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Original Article

Contrast-Enhanced MRI in The Preoperative Evaluation of Endometrial Carcinoma

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Abstract

Objective: To determine the diagnostic accuracy of preoperative contrast-enhanced magnetic resonance imaging (CE-MRI) for assessing myometrial invasion, cervical invasion, and lymph node metastasis in endometrial carcinoma and to evaluate their association with postoperative histopathological findings.

Methodology: This Prospective Longitudinal Study was conducted in the Department of Obstetrics and Gynecology, Ayub Teaching Hospital, Abbottabad, Pakistan, from January to December 2025. Following institutional Ethical Review Committee approval, 144 patients with biopsy-proven endometrial carcinoma underwent pelvic CE-MRI within one month before surgery. We assessed myometrial invasion, cervical invasion, and lymph node metastasis on T2-weighted and contrast-enhanced T1-weighted images. We used histopathological findings as the definitive reference standard. We used correlation analysis to assess associations between MRI and histopathological findings, and logistic regression to evaluate factors associated with positive pelvic lymph nodes.

Results: For detecting myometrial invasion, cervical invasion, and lymph node metastasis, CE-MRI showed sensitivities of 85.71%, 90.9%, and 85.7% and specificities of 89.47%, 100%, and 79.6%, respectively. Histopathological lymph node metastasis was strongly associated with $\geq 50\%$ myometrial invasion (100% sensitivity, 97.9% specificity), whereas the association with cervical invasion was poor. In univariate analysis, disease stage, tumor grade and type, positive peritoneal cytology, myometrial invasion, and cervical stromal invasion were significantly associated with lymph node involvement.

Conclusion: CE-MRI demonstrated good diagnostic performance for assessing local tumor invasion and lymph node metastasis. Patients with $< 50\%$ myometrial invasion and no cervical invasion on CE-MRI may have a lower likelihood of lymph node metastasis, potentially supporting individualized surgical planning.

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Introduction

Endometrial carcinoma (EC) is the most common malignancy of the female genital tract in many developed countries, and its incidence has also been increasing in developing countries [1]. While most patients have disease limited to the uterus, a significant fraction have extrauterine disease, such as lymph node metastases, which are often not detected preoperatively [2]. Clinicians usually diagnose the disease preoperatively by endometrial biopsy, and definitive staging is based on surgical and histological findings. The 2023 International Federation of Gynecology and Obstetrics (FIGO) staging system has also been updated with histopathological and molecular features, which further aid risk stratification and staging [3]. While computed tomography (CT) and magnetic resonance imaging (MRI) are not the only methods for staging EC, MRI can provide useful pre-operative information about the local extent of EC and help with treatment planning [4]. Specifically, MRI can measure the depth of myometrial invasion (MI), the cervical stromal involvement (CI), and suspicious pelvic lymph nodes. Contrast-enhanced MRI is useful for assessing deep MI and cervical involvement [5]. Previous studies show MRI is sensitive for diagnosing deep MI and has good diagnostic accuracy [5,6]. MRI accuracy for detecting lymph node metastasis is comparatively low. Therefore, imaging findings should be analyzed alongside clinical and pathological risk factors. Surgery is the primary treatment for operable EC and usually involves hysterectomy and bilateral salpingo-oophorectomy; the extent of lymph node assessment depends on the patient's risk profile and disease characteristics [7]. MI and histological grade are significant prognostic factors and risk factors for lymph node metastasis. Deep MI is relevant because it correlates with the likelihood of extrauterine spread [8]. Likewise, cervical stromal involvement is an important factor in determining local tumor extension and could affect surgical planning and subsequent adjuvant therapy [9]. Therefore, accurate preoperative evaluation is crucial for selecting a surgical strategy and identifying those who may need further staging and/or personalized adjuvant therapy. Preoperative MRI combined with postoperative histopathology is accurate and provides useful information regarding MI and CI. However, its diagnostic value depends on the anatomical parameter assessed [5,6]. MRI may then assist risk stratification before surgery, but histopathology remains the gold standard for diagnosis. In the present study, we directly compare pre-operative contrast-enhanced MRI findings with postoperative histopathological evaluation of MI, CI, and lymph node metastasis in patients with EC. Furthermore, the study assesses correlations among histopathological MI, CI, and lymph node involvement in the same patient population, providing an integrated imaging-pathology evaluation. This study aimed to determine the association between preoperative contrast-enhanced MRI findings and postoperative histopathological parameters, including MI, CI, and lymph node involvement, in patients with EC. The study also evaluated the relationship between histopathological MI and CI and lymph node metastasis.

