



Evaluation of lymph node metastasis in cervical cancer: A retrospective comparison of preoperative MRI and PET/CT with postoperative histopathology results

Serviks kanserinde lenf nodu metastazının değerlendirilmesi: Preoperatif MRG ve PET/BT ile postoperatif histopatoloji sonuçlarının retrospektif olarak karşılaştırılması

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Abstract

Objective: The aim of this study is to assess the diagnostic performance of positron emission tomography/computed tomography (PET/CT) and magnetic resonance imaging (MRI) in detecting pelvic and paraaortic lymph node involvement in cervical cancer patients by correlating imaging results with surgical pathology findings.

Materials and Methods: A retrospective analysis was conducted on cervical cancer patients treated at İstanbul Medeniyet University Prof. Dr. Süleyman Yalçın City Hospital from 2016 to 2022. Patients who underwent preoperative PET/CT or MRI imaging and subsequent lymph node dissection were included. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated for each imaging modality.

Results: Of the 75 cases reviewed, 52 met the inclusion criteria. PET/CT had higher specificity (94.1%) than MRI (82.4%), while MRI demonstrated greater sensitivity (55.6% vs. 50%). False-negative rates were 15.3% for MRI and 17.3% for PET/CT. Receiver operating characteristic analysis indicated an area under the curve of 0.78 for PET/CT and 0.69 for MRI. No statistically significant differences in sensitivity or specificity were observed, with both modalities showing complementary strengths.

Conclusion: MRI and PET/CT each contribute significantly to preoperative cervical cancer evaluation, with MRI favored for local assessment and PET/CT for nodal detection. Combining both modalities enhances diagnostic accuracy. Further prospective research is required to confirm and strengthen these results. and improve imaging strategies for clinical practice.

Keywords: Lymph node, MRI, PET/CT

Öz

Amaç: Bu çalışma, serviks kanseri hastalarında pelvik ve paraaortik lenf nodu metastazlarının saptanmasında pozitron emisyon tomografisi/bilgisayarlı tomografi (PET/BT) ve manyetik rezonans görüntülemenin (MRG) tanısal doğruluğunu araştırmakta ve görüntüleme bulgularını postoperatif histopatoloji ile karşılaştırmaktadır.

Gereç ve Yöntemler: 2016-2022 yılları arasında İstanbul Medeniyet Üniversitesi Prof. Dr. Süleyman Yalçın Şehir Hastanesi'nde tedavi edilen serviks kanseri hastalarının retrospektif analizi yapılmıştır. Preoperatif PET/BT veya MRG görüntülemesi ve ardından lenf nodu diseksiyonu yapılan hastalar çalışmaya dahil edilmiştir. Her bir görüntüleme yöntemi için duyarlılık, özgüllük, pozitif prediktif değer ve negatif prediktif değer hesaplanmıştır.

PRECIS: Positron emission tomography/computed tomography and magnetic resonance imaging complement each other in detecting cervical cancer lymph node metastasis, with false negativity rates of 15.3% and 17.3%, respectively. Their combination improves accuracy and warrants further research.

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Bulgular: İncelenen 75 olgudan 52'si dahil edilme kriterlerini karşıladı. PET/BT, MRG'ye kıyasla daha yüksek özgüllüğe (%94,1) sahipken, MRG daha yüksek duyarlılık (%55,6'ya karşı %50) gösterdi. Yanlış negatiflik oranları MRG için %15,3, PET/BT için %17,3 olarak bulundu. Alıcı işletim karakteristiği analizi, PET/BT için eğri altındaki alanın 0,78, MRG için ise 0,69 olduğunu gösterdi. Duyarlılık veya özgüllük açısından istatistiksel olarak anlamlı bir fark bulunmamakla birlikte, her iki yöntemin de birbirini tamamlayıcı güçlü yönleri sahip olduğu görüldü.

Sonuç: MRG ve PET/BT, serviks kanserinin preoperatif değerlendirilmesinde değerlidir; MRG, lokal evrelemede üstünlük sağlarken PET/BT, lenf nodu tutulumu tespitinde daha başarılıdır. Her iki modalitenin birlikte kullanımı tanısal doğruluğu artırmaktadır. Bu bulguları doğrulamak ve klinik uygulamalar için görüntüleme stratejilerini geliştirmek adına ileriye dönük çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Lenf nodu, MRG, PET/BT

Introduction

Cervical cancer ranks as the fourth most prevalent cancer among women worldwide, with 85% of cases occurring in developing countries, making it a leading cause of cancer-related deaths in women^(1,2). Data released by the Turkish Ministry of Health Cancer Department in 2025 revealed that cervical cancer had an incidence of 4.7 per 100,000, positioned it eighth among cancers affecting women in Türkiye⁽³⁾. Similarly, the American Cancer Society estimated that in 2025, 13,360 women in the United States would be diagnosed with invasive cervical cancer, leading to 4,320 deaths⁽⁴⁾.

