



# Evaluation of Cervical Cancer Staging Based on Magnetic Resonance Imaging in Comparison with Surgical Staging

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## Abstract

**Background:** Cervical cancer is prevalent cancer among women that correct diagnosis has very important role in its treatment.

**Objectives:** The aim of this study was to evaluate the accuracy of magnetic resonance imaging (MRI) in comparison with surgical staging. Also, we compared the accuracy of physical examination with surgical pathology.

**Methods:** This retrospective cross-sectional study was performed on women who had cervical cancer from the start of 2017 to the end of 2021. Age, tumor pathology report (squamous cell carcinoma, clear cell carcinoma, adenocarcinoma, and small cell carcinoma), stage of the tumor, involvement of vagina, uterine, and parametrium, cervical stroma invasion, mass size, pelvic and abductor lymph node metastasis were extracted from the patient's data and all were evaluated. The pathology report was considered as the gold standard.

**Results:** Eighty women with cervical cancer were evaluated and the mean age was 47.3 years. There was a statistically significant difference between the different prevalence of disease stages (P-value = 0.035) and also stage diagnosis between the three methods (P-value = 0.0004). The diagnostic accuracy of physical examination and MRI in terms of vaginal involvement, parametrium involvement, and uterine involvement were 97.5% and 98.7%; 98.7% and 96.2%; 94.9% and 93.6%; respectively.

**Conclusions:** Magnetic resonance imaging is a good method for the assessment of the clinical staging of cervical cancer and its accuracy is more than 94% in the diagnosis of different parts of cervical cancer involvement.

**Keywords:** Uterine Cervical Neoplasms, Neoplasms, Magnetic Resonance Imaging, Physical Examination

## 1. Background

Cervical cancer is the cause of more than 0.3 million deaths globally each year, ranking fourth among all malignancies in terms of mortality (1). The prevalence of cervical cancer is low in Iran such as in many Muslim countries, but its death rate is considerable (2). In recent years, magnetic resonance imaging (MRI) or computed tomography (CT) has become popular for cervical cancer diagnosis but surgical staging is the gold standard yet (3, 4). Cervical cancer outcomes have considerably improved with the introduction of MRI technology to the practice of definitive radiotherapy (5, 6).

The mainstays of the curative treatment of cervical cancer are surgery or chemoradiotherapy. The stage of cervical cancer is the most important factor in deciding which therapy to use. As a result, precise staging is critical in the treatment of cervical cancer. The tumor size, local tumor invasion, including invasion of surrounding organs and

tissues (parametria, vagina, bladder, rectum, ureter, pelvic wall), and the existence of lymph node metastases and systemic disease are all important factors in therapy allocation. The most widely used staging systems for cervical cancer are the Fédération Internationale de Gynécologie et d'Obstétrique (FIGO) system and the Tumour, Node, Metastasis (TNM) system developed by the Union Internationale Contre le Cancer (UICC)/ American Joint Committee on Cancer (AJCC) (7-9). Using the TNM staging method, which includes imaging, clinical, and histopathologic data for nodal, local, and distant disease, is recommended for staging of cancer of cervix in the recently published European Society of Gynecological Oncology/European Society for Radiotherapy and Oncology/European Society of Pathology "guidelines for the management of patients with cervical cancer". Meanwhile, the FIGO system integrates nodal cancer status as well as imaging results (10-12). The prognosis of cervical cancer is strongly dependent on the stage

of the disease according to FIGO (13). There are few studies about the assessment of diagnostic values of MRI for the diagnosis of cervical cancer staging.

## 2. Objectives

The aim of this study was to evaluate and compare clinical staging based on MRI findings in cervical cancer before surgery with the surgical staging based on postoperative histopathology.

## 3. Methods

This retrospective cross-sectional study was performed on patients who had cervical cancer and were referred to Imam Khomeini Hospital (Tehran-Iran) from the start of 2017 to the end of 2021.

The inclusion criteria were positive pathology indicates cervical cancer that underwent primary surgery. Exclusion criteria were lack of data in the patient's file and patients who previously received radiotherapy or chemotherapy. Finally, 80 patients were enrolled in the study. The files of these patients were studied retrospectively and the required data for each patient were recorded in a checklist. The checklist included age, tumor pathology report (squamous cell carcinoma, clear cell carcinoma, adenocarcinoma, and small cell carcinoma), stage of tumor based on physical examination, MRI and post-surgery pathology report, involvement of vagina, uterine, and parametrium based on physical examination, MRI and post-operation pathology report, cervical stroma invasion based on MRI and post-operation pathology report, mass size based on physical examination, MRI and post-operation report, pelvic and abductor lymph node metastasis based on MRI, and pathology report.