Materials and Methods

This prospective longitudinal study was conducted in the Department of Obstetrics and Gynecology, Ayub Teaching Hospital, Abbottabad, Pakistan, from January to December 2025. We included 144 eligible patients. The study was conducted after approval from the institutional Ethical Review Committee. The patients were included if they had been diagnosed with endometrial carcinoma preoperatively by endometrial biopsy. Patients with a concurrent malignancy of the genital tract other than endometrial carcinoma, those who did not have lymph node dissection, and those who were given neoadjuvant chemotherapy were excluded. All patients had a pelvic MRI with contrast within one month before surgery. The surgical specimen was the definitive reference standard for histopathological examination. We used a 1.5-Tesla Siemens Avanto MRI (Siemens, Erlangen, Germany) with a pelvic phased-array coil for contrast-enhanced imaging. The MRI scans used a standard sequence set: T1-weighted coronal and T2-weighted axial, sagittal, and coronal scans. Gadolinium-based contrast was given as an intravenous bolus at 0.1 mmol/kg (0.2 mL/kg). Contrast-enhanced T1-weighted images then followed in the axial, sagittal, and coronal planes.

Radiologists with over 5 years' experience in women's imaging interpreted the MRI images. Focal disruption in the junctional zone, but not > half or the entire myometrial thickness, was classified as <50% myometrial invasion, while disruption > half or the entire myometrial thickness was classified as >50% myometrial invasion. Contrast-enhanced MRI was used to define <50% myometrial invasion as an irregular tumor-myometrial border with the tumor limited to the inner half of the myometrium. If the myometrium was invaded beyond 50% of the thickness, it was considered deep myometrial invasion (MI>50%). Cervical invasion was defined as an abnormal signal-intensity lesion on T2-weighted images that invaded the cervical canal or cervical stroma. Cervical enlargement was deemed a supportive imaging feature. Normal cervical epithelial enhancement was also disrupted on contrast-enhanced MRI, which was also taken as suggestive of cervical invasion. Any pelvic lymph nodes > 1 cm short axis diameter, with or without an area of necrosis in the center (on contrast-enhanced MRI), were regarded as suspicious for metastatic involvement. Surgical staging involved collecting peritoneal fluid for cytology, total abdominal hysterectomy, bilateral salpingo-oophorectomy, and pelvic lymphadenectomy. All resected specimens were sent for histopathology. Histopathological examination was used as the gold standard for evaluating myometrial invasion, cervical invasion, and lymph node metastasis.

Data Collection

We identified eligible patients through the hospital's Index and Coding system in the Hospital Information Management System. We retrospectively reviewed medical records, MRI reports, and histopathology reports. We collected data using a predefined proforma containing demographic, imaging, surgical, and histopathological variables.

Statistical Analysis

We entered and analyzed the data using SPSS version 19.0. We assessed the diagnostic performance of contrast-enhanced MRI by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) using standard formulas, with histopathological findings as the reference standard. We calculated the correlation coefficient to assess the association between preoperative contrast-enhanced MRI findings and postoperative histopathological staging parameters. We used the chi-square test to evaluate associations between categorical predictive factors and lymph node metastasis. We used logistic regression to evaluate the relationship between selected clinical and histopathological factors and the presence of positive pelvic lymph nodes. We considered a two-sided p-value <0.05 statistically significant.