Persistent infection with human papillomavirus (HPV) is recognized as the primary risk factor for the development of invasive cervical cancer⁽⁵⁾. Although advancements in HPV vaccination and improved cervical cancer screening programs have mitigated the burden in certain regions, the disease remains a significant issue in developing countries⁽⁶⁾.

Lymph node metastasis is a critical determinant of treatment response and overall prognosis in cervical cancer patients. Preoperative imaging methods, including positron emission tomography/computed tomography (PET/CT) and magnetic resonance imaging (MRI), play a vital role in evaluating lymph node involvement since routine surgical dissection is not always recommended⁽⁷⁾. The International Federation of Gynecology and Obstetrics 2018 cervical cancer staging system emphasizes the importance of pelvic and paraaortic lymph node involvement, further underscoring the necessity of preoperative imaging⁽⁸⁾. MRI provides detailed local staging, accurately measuring tumor size and parametrial infiltration, particularly in patients with larger tumors or during pregnancy, where radiation-free modalities are essential. Meanwhile, PET/CT offers insights into metabolic activity, aiding in the detection of distant metastases⁽⁹⁾.

Our study aims to assess the diagnostic accuracy of preoperative PET/CT and MRI in detecting pelvic and paraaortic lymph node metastases in cervical cancer patients. We compared imaging findings with postoperative histopathological evaluations, considered the gold standard, to determine the effectiveness of these imaging modalities.

Materials and Methods

This retrospective study reviewed cervical cancer cases diagnosed and treated at İstanbul Medeniyet University Prof. Dr. Süleyman Yalçın City Hospital's Obstetrics and Gynecology

Clinic from January 1, 2016, to December 31, 2022. Inclusion criteria encompassed patients who underwent preoperative PET/CT or MRI imaging followed by pelvic and/or paraaortic lymph node dissection. Patients who lacked preoperative imaging, did not undergo lymph node sampling, or were deemed inoperable were excluded.

The patients' demographic and clinical characteristics were documented, and lymph node status based on imaging findings was compared to postoperative histopathological results.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages, and continuous variables were presented as means \pm standard deviations. The diagnostic performance of MRI and PET/CT in detecting lymph node metastasis was evaluated by calculating sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy. Receiver operating characteristic (ROC) curve analysis was used to compare the diagnostic power of both imaging modalities, and the area under the curve (AUC) was reported. The McNemar's test was used to compare paired proportions (e.g., sensitivity and specificity) between MRI and PET/CT. A p-value of <0.05 was considered statistically significant.

Ethical approval for this study was granted by the Clinical Research Ethics Committee of İstanbul Medeniyet University Göztepe Training and Research Hospital under protocol number 2023/0166, dated 15.03.2023. Informed consent was not obtained due to the retrospective nature of the study, in accordance with the institutional and national ethical guidelines.

Results

Between January 1, 2016, and December 31, 2022, a total of 75 cervical cancer cases were reviewed. Of these, 23 patients (30.6%) were excluded due to lack of preoperative imaging or being deemed inoperable. The final study cohort consisted of 52 eligible patients who met the inclusion criteria. Table 1 provides a summary of the demographic and clinical features of the study cohort.

The comparative diagnostic capabilities of MRI and PET/CT in detecting metastatic lymph nodes are outlined in Table 2. MRI exhibited a sensitivity of 55.6%, slightly higher than PET/CT's 50.0%, indicating a greater capacity than PET/CT to

identify true positive cases. However, PET/CT surpassed MRI in specificity (94.1% vs. 82.4%), showcasing better accuracy in identifying true negatives and reducing false positives.

Figure 1, depicting the ROC curves for MRI (in green) and PET/CT (in blue), demonstrates that there was no statistically significant variation in sensitivity or specificity between MRI and PET/CT, as evidenced by p-values of 1.0 and 0.26. Nevertheless, the AUC values highlighted PET/CT's superior overall diagnostic capability (with an AUC of 0.78) compared to MRI's 0.69. Table 3 summarizes previously published sensitivity and specificity values for MRI and PET/CT, offering a comparative perspective on the diagnostic performance observed in our study.