After obtaining a pathological assessment of the patient's cervical mass, physical examinations were performed for all patients. Physical examinations included bimanual examination and digital rectal examination. If there was no mass in the in physical examination but there was a mass in pathology report, we consider this mass as stage IA. If there was a mass in pathology report and only we could see the mass in physical examination with speculum, it considers as stage IB.

Magnetic resonance imaging and pathology reports were extracted from hospital data and reviewed by a specialist radiologist and pathologist. If previous reports there was a conflict with the new reports, another expert was evaluated to provide an opinion, and his/her diagnosis was considered as the final diagnosis.

### 3.1. Statistical Analysis

Frequency and percentage were used to describe qualitative data and mean, standard deviation, median, and amplitude were used for quantitative data. Indices that are related to the diagnostic power of MRI in cervical cancer staging were evaluated. The indices were true positive (TP), false-positive (FP), true negative (TN), false negative (FN), Sensitivity (Sen), specificity (Spe), positive predictive value (PPV), negative predictive value (NPV), accuracy (ACC), and sub-curve rock area (ROC Area). These indices were compared to pathology reports as a gold standard method for staging. ANOVA and chi-square tests were used for significant assessment. Analysis was performed using SPSS 25.0 statistical software. P-value less than 0.05 was considered as definitive statistical significance.

## 4. Results

The aim of this study was to evaluate the clinical staging of cervical cancer based on MRI and in comparison with the surgical staging based on pathology reports in patients who were referred to Imam Khomeini Hospital (Tehran-Iran). Eighty patients were included in the study with a mean age of  $47.3 \pm 11.1$  and with a range of 27 to 80 years.

The mean and standard deviation of the mass size based on the three diagnostic methods including physical examination, MRI, and pathology were  $1.04 \pm 2.08$  cm,  $2.17 \pm 1.16$  cm, and  $2.43 \pm 1.23$  cm, respectively. The mean mass size based on three tests did not show a statistical difference. In other words, all three tests were the same in detecting mass size accuracy (P-value = 0.128).

We examined the frequency of the disease stage based on the three diagnostic methods. The stage of the disease is divided into 9 states. The diagnosis of stage IA was the same based on all three tests. The diagnosis of the IA2 stage was the same based on the first two tests, but the pathology test result was different. All results are shown in Table 1. There was a statistically significant difference between the different prevalence of disease stages (P-value = 0.035). Also, there was a significant difference between three methods of diagnosis in terms of disease stage (P-value = 0.0004).

In stage IB, MRI had better diagnostic results than physical examination. MRI diagnosed 43 cases with stage IB1 and 10 cases of them were falsely detected. Fifty-one cases were diagnosed as stage IB1 by physical examination but, 18 cases of them were not in this stage. Stage IB2, 24 cases were diagnosed as stage IB2 by MRI and 20 cases were diagnosed as this stage by physical examination but, 27 cases were in stage IB2 based on pathology.

In terms of tumor type frequency, 54(67.5%) patients had squamous cell carcinoma and 23 (28.7%) patients had

**Table 1.** Frequency of Disease Stage Based on Three Diagnostic Tests

Disease Stage	Examination	MRI	Pathology	P-Value
IA	1	1	1	0.035
IA2	1	1	0	
IB1	51	43	33	
IB2	20	24	27	
IB3	6	4	8	
IIA1	1	0	1	
IIA2	0	0	0	
IIB	0	6	3	
III	0	0	6	
P-value	0.0004			

adenocarcinoma. Mucinous cell carcinoma, small cell carcinoma, and clear cell carcinoma were observed in one patient (1.25% for each one).