Results

We included 144 women with endometrial carcinoma that met the eligibility criteria. The mean age was 57.81 ± 9.78 years. Table 1 presents the demographic and clinicopathological characteristics, including body mass index (BMI), menopausal status, surgical stage, histological type, and tumor grade. The majority of patients (90.26%) had stage I disease, while 83.33% were postmenopausal. Table 2 presents the diagnostic performance of contrast-enhanced MRI for assessing myometrial invasion (MI), cervical invasion (CI), and pelvic lymph node metastasis (LNM). For MI detection, MRI showed a sensitivity of 85.71% and specificity of 89.47%. For CI, the sensitivity and specificity were 90.9% and 100%, respectively. For pelvic LNM, MRI demonstrated a sensitivity of 85.7% and specificity of 79.6%. The association between histopathological pelvic lymph node metastasis and $\geq 50\%$ histopathological myometrial invasion demonstrated a sensitivity of 100% and specificity of 97.9% (Table 3). In contrast, the association between histopathological cervical invasion and lymph node metastasis demonstrated comparatively lower diagnostic performance. In univariate logistic regression, age, BMI, and menopausal status were not significantly associated with lymph node involvement. In contrast, disease stage, tumor grade, histological type, positive peritoneal cytology, histopathological myometrial invasion, and histopathological

cervical invasion were significantly associated with lymph node involvement (Table 4).

Table 1. Clinicopathological characteristics of patients with endometrial carcinoma (n=144)

Variable	n	%
Age, years (mean ± SD)	57.81 ± 9.78	–
BMI, kg/m² (mean ± SD)	32.27 ± 7.0	–
Surgical stage		
Stage IA	91	63.19
Stage IB	39	27.08
Stage II	5	3.47
Stage IIIA	3	2.08
Stage IIIB	1	0.69
Stage IIIC	4	2.77
Stage IV	3	2.08
Histopathological type		
Endometrioid	126	87.50
Clear cell	8	5.50
Papillary serous	10	6.94
Menopausal status		
Premenopausal	24	16.66
Postmenopausal	120	83.33
Histopathological grade		
Grade 1	47	32.63
Grade 2	70	48.61
Grade 3	27	18.75

Data are presented as mean ± SD or frequency (percentage). BMI, body mass index; SD, standard deviation.

Table 2. Diagnostic performance of contrast-enhanced MRI for myometrial invasion, cervical invasion, and lymph node metastasis

MRI assessment	T P	F P	F N	T N	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	+LR	κ
Myometrial invasion >50%	42	10	7	85	85.71	89.47	80.77	92.39	8.14	0.74
Cervical invasion	10	0	1	90	90.90	100.00	100.00	99.30	N/A	0.949
Lymph node metastasis	68	28	19	85	85.70	79.60	17.60	99.10	4.19	0.231

TP, true positive; FP, false positive; FN, false negative; TN, true negative; PPV, positive predictive value; NPV, negative predictive value; +LR, positive likelihood ratio; κ, Cohen's kappa; NA, not applicable.

Table 3. Association of histopathological myometrial and cervical invasion with lymph node metastasis

Histopathological finding	LNM present, n	LN absent, n	Total, n	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
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Myometrial invasion >50%	7	42	49	100.0	97.9	14.28	100.0
Myometrial invasion ≤50%	0	95	95	–	–	–	–
Total	7	137	144	–	–	–	–
Cervical invasion present	3	8	11	42.9	94.1	27.27	96.99
Cervical invasion absent	4	129	133	–	–	–	–
Total	7	137	144	–	–	–	–

LNM, lymph node metastasis; PPV, positive predictive value; NPV, negative predictive value.