Table 1. Demographic and clinical characteristics of the study population

Description	Data
Age	50.35±10.71
Smoking status	
Non-smokers	31 (59.6%)
Smokers	21 (40.4%)
BMI	27.84±4.39
Histological type	
Squamous cell carcinoma	42 (80.8%)
Adenocarcinoma	10 (19.9%)
Contraception use	
None	50 (96.2%)
Used	2 (3.8%)
HPV status	
Negative	19 (36.5%)
Positive	33 (63.5%)
Pap smear	
Negative	22 (42.3%)
Positive	30 (57.7%)
Pelvic lymph nodes	
Negative	35 (67.3%)
Positive	17 (32.7%)
Para-aortic lymph nodes	
Negative	43 (82.7%)
Positive	9 (17.3%)
Lymph nodes overall	
Negative	34 (65.4%)
Positive	18 (34.6%)

Table 2. Performance comparison of MRI and PET/CT

Parameter	MRI	PET/CT
Total, n	52	52
True positive, n	10	9
True negative, n	28	32
False positive, n	6	2
False negative, n	8	9
Total positive, n	18	18
Total negative, n	34	34
Sensitivity, %	55.6	50
Specificity, %	82.4	94.1
Accuracy, %	73.1	78.8
PPV, %	62.5	81.8
NPV, %	77.8	78

PPV: Positive predictive value, NPV: Negative predictive value, PET/CT: Positron emission tomography/computed tomography, MRI: Magnetic resonance imaging

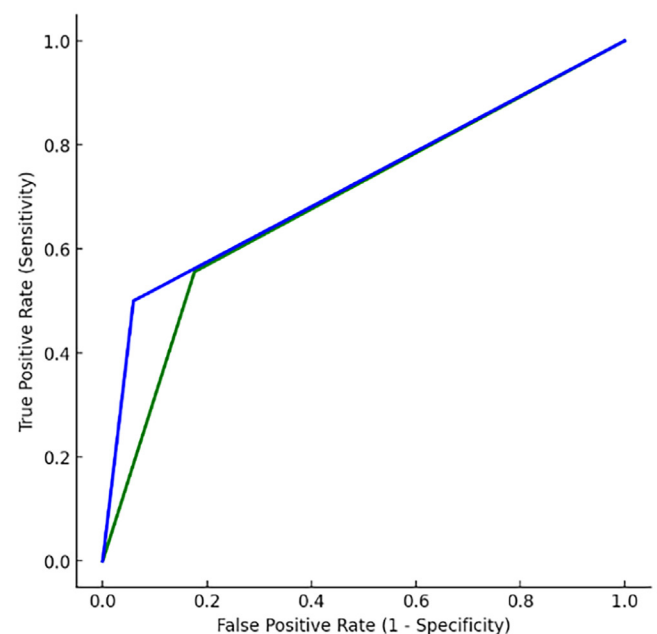


Figure 1. The ROC analysis comparing PET/CT and MRI

ROC curve for MRI (in green) and PET/CT (in blue), with p-values of 1.0 and 0.26 ($p < 0.05$). The area under curve (AUC) of 0.78 for PET/CT shows an improvement compared to 0.69 for MRI

PET/CT: Positron emission tomography/computed tomography, MRI: Magnetic resonance imaging, ROC: Receiver operating characteristic, AUC: Area under the curve

Table 3. The sensitivity and specificity of MRI and PET/CT from the studies

Study	Year	MRI sensitivity (%)	MRI specificity (%)	PET/CT sensitivity (%)	PET/CT specificity (%)
Choi et al. ⁽¹⁰⁾	2010	38.5	44.4	76.9	55.5
Chung et al. ⁽¹³⁾	2010	64.3	69.1	28.6	83.6
Ferrandina et al. ⁽¹²⁾	2012	35.7	95.9	26.8	97.8
Lv et al. ⁽¹⁵⁾	2014	37.3	98.5	91.0	98.4
Jung et al. ⁽¹⁴⁾	2017	24.3	96.3	48.6	89.3
Liu et al. ⁽¹¹⁾	2017	54.0	93.0	66.0	97.0
Ozen et al.	2025	55.6	82.4	50.0	94.0

PET/CT: Positron emission tomography/computed tomography, MRI: Magnetic resonance imaging

Discussion

Accurate nodal staging is pivotal as it significantly influences both treatment planning and prognosis in cervical cancer. In this study, MRI and PET/CT demonstrated sensitivities of 55.6% and 50%, respectively, and specificities of 82.4% and 94%. These findings align with previous research, which consistently shows MRI as having higher sensitivity but lower specificity compared to PET/CT.