In the following, we have compared the indicators related to the diagnostic value of clinical examination and MRI. The pathology test was used as a gold standard test for evaluations. In all tables, true positive (TP), false positive (FP), true negative (TN), and false negative (FN), sensitivity (Sen), specificity (Spe), positive predictive value (PPV), negative predictive value (NPV), accuracy (ACC), and sub-curve rock (ROC Area) have also been reported. The tables are divided into four modes: vaginal involvement, uterine involvement, parametrium involvement, and cervical stromal invasion. In Table 2, the diagnostic values for the two diagnostic tests including clinical examination and MRI were compared in vaginal, uterine, parametrium involvement, and cervical stroma invasion. Pathology was considered as gold standard for this assessment. As it is shown, MRI had better diagnostic value than clinical examination in vaginal involvement, in contrast, the clinical examination had better results than MRI in terms of uterine involvement. Regarding parametrium involvement, MRI was more valuable than clinical examination. For assessment of cervical stromal invasion, a clinical examination can't be done. Then, we evaluated our indices for MRI, only.

We assessed our patients based on abductor lymph node metastasis and Pelvic lymph node metastasis. There was one abductor lymph node metastasis and five pelvic lymph node metastasis were diagnosed in the surgery report but MRI couldn't diagnose these types of lymph node metastasis (P-value = 0.006).

## 5. Discussion

The present study was performed on 80 Iranian women with cervical cancer to evaluate the diagnostic power of

MRI in comparison with post-operation pathology as a gold standard.

Regarding the difference between different stages of the disease in the three tests performed in this study, the numerical value of P showed that the frequency of diagnosis of the stages of the disease was different based on the three types of diagnostic tests. It can be noted that the diagnosis of IA stage was the same based on all three tests. The diagnosis of stage IA2 was the same based on the physical examination and MRI, but it is different from the pathology result. Also, the diagnosis of stage III was made based on pathology for 6 patients, but the other two tests couldn't diagnose this stage. This difference in the frequency of diagnosing the stage of the disease between the three tests was statistically significant (P-value = 0.035). In fact, this P-value was to compare the difference in the frequency of different stages of the disease, but, P-value = 0.004 was used to measure the difference of diagnosed stages only between MRI and pathology methods.

Cervical cancer is the second most frequently diagnosed malignancy among women in developing nations, and the third greatest reason for cancer-related mortality. Women between the ages of 45 and 55 are the most commonly affected by cervical cancer (14-18). About 69 percent of all cervical cancers are squamous cell carcinomas (19). The cancer progression, therapeutic outcome, and patient survival are all determined by the histological subtype and differentiation grade. Though the evidence is mixed, most studies have demonstrated that adenocarcinomas have a lower 5-year overall survival rate than squamous cell carcinomas, with about 10% - 20% disparities in 5-year overall surveillance (20, 21). In Iran, the incidence of cervical cancer is low. The age-standardized incidence rate for Iran is about 2.5/100,000 women. But, the mortality to incidence ratio is high in Iran and it is about 42% (22, 23).

In the current study, we observed that the mean age of women was 47.3 years which was compatible with the studies report that was mentioned above (14-18). Also, squamous cell carcinoma was found in 67.5% and Adenocarcinoma in about 28%. These rates were approximately similar to the WHO report for squamous cell carcinoma and adenocarcinoma prevalence (17).

Preoperatively, MRI is the greatest method for determining the involvement of cervix, which is associated with the grade of tumor, the occurrence of lymph node metastases, and total survival. The American College of Radiology advises MRI for the planning of treatment; however, the National Comprehensive Cancer Network (NCCN) recommends MRI in patients with type II cancer of endometrium with suspected invasion to cervix (24-27). Because it can reliably evaluate tumor size, pelvic sidewall invasion, parametrial invasion, and lymph node metastasis

**Table 2.** Comparison of Diagnostic Value Between Clinical Examination and MRI <sup>a</sup>

Test	TP	FP	TN	FN	Sen	Spe	PPV	NPV	ACC	AUC Area
<b>Diagnostic Values of Examination and MRI in Vaginal Involvement</b>										
<b>Examination</b>	78	1	0	1	98.7	50	98.7	0	97.5	0.49
<b>MRI</b>	79	1	0	0	98.7	50	98.7	0	98.7	0.50
<b>Diagnostic Values of Examination and MRI in Uterine Involvement</b>										
<b>Examination</b>	79	1	0	0	97.5	50	98.7	0	98.7	0.50
<b>MRI</b>	77	1	0	2	97.5	50	98.7	0	96.2	0.49
<b>Diagnostic Values of Examination and MRI in Parametrium Involvement</b>										
<b>Examination</b>	75	4	0	0	98.68	20	-	-	94.9	0.50
<b>MRI</b>	71	1	3	4	94.7	75.0	98.6	42.9	93.6	0.84
<b>Diagnostic Values of MRI in Cervical Stroma Invasion</b>										
<b>MRI</b>	24	52	4	0	100.0	7.14	31.6	100.0	35.0	0.54

