

Uterine Cervical Cancer: Diagnostic Accuracy of Clinical Staging, Magnetic Resonance Imaging, and Histopathology Findings

Abstract

Background: Cervical cancer (CC) ranks as the fourth most commonly diagnosed cancer in women globally. Accurate staging is crucial for treatment planning. Although magnetic resonance imaging (MRI) has been validated as a reliable modality for CC staging, limited evidence exists on its accuracy compared to dual International Federation of Gynecology and Obstetrics (FIGO) classifications in an Iranian population. This study addresses this gap by evaluating the diagnostic accuracy of MRI against both clinical FIGO staging systems and the gold standard of histopathology in untreated CC patients. **Materials and Methods:** A prospective study was conducted on 45 CC patients from January 2021 to December 2023, at tertiary-care centers in Isfahan, Iran. Clinical FIGO staging and pretreatment MRI were performed, followed by surgery and histopathological examination. MRI's diagnostic accuracy was compared with clinical FIGO staging and postoperative pathological findings. **Results:** The overall diagnostic accuracy of MRI for staging cervical carcinoma was 82.20%, with clinical FIGO staging achieving 57.80% accuracy. MRI demonstrated higher sensitivity (82.20%) and positive predictive value (PPV; 97.40%) compared to clinical FIGO. However, both methods showed equal and lower specificity (50%) compared with the postoperative pathological findings. **Conclusions:** MRI appears to be more effective than FIGO in terms of sensitivity and PPV for staging cervical carcinoma. The present study underlines the need for cautious interpretation of the results and further research due to significant uncertainty in specificity and negative predictive value. Combining FIGO staging and MRI provides a comprehensive assessment essential for effective treatment planning.

Keywords: Diagnostic accuracy, classification, magnetic resonance imaging, neoplasm staging, uterine cervical neoplasm

Introduction

Cervical cancer (CC) ranks as the fourth most commonly diagnosed cancer and a leading cause of cancer-related death in women globally.^[1,2] The treatment approach for CC hinges on its stage, determined by the International Federation of Gynecology and Obstetrics (FIGO) system. Early-stage cancer (stages IA, IB1, and IIA) usually involves radical surgery, such as trachelectomy or radical hysterectomy. In contrast, advanced stages (IB2/IIA2 and beyond) typically require radiotherapy combined with chemotherapy, particularly for patients with bulky tumors or extensive disease spread.^[3,4]

Originally, the clinical FIGO system utilized physical examinations, including pelvic inspections and various imaging tests like chest X-rays, to stage the cancer.

However, these methods could be limited in accurately assessing the full extent of the cancer, particularly in evaluating parametrial invasion and lymph node involvement. This limitation has often led to notable discrepancies between clinical and actual pathological staging, especially in more advanced cancer stages.^[5-7] Responding to these challenges, the 2018 update of the FIGO staging included the use of advanced imaging techniques, like magnetic resonance imaging (MRI), as critical components in the diagnostic process. This inclusion was due to MRI's demonstrated effectiveness in accurately determining the local extent of CC and evaluating lymph node involvement. Based on previous studies, in diagnosing parametrial involvement, MRI has shown an accuracy rate of 85%, and it is extremely reliable in identifying vaginal infiltration.^[8,9]

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**Fatemeh Zahrasadat Allameh,
Fahimeh Sabet,
Fariba Behnamfar,
Leila Mousavi Seresht,
Sara Amini**

Department of Gynecology and Obstetrics, Isfahan University of Medical Sciences, Isfahan, Iran

Address for correspondence:

Dr. Sara Amini,
Department of Gynecology and Obstetrics, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: aminisara1366@gmail.com

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MRI is also instrumental in monitoring treatment response, particularly in early-stage cancer, where its precision is most notable. Techniques such as T2-weighted MRI provide enhanced details of the cervical anatomy, crucial for detecting the spread of cancer to surrounding areas. Moreover, diffusion-weighted imaging and dynamic contrast-enhanced MRI offer advanced capabilities in detecting small cancerous tissues and understanding tumor angiogenesis, further improving the diagnostic accuracy.^[10-13]

Despite the inclusion of imaging in the 2018 FIGO staging system, real-world data comparing MRI to both versions of FIGO classification and to histopathology in treatment-naïve patients is limited. This prospective diagnostic accuracy study was conducted on 45 patients with histopathologically confirmed CC. The inclusion criteria involved newly diagnosed, treatment-naïve patients undergoing both FIGO staging classifications (2009 and 2018) and pelvic MRI prior to any treatment. Both FIGO staging systems were applied to capture the extent of the disease clinically. MRI imaging and clinical assessments were completed before surgery and were compared against postoperative histopathology, which served as the gold standard.

