCE) MRI achieved a diagnostic accuracy of 96% for deep myometrial invasion, highlighting the incremental benefit of multiparametric imaging in delineating tumor myometrium interfaces (Takeuchi *et al*.,2018). Similarly, Zamani *et al*. employing a 1.5 T system with gadolinium enhancement, reported sensitivity 82%, specificity 95%, and overall accuracy 90.7%, with a strong MRI–pathology agreement (κ = 0.72). Both studies emphasize that contrast and DWI sequences substantially improve staging precision, particularly in differentiating tumors that are isointense with the myometrium on T2-weighted images (Zamani *et al*., 2012).

In contrast, Gul *et al*. evaluated MRI accuracy in a low-resource setup, reporting 55–75% accuracy for myometrial depth estimation using non-contrast MRI, which parallels the performance observed in our study. Gul and colleagues attributed diagnostic variability to field-strength differences, operator expertise, and interobserver variation factors also relevant in our institutional context (Gul *et al*., 2022).

Notably, the Sanjuan *et al*. using DCE-MRI in 72 women, reported a 71% sensitivity, 86% specificity, and 58% overall accuracy for ≥50% myometrial invasion, with significantly higher specificity (97%) than sensitivity (41%) for cervical stromal detection. The authors identified key sources of misdiagnosis tumors isointense with the myometrium, polypoid configurations, myometrial thinning, adenomyosis, and leiomyomas all of which remain practical interpretive challenges, particularly in unenhanced MRI (Sanjuán *et al*., 2008).

A recent 1.5 T diffusion-weighted MRI study by Sajid *et al*. (2025) reported a sensitivity of 81.5 %, specificity of 87.5 %, and accuracy of 83.1 % for detecting deep myometrial invasion. However, that study was limited by its single-centre design, short six-month duration, and dependence on advanced diffusion sequences that require greater technical expertise and standardised b-value protocols. In contrast, our six-year retrospective dataset of 189 patients provides a broader temporal representation using only T1- and T2-weighted images without contrast, thereby offering a

baseline diagnostic benchmark for settings where functional imaging is unavailable. While our sensitivity was considerably lower, the comparable specificity suggests that even non-contrast MRI retains substantial reliability for ruling out deep invasion and can guide pre-operative triaging in low-resource hospitals (Sajid *et al*., 2025).

Similarly, Akçay and Peker (2025) compared T2-weighted, diffusion-weighted, and dynamic contrast-enhanced sequences in 98 patients and found that T2-weighted MRI alone yielded excellent performance (AUC 0.967; Se 100 %; Sp 93 %). Their work underscores the diagnostic potential of multiparametric MRI but was restricted by a small sample and lack of inter-observer assessment. The present study, with nearly double the sample size and a longer observation period, demonstrates that plain MRI—though less sensitive—remains clinically pragmatic and identifies the diagnostic floor upon which future multiparametric or 3 T protocols may build (Akçay and peker. 2025).

Taken together, these findings establish a diagnostic accuracy spectrum of 60–96% across studies, reflecting how sequence selection, field strength, and reader expertise modulate MRI performance. The present study's results, though based on plain MRI, lie within this range, confirming that careful protocol standardization and expert interpretation can yield clinically reliable staging without the routine use of contrast agents. This has significant implications for resource-constrained centers, supporting the feasibility of MRI-based surgical triage when DCE or DWI facilities are unavailable.

Our results reinforce previous evidence that MRI excels in identifying superficial (Stage IA) myometrial invasion, with declining accuracy in advanced stages due to distortion of uterine anatomy and inflammatory signal changes. The study by Zamani *et al*. also reported maximal concordance in early disease and a similar trend of under-staging in higher grades, suggesting a consistent global pattern (Zamani *et al*., 2012). Importantly, despite modest sensitivity, MRI's high specificity minimizes false positives and thus prevents unnecessary radical surgery, an especially relevant consideration for postmenopausal and comorbid patients.

This work provides region-specific validation of MRI accuracy for endometrial carcinoma in the Indian population an area with limited published data. However, several limitations must be acknowledged, such as retrospective design inherently carries selection and information biases, and the absence of interobserver variability assessment may have influenced staging accuracy. The lack of contrast-enhanced sequences and diffusion-weighted imaging likely contributed to the modest sensitivity in higher stages. Additionally, the unequal distribution of cases across stages (predominance of Stage IA) might have skewed overall accuracy toward early disease detection. Nonetheless, these limitations are offset by the study's clinical relevance, robust histopathological validation, and focus on real-world feasibility in low-resource environments.

In conclusion MRI is a valuable tool for the preoperative assessment of endometrial cancers and should be routinely made use of. MRI is also useful when fertility preservation is considered to avoid missing a higher risk tumor. This study performed on a south Indian population, can be utilized to create awareness among primary practitioners in order to avoid mismanagement and missed diagnoses.

Declarations

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Conflict of interest

Nil

Funding/ financial support

Nil

Ethical Clearance

The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC e-meeting held as per ICH-GCP guidelines, New Drug and clinical trials Rule March 2019 requirements & ICMR - EC Guidance during COVID -19 Pandemic on 21.07.2022 at the Medical Education Unit, Chengalpattu Government Medical College, Chengalpattu at 11.00 AM for the IEC-Chengalpattu Medical College members. [Registration No: ECR/774/Inst/TN/2015; No. IEC-CMC/Approval/22/2022, Ref.No.: CMCH -22-PR-173]

Data Availability Statement

The data supporting the findings of this study are available within the hospital's secured database and may be shared by the corresponding author upon reasonable request, following institutional data protection policies.

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