For pelvic lymph node involvement specifically, MRI exhibited a sensitivity of 58.8% and specificity of 82.8%, while PET/CT showed 47.1% sensitivity and 91.4% specificity. Differences in imaging performance may relate to variations in patient stages across studies. Early-stage cervical cancer tends to feature fewer metastatic lymph nodes, potentially lowering detection rates; while advanced stages often present with larger or bulkier lymph nodes, which are more readily detected.

In comparison to earlier studies, our findings were consistent. For instance, Choi et al.⁽¹⁰⁾ demonstrated that PET/CT was more sensitive than MRI in identifying lymph node metastasis. Similarly, a meta-analysis by Liu et al.⁽¹¹⁾, involving 67 studies, reported higher specificity for PET/CT and greater sensitivity for MRI. Other investigations, including the studies by Ferrandina et al.⁽¹²⁾ and Chung et al.⁽¹³⁾, corroborated these trends, indicating that MRI performs better for local staging, while PET/CT excels in identifying distant metastasis. In their study, Jung et al.⁽¹⁴⁾ investigated the comparative performance of MRI and PET/CT in detecting pelvic lymph node metastases in early-stage cervical cancer patients. In a similar context, Lv et al.⁽¹⁵⁾ found PET/CT to be significantly more sensitive (91%) than MRI (31.3%) for identifying nodal metastasis in early-stage cervical cancer, emphasizing the utility of PET/CT in functional imaging.

While our results are broadly consistent with existing literature, some differences are noteworthy. Specifically, the studies by Lv et al.⁽¹⁵⁾ and Jung et al.⁽¹⁴⁾ found that PET/CT had greater sensitivity than MRI, whereas MRI demonstrated higher specificity-an inverse pattern compared to our findings. Several factors may account for these differences, including variability

in patient characteristics, tumor staging profiles, and imaging protocols across institutions. Our cohort included a wide range of disease stages and was evaluated retrospectively in a single-center setting, potentially influencing the diagnostic outcomes. Additionally, variability in radiologic assessment and differences in imaging equipment and thresholds for interpreting tracer uptake may have contributed to the observed deviation. Table 3 provides a detailed comparison of diagnostic metrics from multiple studies.

Despite its high specificity, PET/CT is limited by moderate sensitivity, resulting in false negatives for micrometastases or small metastatic nodes. False positives also arise due to the non-specificity of the F-18 fluorodeoxyglucose tracer, which accumulates in inflamed or infected tissues⁽¹⁶⁾. MRI, with its superior soft-tissue resolution, excels in assessing tumor size and parametrial invasion, especially in early stages. However, its sensitivity in detecting nodal involvement decreases in advanced stages⁽¹⁷⁾.

In our cohort, false negativity rates for nodal metastasis were 15.3% for MRI and 17.3% for PET/CT. This is consistent with the Francogyn study, which identified a false-positive rate of 15% for PET/CT and emphasized the need for careful risk stratification to mitigate these errors⁽¹⁸⁾. Additionally, a meta-analysis by Thelissen et al.⁽¹⁹⁾, highlighted a 13% false-negative rate in preoperative imaging despite histopathological confirmation of lymph node metastasis postoperatively.

Study Limitations

Among the primary constraints of this study are its retrospective methodology, the modest number of cases analyzed, and the independent assessment of radiologic and pathologic findings by different clinicians.

Conclusion

MRI and PET/CT serve as complementary tools in the staging and management of cervical cancer. While MRI is preferred for detailed local assessments, such as tumor size and parametrial invasion, PET/CT is invaluable for evaluating lymph node involvement and detecting distant metastases. The integration

of these modalities enhances diagnostic accuracy and optimizes treatment planning. However, clinicians must remain cautious of their respective limitations, particularly regarding false positives and negatives.

Prospective studies and advancements in imaging technology are necessary to further refine diagnostic accuracy. Enhanced methods and larger patient cohorts may help address the limitations observed in retrospective analyses, ultimately improving the outcomes for cervical cancer patients.

Ethics

Ethics Committee Approval: Ethical approval for this study was granted by the Clinical Research Ethics Committee of İstanbul Medeniyet University Göztepe Training and Research Hospital under protocol number 2023/0166, dated 15.03.2023.

Informed Consent: Informed consent was not obtained due to the retrospective nature of the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: S.Ö., E.D., A.T., Concept: S.Ö., Design: S.Ö., A.T., Data Collection or Processing: S.Ö., A.T., Analysis or Interpretation: S.Ö., M.S., Literature Search: S.Ö., E.D., Writing: S.Ö., M.S.

Conflict of Interest: No conflict of interest was declared by the authors.

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