<sup>a</sup> Pathology was considered as a gold standard in all assessments.

with up to 95 percent accuracy for stage IB or higher, MRI is the best method for primary tumors over 1 cm assessment in size. In young individuals who want to keep their fertility, an MRI is required to assess the possibility of conservative therapies (12, 15, 28, 29). In the present study, we found that 43 patients were diagnosed as stage IB1 by MRI but 33 patients were in the stage IB1 category or, 24 patients were in the stage IB2 group based on MRI but 27 patients had cervical cancer with stage IB2 based on pathology.

In a study by Lou et al, it was found that the sensitivity, specificity, and diagnostic accuracy of MRI in the diagnosis of lymph node metastasis of early cervical cancer were 75%, 72.92%, and 77.50%, respectively in stage Ia-Ib. In the current study, we didn't assess these subtypes but it was observed that MRI had no detection rate in lymph node metastasis and its sensitivity, specificity, and accuracy rate were more than 95% in uterine and vaginal involvements (30). Because MRI cannot distinguish microinvasive tumors, it is useless in the assessment of stage IA lesions. MRI has 90% sensitivity and 98% specificity for staging early IB1 cancers (31). In the present study, only one patient was in stage IA and it was diagnosed by MRI, correctly. About diagnosis of stage IB1, we observed that MRI had accuracy lower than 80% but we didn't assess sensitivity or specificity based on different staging. This issue should be evaluated in future studies.

Balleyguier et al. mentioned that MRI has high accuracy (86 - 93%) for vaginal invasion assessment (15). In the current study, we found that MRI had more Accuracy than Balleyguier et al. study and it was 98.7%.

In a study by Wang et al. (32), it was observed that there was no statistically significant difference between postoperative pathologic staging and preoperative MRI staging.

This result is in contrast with our findings. We found there was a statistically significant difference between MRI staging and postoperative pathologic staging. The Wang et al. study mentioned sensitivity of MRI in comparison with pathology was 97.0% in vaginal involvement. In the current study, it was observed that the sensitivity of MRI for assessment of vaginal involvement in cervical cancer was 98.7% which was similar to the Wang et al. study. In the current study, we found that MRI has no value for pelvic or abductor lymph node metastasis and it couldn't diagnose these sites lymph node metastasis but the Wang et al. study showed that MRI is a sensitive good for evaluating lymph node metastasis in cervical cancer. About this finding, the two studies were different (32).

In the current study, a physical examination was also evaluated and we saw there was a considerable diagnostic value for vaginal and uterine involvement for a physical examination with a combination of bimanual examination, TV and TR. The transvaginal US is a highly accurate way to assess cervical stroma invasion in patients with early-stage cervical cancer in professionally trained hands. The transvaginal US can also detect local invasion complications, such as endometrial cavity dilatation or hydronephrosis. However, because of the poor contrast of soft-tissue and restricted field of view, transvaginal US has a limited function in staging cervical cancer (33).

### 5.1. Conclusions

Magnetic resonance imaging is a good method for the assessment of the clinical staging of cervical cancer. This method can detect vaginal, uterine, and parametrial invasion with a sensitivity of 98.7%, 97.5%, and 94.7%, respectively. The specificity of MRI is low (about 50%) and it shows

that MRI can't diagnose masses types, properly. MRI can't diagnose abductor or pelvic lymph node metastasis and for diagnosis of the abductor or pelvic lymph node metastasis, post-operation pathology is the best way. When MRI is not available, physical examination can be used as a reliable way but it should be considered its accuracy has a strong relation with operator professionalism and also has lower accuracy than MRI.

## Footnotes

**Authors' Contribution:** Study concept and design: S. A., and A. M.; analysis and interpretation of data: S. S., and Z. T. K.; drafting of the manuscript: Z. T. K. and N. Z.; critical revision of the manuscript for important intellectual content: S. A. and Z. T. K.; statistical analysis: E. R.

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