Table 4. Univariate logistic regression analysis of factors associated with lymph node metastasis

Predictor	OR (95% CI)	P value
Age	1.014 (0.93–1.09)	0.741
BMI	1.014 (0.93–1.09)	0.535
Menopausal status	1.21 (0.139–10.58)	0.862
Stage I vs II	86.0 (6.02–1228.75)	0.001
Stage I vs III–IV	103.2 (9.68–1100.014)	<0.001
Grade 1–2 vs Grade 3	13.06 (2.38–71.68)	0.003
Endometrioid vs clear cell	13.66 (1.91–98.97)	0.010
Endometrioid vs serous	10.25 (14.9–70.39)	0.018
Positive peritoneal cytology	0.115 (0.018–0.716)	0.020
Histopathological myometrial invasion	NA*	<0.001
Histopathological cervical invasion	12.09 (2.30–63.51)	0.003

OR, odds ratio; CI, confidence interval; BMI, body mass index; NA, not applicable. *NA indicates that an odds ratio could not be estimated because of Zero cells.

Discussion

The FIGO staging system for endometrial carcinoma has undergone important revisions, most recently in 2023, incorporating histopathological and molecular characteristics to improve prognostic stratification. Histological type, tumor grade, depth of myometrial invasion (MI), cervical stromal involvement, lymphovascular space invasion, and lymph node status remain important factors in treatment planning and prognosis [11,12]. Current international guidelines also focus on surgical management based on clinicopathological and molecular risk groups, rather than extended staging procedures in all patients [13].MRI is an important pre-operative imaging modality because of its excellent soft-tissue contrast and its ability to assess local tumor extension. T2-weighted, diffusion-weighted, and contrast-enhanced sequences can provide complementary information for evaluating MI and cervical stromal invasion. Recent studies show that MRI can help with preoperative tumor staging, but diagnostic accuracy varies by imaging protocol and tumor characteristics [14,15]. The present study found that contrast-enhanced MRI had good diagnostic performance for MI (sensitivity 85.71%, specificity 89.47%, κ coefficient 0.74), with good agreement with histopathology. These results support using MRI for preoperative evaluation of myometrial involvement.Assessing MI is important, as deep invasion is associated with a higher risk of lymphovascular and nodal involvement. A large meta-analysis found significant associations between MI and lymph node metastasis, lymphovascular space invasion, recurrence, and overall survival [16]. Moreover, various MRI protocols have been evaluated, and diffusion-weighted MRI, T2-weighted MRI, and dynamic contrast-enhanced MRI

