OPEN ACCESS

Scholars International Journal of Obstetrics and Gynecology
Abbreviated Key Title: Sch Int J Obstet Gynec
ISSN 2616-8235 (Print) | ISSN 2617-3492 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Diagnostic Accuracy of Preoperative MRI in Predicting Surgicopathological Factors in Early Cervical Cancer

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DOI: https://doi.org/10.36348/sijog.2025.v08i12.001 | **Received:** 18.10.2025 | **Accepted:** 09.12.2025 | **Published:** 12.12.2025

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Abstract

***Background*:** Accurate preoperative assessment of surgicopathological factors is essential for optimal management of early cervical cancer. Magnetic resonance imaging (MRI) is widely used for preoperative staging, but its diagnostic accuracy varies across key pathological predictors. This study aimed to evaluate the sensitivity, specificity, and predictive values of MRI in determining surgicopathological factors in early-stage cervical cancer using histopathology as the gold standard. ***Methods*:** This prospective cross-sectional study was conducted at the Gynecological Oncology Unit of Dhaka Medical College Hospital from June 2021 to May 2022. Fifty histologically confirmed early-stage cervical cancer patients undergoing primary radical hysterectomy with pelvic lymph node dissection were included. Preoperative MRI assessed tumor size, vaginal extension, parametrial involvement, lymph node metastasis, deep stromal invasion, and corpus extension. MRI findings were compared with clinical examination and final histopathology. Diagnostic accuracy parameters were calculated. ***Results*:** Clinically, 94% of tumors were <4 cm, and 14% showed vaginal involvement. MRI demonstrated high accuracy for tumor size assessment with sensitivity 97.87%, specificity 100%, and overall accuracy 98%. For vaginal extension, MRI showed sensitivity 71.43% and specificity 100% with accuracy 96%. MRI detected lymph node metastasis with sensitivity 60%, specificity 91.11%, and accuracy 88%. Deep stromal invasion was identified with 72.41% sensitivity and 71.43% specificity. Corpus extension demonstrated sensitivity 55.56%, specificity 93.75%, and accuracy 80%. ***Conclusion*:** MRI is a highly sensitive and specific modality for preoperative evaluation of key surgicopathological factors in early cervical cancer. Its strong concordance with histopathology supports its essential role in guiding surgical planning and staging.

Keywords: Cervical cancer, MRI, diagnostic accuracy, surgicopathological factors, early-stage cervical cancer, histopathology.

INTRODUCTION

Worldwide cervical cancer is a public health problem among women with an estimated 604,127 new cases representing 6.5% of all female cancer and 341,831 deaths in 2020. Cervical cancer is the fourth leading cause of female cancer death. About 90% of cervical cancer occurs in low and middle income countries but the highest incidence rates are found in Sub-Saharan Africa, Melanesia, South America and South-Eastern Asia.[1]

Cervical cancer is the 3rd most common type of cancer in women in Asia with an estimated 315,346 new cases and 168,411 deaths in 2018. India contributes one-third of the cervical cancer burden in Asia, with 1,23,907 new cases and 77,384 deaths in 2020. In Bangladesh, cervical cancer has been the second most common cancer in women with 8268 new cases diagnosed and 4971 deaths annually.[1]

This carcinoma were strictly clinically staged according to the International Federation of Gynecology and Obstetrics (FIGO) system on the basis of gynecological examination, and if needed cystoscopy, proctoscopy, and colposcopy.[2]

One of the major changes in the updated FIGO 2018 staging system is that stage IB disease (ie, invasive carcinoma limited to the cervix) now includes three, rather than two, subgroups based on tumor size measured in its maximal dimension. The maximal cross-sectional tumor diameter visualized in any plane is measured at imaging, clinically and at pathologic analysis. Another change included is assessment of abdominopelvic retroperitoneal lymph nodes. Both these changes can be assessed by preoperative MRI & are major prognostic factors for survival as well as important determinant of treatment planning.[3]