Materials and Methods

This prospective, diagnostic accuracy study included 45 patients with CC in tertiary care hospitals affiliated to Isfahan University of Medical Sciences, Iran. The inclusion criteria were histopathology-confirmed CC, pretreatment MRI, and both FIGO staging versions (2009 and 2018) used at diagnosis. FIGO and MRI were done prior to entry into the final histopathology comparison arm. All FIGO staging and MRI assessments were performed prior to any treatment or surgical intervention. Both the 2009 and 2018 versions of FIGO staging were applied to evaluate the comparative diagnostic consistency. Patients with previous pelvic cancer, newly diagnosed patients of CC who had had any kind of treatment before MRI, patients with contraindications for MRI (stents, claustrophobia, metallic prosthesis, and pacemakers), and patients who were unable to take contrast media were excluded from the study. The ages of patients ranged from 28 to 75 years, and all of them underwent assessment of clinical staging according to the FIGO guideline and pretreatment MRI for the lower abdomen from January 2021 to December 2023.

Demographic information of the patients, including age, occupation, education, gravidity, clinical symptoms of cancer (bleeding–discharges–lumps), as well as HPV status, and Pap smear and colposcopy results, were asked and recorded. Patients with a frank growth on cervix, unhealthy cervix, and high-grade lesion on Pap smear underwent cervical biopsy and clinical staging based on clinical FIGO staging information (based on both 2009 and 2018 versions of FIGO staging) in the same setting. Histopathologically proven CC patients were sent to the radiology department

of hospitals for MRI. The radiologist was blind to the clinical stage. Patients had to fast for at least 4 h before imaging. Also, an intramuscular injection of hyoscine butylbromide was given to all patients before scanning. Images were taken with a half-full bladder in T1, T2, and postgadolinium sequences in sagittal, axial, and coronal sections. MRIs were reviewed for the morphological characteristics, including origin, greatest diameters, margin, tumor shape, signal intensity, growth pattern, and internal appearance, the presence or absence of tumor invasion into the parametrium, vagina, and adjacent organs, as well as the presence or absence of abdominopelvic tumor. Tumor origin from the endocervical canal or from the cervical stroma was noted. Lymph nodes greater than 1 cm were considered pathological, and the presence of intranodal necrosis was considered a confirmatory finding. According to the obtained stage, the patients were subjected to appropriate surgery, the removed tissues were sent for pathology, and the exact stage of CC in each patient was determined by pathological examinations (gold standard).

In each patient, we compared the stages predicted through three methods (clinical FIGO staging, MRI staging, and histopathological findings). Statistical analysis was done using Epi Info (version 6.00; CDC, Atlanta, GA, USA). Moreover, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were estimated.

Ethical considerations

This study was approved by the ethical committee of Isfahan University of Medical Sciences with the code IR.MUI.MED.REC.1400.468, and all participants signed informed consent forms before enrollment.

Results

In this study, a total of 45 patients were included. Their ages ranged from 28 to 75 years, with a mean (SD) age of 49.40 (12.20) years, and a notable distribution across 3 age groups. Ages 28–39 years comprised 24.50% of the patients (11 patients), ages 40–59 years were the most represented with 51.0% (23 patients), and ages above 60 years accounted for the remaining 24.50% (11 patients).

The most common complaint among these patients was irregular vaginal bleeding, which was observed in 60% of them. Concordance between MRI and FIGO staging varied across different FIGO stages. Regarding clinical staging, 10 patients (22.20%) were categorized as stage 1. Among these, seven had MRI staging consistent with their clinical stage, while two patients were staged as 2B, and one patient was staged as IIA based on MRI findings. No patients were diagnosed as stage 2A, 3A, 4A, 4B, or III based on clinical staging.

Fifteen patients (33.30%) were classified as stage 2B according to clinical staging. Among these patients, nine patients had MRI staging that matched their clinical stage.

Of the remaining patients, one had an MRI reported as stage IIIB, one as stage IB, and four as stage III.

Two patients were identified as stage 3B based on clinical staging. One of them had MRI staging consistent with their clinical stage, while the other had an MRI report of stage IVA.

Additionally, six patients (13.30%) were staged as II based on clinical evaluation. Among them, four had MRI staging in agreement with their clinical stage, one had an MRI report of stage IIB, and another one was reported as stage IVA [Table 1].