have proven useful for diagnosing deep MI [14,15]. Our findings agree with current data supporting MRI evaluation of the depth of myometrial involvement. Correct diagnosis of cervical stromal involvement is also crucial for surgical planning. Contrast-enhanced MRI was accurate with a sensitivity of 90.9%, specificity of 100%, PPV of 100%, and NPV of 99.3% for CI in our cohort. MRI identified 10/11 cases diagnosed histopathologically. A single case may have been a case of microscopic or focal cervical stromal invasion, which MRI may not have detected. Contemporary imaging literature also highlights MRI for assessing local extension, especially when distinguishing between confined and cervical stromal disease and its possible effect on surgical planning [12,17]. Assessment of lymph node metastasis was more challenging. Applying the >1 cm MRI criterion identified 34 patients as positive, while histopathology revealed metastasis in only seven. Therefore, MRI sensitivity was 85.7%, specificity was 79.6%, positive predictive value was 17.6%, negative predictive value was 99.1%, and the κ coefficient was 0.231. Many false-positive results were due to nodal enlargement alone, as reflected by the low PPV. In contrast, the high NPV indicates that a negative MRI rarely correlated with histopathologically proven nodal disease. More recent studies have also identified the shortcomings of traditional MRI evaluation of nodal disease and explored radiomics, multiparametric MRI, and PET/CT to improve nodal prediction [18-20]. In our study, we observed a strong correlation between histopathological MI and lymph node metastasis. Histological confirmation of nodal metastasis was found in all seven patients with >50% MI, but in none of the 95 patients with $\leq$ 50% MI. This yielded a sensitivity of 100% and specificity of 97.9% for the association between deep MI and LN metastasis. Recent studies have established deep MI as a significant prognostic factor, along with tumor grade, histological type, cervical stromal invasion, and lymphovascular space invasion [16,21,22]. Our nodal metastasis rate was 4.86%, partly attributable to the high proportion of stage I disease (90.26%) and endometrioid histology (87.5%). Current evidence supports selecting, rather than standardizing, lymph node assessment in appropriately stratified patients. Meta-analytic comparisons of sentinel lymph-node mapping and systematic lymphadenectomy show the growing contribution of sentinel-node approaches in surgical staging [12]. International guidelines also recommend risk-adapted nodal assessment based on tumor characteristics and overall risk classification [13]. In our series, the following features were significantly associated with lymph node metastasis: Advanced disease stage, high tumor grade, non-endometrioid histology, positive peritoneal cytology, deep MI, and cervical stromal involvement. Conversely, no other factors, including age, BMI, and menopausal status, were significantly related to nodal involvement. Recent predictive studies have also established that certain tumor characteristics, especially histological type, grade, MI, cervical involvement, and other pathological factors, are also important predictor variables for nodal disease [21]. These results support the usefulness of contrast-enhanced MRI as a preoperative tool, especially for MI and CI. However, its relatively poor PPV for lymph node metastasis suggests that MRI should not be relied upon alone to decide nodal status. Combining imaging assessment with histological grade, tumor type, MI, cervical involvement, and other clinical risk factors could offer a more holistic approach to individual surgical planning [22]. This study has several limitations. First, the number of patients with cervical stromal invasion (n=11) and lymph node metastasis (n=7) was small, which may limit statistical power and precision of the estimates. Second, approximately 90% of patients had stage I disease, and 87.5% had endometrioid carcinoma; therefore, the findings may be most applicable to patients with predominantly early-stage endometrioid EC. Finally, the retrospective single-center design may limit generalizability. Further prospective, multicenter studies with larger numbers of advanced-stage and non-endometrioid tumors are warranted.

Conclusion

Preoperative pelvic contrast-enhanced magnetic resonance imaging has moderately high sensitivity and specificity for predicting disease stage in endometrial carcinoma. Preoperative assessment, together with contrast-enhanced magnetic resonance imaging, can help Gynae oncologists with clinical decision-making and patient counseling.

Ethical Approval

Ethical approval was obtained from the Ayub Medical Teaching Institution Abbottabad Institutional Medical & Ethics Review Committee (Approval Code/Ref. No. RC-FA-2024/166; approved 20 August 2024) before data collection began.

Informed Consent

Informed consent was not applicable because this systematic review did not involve direct participation of human subjects or collection of primary participant data.

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Conflict of Interest

The authors declare that they have no competing interests or conflicts of interest related to this study.

Authors' Contributions

Shehla Noor: Conceptualization, study design, literature search, study screening, data extraction, manuscript drafting, and critical revision.

Bushra Khan: Conceptualization, supervision, interpretation of findings, critical revision of the manuscript, and final approval of the version to be published.

Laraib Istafa: Literature search, study screening, data extraction, preparation of tables and figures, and manuscript revision.

Mahnoor Mushraf: Data extraction, literature review, manuscript drafting and revision, and reference verification.

Fatima Nasir: Literature search, data verification, manuscript revision, interpretation of findings, and final review and approval of the manuscript.

Data Availability

All data analyzed in this systematic review were obtained from previously published studies and publicly available sources. No individual-level primary patient data were collected or generated for this study. Further information may be obtained from the corresponding author upon reasonable request.

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References

1. Concin N, Matias-Guiu X, Vergote I, et al. ESGO/ESTRO/ESP guidelines for the management of patients with endometrial carcinoma. *Int J Gynecol Cancer*. 2021;31(1):12-39. doi:10.1136/ijgc-2020-002230.
2. Concin N, Creutzberg CL, Vergote I, Cibula D, Mirza MR, Marnitz S, et al. ESGO/ESTRO/ESP guidelines for the management of patients with endometrial carcinoma. *Virchows Arch*. 2021;478(2):153-190. doi:10.1007/s00428-020-03007-z.