The FIGO stage is directly related to prognosis and guides the stratification of patients to different treatment regimens ranging from primary (radical) surgical resection to definitive chemoradiation or palliative chemotherapy.[2] Cervical cancer traditionally has been staged clinically. Advances in imaging could improve the staging of cervical cancer by facilitating the detection of lymph node metastases and micro-metastases in distant organs. Such progress could lead to selection of modality of treatment and therefore increase overall survival rates. MRI, which is valuable because of its superior soft tissue contrast resolution, multiplanar capabilities, is used to determine the tumor size, degree of stromal penetration, vaginal extension, corpus extension, parametrial extension, lymph node status.[4]

MRI can detect the presence of disease in the ureter, lung and liver. The presence of lymph node metastases was not incorporated into the clinical staging system in the previous 2009 FIGO classification; nonetheless, it is an important factor in determining prognosis. Assessment of abdominopelvic retroperitoneal lymph nodes in cervical cancer staging was introduced with the 2018 update that was not in any previous versions of the FIGO system. Patients with pelvic and/or para-aortic lymph node metastases are designated as having stage IIIC disease, irrespective of primary tumor size or local pelvic spread. Stage IIIC1 corresponds to nodal metastases confined to the pelvis and stage IIIC2 to para-aortic nodal metastases. Lymph node status will be assigned based on imaging and/or pathologic analysis and the methodology will be recorded.[3]

Cervical carcinoma is the only gynecological tumor still being staged mainly by clinical examination and only a limited use of diagnostic radiology. Cross sectional imaging is increasingly used as an aid in the staging procedure. The primary treatment of cervical cancer in very early-stage disease (IA1-IB1) is surgery and for more advanced disease (IIB and IB3-IVA) radiotherapy combined with chemotherapy. Clinical staging based on physical examination combined with multimodality imaging is of utmost importance as it determines whether a woman is eligible for surgery and also describes the extent of the cancer for women who are not surgical candidates.[5] In this study, it was an attempt to assess the role of preoperative magnetic resonance imaging (MRI) for the assessment of surgicopathological factors in addition to the clinical staging of patients in early cervical cancer.

The objective of this study was to determine the role of preoperative MRI in assessing the surgicopathological factors in cervical cancer.

METHODOLOGY & MATERIALS

This prospective cross-sectional study was conducted at the Gynecological Oncology Unit, Dhaka Medical College Hospital over one year from June 2021 to May 2022. The study population included histologically diagnosed early-stage cervical cancer patients attending the Gynecological Oncology outpatient and inpatient departments for surgery. Although the initial sample size was larger, the final number of participants decreased to 50 due to previously mentioned factors. Histopathologically confirmed early-stage cases selected for primary radical hysterectomy and bilateral pelvic lymph node dissection were included. Patients were admitted through both OPD and indoor admission units. FIGO staging was determined based on bimanual pelvic examination, EUA findings in the operating theatre, and radiological assessments. All patients underwent preoperative MRI interpreted by an expert radiologist, focusing on tumor size, parametrial invasion, uterovaginal extension, and lymph node involvement. Surgical management consisted of Radical or Modified Radical Hysterectomy with BPLND, followed by histopathological evaluation of surgical specimens based on FIGO and TNM criteria. MRI findings were then compared with postoperative surgicopathological results.

Inclusion criteria were biopsy-documented invasive cervical cancer, clinical FIGO stage IA2, IB, or IIA1 disease, and histopathologic diagnosis of squamous cell carcinoma, adenocarcinoma, or adenosquamous carcinoma, with no medical or surgical contraindication to radical surgery and with informed consent. Exclusion criteria included advanced cervical cancer, contraindication to MRI, refusal of contrast-enhanced MRI, associated vulvovaginal cancer, and pregnancy. Dependent variables included tumor size, deep stromal penetration, parametrial extension, vaginal and corpus extension, and lymph node involvement. Independent variables included sociodemographic characteristics and clinical variables, and potential confounders included demographic variables and selection bias. Operational definitions followed standard FIGO descriptions of early-stage disease.