The overall diagnostic accuracy of MRI in staging carcinoma of the cervix was 82.20% (95% confidence interval [CI]: 67.46–89.58), and that of clinical FIGO staging was 57.80% (95% CI: 43.28–70.49). MRI was inaccurate in 17.80% (8.45) of cases [Table 2]. On the other hand, of the 37 patients accurately staged by MRI, 66.70% (30.45) of patients were staged alike by MRI and clinical FIGO staging [Table 1].

Based on the data provided in Table 3, we analyzed and described the significance of the findings for staging carcinoma of the cervix using clinical FIGO and MRI, with a focus on their respective performance metrics and the 95% CIs. The sensitivity of FIGO and MRI was 57.80% (CI: 43.3–71.030%) and 82.2% (CI: 68.67–90.71%), respectively. Both FIGO and MRI specificity were 50% (CI: 9.45–90.55%).

Discussion

In the current study, we evaluated the diagnostic accuracy of MRI for staging cervical carcinoma. The results revealed an overall diagnostic accuracy of 82.2% (95% CI: 67.46–89.58) for MRI, whereas clinical FIGO staging achieved an accuracy of 57.8% (95% CI: 43.28–70.49). MRI exhibited inaccuracies in 17.8% (8.45) of cases [Table 2]. Conversely, among the 37 patients accurately staged by MRI, 66.7% (30.45) were concordantly staged using MRI and clinical FIGO staging [Table 1].

MRI outperforms FIGO in both sensitivity and PPV, which is significant for clinical practice. This suggests that MRI is a more reliable tool for correctly identifying patients with cervical carcinoma, and when a positive result is obtained, it is very likely to be correct.

These findings, particularly the higher sensitivity and PPV of MRI, could influence clinical decision-making, leaning toward MRI as a more reliable diagnostic tool in certain scenarios. Due to the inclusion of only histopathologically confirmed CC patients, the specificity calculation in this context is limited and should be interpreted cautiously, as true-negative cases are not represented. Our findings align with previous studies on the staging of cervical carcinoma. Dhoot *et al.*^[14] reported an overall MRI accuracy of 89.3% (67.75), while clinical FIGO staging achieved an accuracy of 61.3% (46.75). MRI exhibited inaccuracies in 10.6% (8.75) of cases. They concluded that MRI is highly accurate for evaluating cervical carcinoma and significantly influences therapeutic decisions in 26.6% of patients, suggesting its consideration in treatment planning for all patients.^[14] The wide CIs in some of the metrics call for further research with a sufficient sample size to refine these values and improve the accuracy and reliability of staging methods for cervical carcinoma.

Nawapun *et al.*^[15] found a strong correlation between clinical and MRI staging, with an overall agreement of 78.4%. This correlation was particularly notable in assessing vaginal invasion (77.0% agreement), pelvic sidewall invasion (67.6% agreement), adjacent pelvic organ invasion (78.4% agreement), and distant organ involvement (91.9% agreement). The kappa coefficient indicated a statistically significant substantial correlation in evaluating hydronephrosis between clinical and MRI assessment.^[15]

Kraljević *et al.*^[16] conducted surgical procedures on selected patients and compared clinical FIGO classifications, MRI findings, and histopathological results. They observed discrepancies in clinical and MRI staging, with MRI demonstrating better accuracy (90.9%) compared to clinical

Table 1: Age frequency and magnetic resonance imaging (MRI) staging concordance with clinical stage

Age/year	No (%)							
28–39	11 (24.50)							
40–59	23 (51.0)							
>60	11 (24.50)							
FIGO* stage	MRI							
	IA	IB	IIA	IIB	IIIB	IVA	II	III
IA, n=10 (22.20)	7 (24.40)		1 (2.20)	2 (4.40)				
IB, n=12 (26.70)		9 (20.0)	1 (2.20)	1 (2.20)	1 (2.20)			
IIB, n=15 (33.30)		1 (2.20)		9 (20.0)	1 (2.20)			1 (2.20)
IIIB, n=2 (4.50)					1 (2.20)	1 (2.20)		
II, n=6 (13.30)					1 (2.20)	1 (2.20)	4	
III, n=0 (0.0)								3 (6.70)

*International Federation of Gynecology and Obstetrics

examination (79.0%). They recommended a specific MRI protocol for FIGO IIA and IIB patients, emphasizing the importance of MRI in cervical carcinoma staging.^[16]

Kumari *et al.*^[17] reported their findings based on clinical and MRI staging, highlighting the sensitivity and specificity of MRI in detecting parametrial and vaginal infiltration. They found MRI to have a sensitivity of 100% and specificity of 81.26% for parametrial infiltration detection and a sensitivity of 100% and specificity of 88.84% for vaginal infiltration detection.^[17]