3. Berek JS, Matias-Guiu X, Creutzberg C, Fotopoulou C, Gaffney D, Kehoe S, et al. FIGO staging of endometrial cancer: 2023. *Int J Gynaecol Obstet.* 2023;162(2):383-394. doi:[10.1002/ijgo.14923](https://doi.org/10.1002/ijgo.14923).
4. Menendez-Santos M, Gonzalez-Baerga C, Taher D, Waters R, Virarkar M, Bhosale P. Endometrial cancer: 2023 revised FIGO staging system and the role of imaging. *Cancers (Basel).* 2024;16(10):1869. doi:[10.3390/cancers16101869](https://doi.org/10.3390/cancers16101869).
5. Avesani G, Bonatti M, Venkatesan AM, Nougaret S, Sala E. RadioGraphics update: 2023 FIGO staging system for endometrial cancer. *Radiographics.* 2024;44(7):e240084. doi:[10.1148/rg.240084](https://doi.org/10.1148/rg.240084).
6. Iitsuka C, Asami Y, Hirose Y, Nagashima M, Mimura T, Miyamoto S, et al. Preoperative magnetic resonance imaging versus intraoperative frozen section diagnosis for predicting the deep myometrial invasion in endometrial cancer: our experience and literature review. *J Obstet Gynaecol Res.* 2021;47:3331-3338. doi:[10.1111/jog.14891](https://doi.org/10.1111/jog.14891).
7. Wang J, Xu P, Yang X, Yu Q, Xu X, Zou G, et al. Association of myometrial invasion with lymphovascular space invasion, lymph node metastasis, recurrence, and overall survival in endometrial cancer: a meta-analysis of 79 studies with 68,870 patients. *Front Oncol.* 2021;11:762329. doi:[10.3389/fonc.2021.762329](https://doi.org/10.3389/fonc.2021.762329).
8. Wang LJ, Tseng YJ, Wee NK, Low JJH, Tan CH. Diffusion-weighted imaging versus dynamic contrast-enhanced imaging for pre-operative diagnosis of deep myometrial invasion in endometrial cancer: a meta-analysis. *Clin Imaging.* 2021;80:36-42. doi:[10.1016/j.clinimag.2021.06.027](https://doi.org/10.1016/j.clinimag.2021.06.027).
9. Bús D, Nagy G, Póka R, Vajda G. Clinical impact of preoperative magnetic resonance imaging in the evaluation of myometrial infiltration and lymph-node metastases in stage I endometrial cancer—*Pathol Oncol Res.* 2021;27:611088. doi: [10.3389/pore.2021.611088](https://doi.org/10.3389/pore.2021.611088).
10. Chen WC, Hsu LT, Huang YT, Pan YB, Ueng SH, Chou HH, et al. Prediction of myometrial invasion in stage I endometrial cancer by MRI: the influence of surgical diagnostic procedure. *Cancers (Basel).* 2021;13(13):3275. doi: [10.3390/cancers13133275](https://doi.org/10.3390/cancers13133275).
11. Ota T, Tsuboyama T, Onishi H, Nakamoto A, Fukui H, Yano K, et al. Diagnostic accuracy of MRI for evaluating myometrial invasion in endometrial cancer: a comparison of MUSE-DWI, rFOV-DWI, and DCE-MRI. *Radiol Med.* 2023;128:629-643. doi: [10.1007/s11547-023-01635-4](https://doi.org/10.1007/s11547-023-01635-4).
12. Dybvik JA, Fasmer KE, Ytre-Hauge S, et al. MRI-assessed tumor-free distance to serosa predicts deep myometrial invasion and poor outcome in endometrial cancer. *Insights Imaging.* 2022;13:1. doi: [10.1186/s13244-021-01133-z](https://doi.org/10.1186/s13244-021-01133-z).
13. Xie M, Ren Z, Bian D, et al. High-resolution diffusion-weighted imaging with readout segmentation of long variable echo-trains for determining myometrial invasion in endometrial carcinoma. *Cancer Imaging.* 2020;20:66. doi: [10.1186/s40644-020-00346-7](https://doi.org/10.1186/s40644-020-00346-7).
14. Zhang L, Liu L. Evaluation of multi-parameter MRI in preoperative staging of endometrial carcinoma. *Eur J Radiol Open.* 2024;12:100559. doi:[10.1016/j.ejro.2024.100559](https://doi.org/10.1016/j.ejro.2024.100559). Rizescu RA, Sălcianu IA, et al. Can MRI accurately diagnose and stage endometrial adenocarcinoma? *Medicina (Kaunas).* 2024;60(3):512. doi: [10.3390/medicina60030512](https://doi.org/10.3390/medicina60030512).
15. Ali M, Mumtaz M, Naqvi Z, Farooqui R, et al. Assessing tumor size by MRI and pathology in type I endometrial carcinoma to predict lymph node metastasis. *Cureus.* 2022;14(3):e23135. doi: [10.7759/cureus.23135](https://doi.org/10.7759/cureus.23135).
16. Yan B, Zhao T, Deng Y, Zhang Y. Preoperative prediction of lymph node metastasis in endometrial cancer patients via an intratumoral and peritumoral multiparameter MRI radiomics nomogram. *Front Oncol.* 2024;14:1472892. doi: [10.3389/fonc.2024.1472892](https://doi.org/10.3389/fonc.2024.1472892).
17. Praiss AM, Dagher C, Zhou Q, Iasonos A, Rios-Doria E, Abu-Rustum NR, et al. Lymph node metastases in endometrial carcinoma: a modern assessment in the era of sentinel lymph node mapping and molecular subtyping. *Gynecol Oncol.* 2024;191:37-44. doi: [10.1016/j.ygyno.2024.09.012](https://doi.org/10.1016/j.ygyno.2024.09.012).
18. Bose D, Rema P, Suchetha S, Dinesh D, Sivaranjith J, Preethi TR, et al. Evaluation of factors influencing lymph node metastasis in endometrial cancers: a retrospective study. *Indian J Cancer.* 2024;61(1):90-97. doi: [10.4103/ijc.IJC_873_20](https://doi.org/10.4103/ijc.IJC_873_20).
19. Kong TW, Kim J, Kim J, Lee J, et al. A predictive model for lymph node metastasis using tumor location in presumed early-stage endometrioid endometrial cancer patients. *J Gynecol Oncol.* 2024;35(4):e53. doi: [10.3802/jgo.2024.35.e53](https://doi.org/10.3802/jgo.2024.35.e53).
20. Gu Y, Cheng H, Zong L, Kong Y, Xiang Y. Operative and oncological outcomes comparing sentinel node mapping and systematic lymphadenectomy in endometrial cancer staging: meta-analysis with trial sequential analysis. *Front Oncol.* 2021;10:580128. doi: [10.3389/fonc.2020.580128](https://doi.org/10.3389/fonc.2020.580128).
21. Cusimano MC, Vicus D, Pulman K, Maganti M, Bernardini MQ, Bouchard-Fortier G, et al. Assessment of sentinel lymph node biopsy vs lymphadenectomy for intermediate- and high-grade endometrial cancer staging: the SENTOR study. *JAMA Surg.* 2021;156(2):157-164. doi: [10.1001/jamasurg.2020.5060](https://doi.org/10.1001/jamasurg.2020.5060).
22. Moffatt J, Dwan K, Webster KE, Frost JA, et al. Lymphadenectomy or sentinel node biopsy for the management of endometrial cancer: a network

meta-analysis. *Cochrane Database Syst Rev.* 2023;9(9): CD015786. doi: [10.1002/14651858.CD015786](https://doi.org/10.1002/14651858.CD015786).