Recent studies underscore MRI's superior accuracy in staging CC. A systematic review reported an accuracy range of 74–95% for MRI, with a sensitivity of 92–100% and a specificity of 39–97%, in detecting early-stage disease and deep stromal invasion. These findings align with our study, which demonstrated MRI's high sensitivity in identifying parametrial invasion.^[18]

Incorporating MRI into clinical staging significantly enhances accuracy. A study revealed that combining MRI with clinical assessment increased overall staging accuracy from 61.0% to 81.4%, reduced upstaging from 27.7% to 11.9%, and decreased downstaging from 11.3% to 6.8%. Our findings corroborate this, highlighting MRI's role in refining staging and guiding treatment decisions.^[19]

MRI's detailed visualization of tumor size and extent informs treatment strategies. Accurate assessment of tumor dimensions and parametrial involvement can shift

management from surgical intervention to chemoradiation, optimizing patient outcomes.^[20] In our cohort, MRI findings led to treatment plan modifications in several cases, emphasizing its clinical utility.

In summary, FIGO staging is the widely used system for CC staging, primarily relying on clinical examination. However, MRI, known for its excellent soft-tissue contrast, can enhance the assessment of local tumor spread, including size, stromal invasion depth, and involvement of nearby organs. While MRI is valuable, histopathology remains the gold standard for confirming CC diagnosis and characteristics. The correlation between these methods is crucial for accurate staging, influencing treatment decisions and prognosis. Discrepancies may arise, emphasizing the need to integrate all available information for effective CC management.

This study proposes that the simultaneous use of clinical staging and MRI in patient treatment yields better results. The discrepancy between clinical stage and MRI may stem from two primary reasons: Typically, surgeons assign the clinical stage for the radiologist's assessment. Or, Surgeons may subconsciously favor surgery, potentially leading to a lower proposed stage for the patient. This study is limited by its small sample size, lack of a disease-negative cohort for specificity assessment, and single-center design, which may affect external validity. The other limitation is the lack of comparison with a disease-negative control group, which is necessary in calculating study specificity. The short timeframe of the study may also limit its generalizability.

Table 2: Staging results of patients in each correctly determined stage

Stage	No. of patients in each correctly determined stage		
	Pathology*	FIGO** stage	MRI*** staging
IA	8 (17.80)	7 (15.60)	7 (15.60)
IB	10 (22.20)	9 (20.0)	10 (22.20)
IIA	1 (2.20)	0 (0.0)	1 (2.20)
IIB	19 (42.20)	9 (20.0)	12 (26.70)
IIIA	0 (0.0)	0 (0.0)	4 (8.90)
IIIB	4 (8.90)	1 (2.20)	0 (0.0)
IVA	0 (0.0)	0 (0.0)	0 (0.0)
IVB	0 (0.0)	0 (0.0)	0 (0.0)
II	0 (0.0)	0 (0.0)	0 (0.0)
III	3 (6.70)	0 (0.0)	3 (6.70)
Total	45 (100.0)	26 (57.80)	37 (82.20)

*The histopathological stage was used as the gold standard.

International Federation of Gynecology and Obstetrics. *MRI: Magnetic resonance imaging

Conclusion

In conclusion, MRI appears to be more effective than FIGO in terms of sensitivity and PPV for staging cervical carcinoma. However, the wide CIs, especially in specificity and NPV, highlight a significant level of uncertainty, underlining the need for cautious interpretation and further research. The combination of clinical FIGO staging and MRI provides a more comprehensive and accurate assessment of CC, which is essential for effective treatment planning. While FIGO staging offers a standard framework, MRI adds critical detail, especially in terms of local tumor extent and involvement of adjacent structures. This integrated approach aligns with modern oncological practices, which emphasize personalized medicine based on detailed diagnostic information.

Table 3: Staging carcinoma of cervix using clinical international federation of gynecology and obstetrics system and magnetic resonance imaging

95% CI staging	Sensitivity	Specificity	Positive predictive value	Negative predictive value
FIGO*	57.80% (43.3–71.03)	50% (9.453, 90.55)	50% (9.45, 90.55)	5% (0.89, 23.61)
MRI**	82.20 (68.67–90.71)	50% (9.453–90.55)	97.40% (86.50–99.53)	11.10% (1.989, 43.50)

*Magnetic resonance imaging; **International Federation of Gynecology and Obstetrics

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Conflicts of interest

Nothing to declare.

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