Study procedures involved detailed history taking and clinical examination, completion of MRI, surgery, and histopathological assessment. Data were collected using a structured questionnaire and relevant clinical documents. Statistical analysis was performed with SPSS version 23.0, using means for continuous variables and frequencies and percentages for categorical data, with chi-square tests applied where appropriate. Quality assurance was maintained through double-checking clinical and laboratory records, verification of data entry, and logical consistency checks. Ethical approval was obtained from the local research committee, and informed consent was obtained from all participants with assurance of confidentiality and voluntary participation.

RESULTS

Table 1: Distribution of cervical cancer patients according to demographic characteristics (N= 50)

Socio-demographic characteristics		Total Frequency (%)	Histological type		P value
			Squamous cell carcinoma Frequency (%)	Adenocarcinoma Frequency (%)	
Age (years)	≤ 40	10 (20.0)	7 (16.7)	3 (37.5)	[b] 0.305[NS]
	41-50	20 (40.0)	16 (38.1)	4 (50.0)	
	51-60	15 (30.0)	14 (33.3)	1 (12.5)	
	>60	5 (10.0)	5 (11.9)	0 (0.0)	
	Mean± SD	48.84 ± 9.19	50.05 ± 9.36	42.50 ± 4.81	[a] 0.032[S]
Education	Illiterate	24 (48.0)	23 (54.8)	1 (12.5)	[b] 0.089 [NS]
	Primary	18 (36.0)	13 (31.0)	5 (62.5)	
	SSC	8 (16.0)	6 (14.3)	2 (25.0)	
Occupation	Housewife	45 (90.0)	40 (95.2)	5 (62.5)	[b]<0.001[S]
	Garment worker	3 (6.0)	0 (0.0)	3 (37.5)	
	Day labor	2 (4.0)	2 (4.8)	0 (0.0)	
Socio economic status	Lower middle class (≥7000-27000 BDT*)	10 (20.0)	8 (19.0)	2 (25.0)	[c] 0.653 [NS]
	Poor (<7000 BDT)	40 (80.0)	34 (81.0)	6(75.0)	

*Based on the classification designed by World Bank and UNDP

Data were expressed as mean ±SD, Frequency and percentage P value was obtained by [a]Independent sample t test, [b]Chi square test, [c]Fisher's exact test NS=non-significant, S=significant

Table I is showing the distribution of demographic characteristics of the study patients. Majority (40.0%) of the patients were in 41-50 years of age group, followed by 51-60 years and ≤ 40 years where the proportion of the patient was 30% and 20 %, respectively. The majority of the patients suffering from both squamous cell carcinoma and adenocarcinoma were of the 41-50 years age group. The mean± SD age of the participants suffering from early-stage cervical cancer was 48.84 ± 9.19. Mean± SD age of patients suffering from squamous cell carcinoma (50.05 ± 9.36) was significantly higher than patients with adenocarcinoma (42.50 ± 4.81). Almost half of the participants (48%) were illiterate. A majority (90%) of the patients were housewives, followed by garment workers (6%). And 80% ofthe patients were poor. There was a significant association between the histological nature of cervical cancer and the occupation of the patients.

Table II: Clinical examination findings of the cervical growth (N= 50)

Local examination		Frequency (N=50)	Percentage (%)
Growth	Cauliflower like growth	30	60.0
	Ulcerative and endophytic growth	15	30.0
	Normal looking cervix	5	10.0
Size	< 2 cm	23	46.0
	2-<4 cm	24	48.0
	≥4 cm	3	6.0
Vagina	Involved	7	14.0
	Not involved	43	86.0
Parametrium	Involved	0	0.00
	Not involved	50	100.00

Data were expressed as Frequency and percentage

Findings of cervical cancer growth on clinical examination are presented in table 3.3. In 94% cases the tumor size was < 4cm. Cauliflower-like growth was found in 60% of cases, where Ulcerative growth was found in 30% of cases. Parametrium was not involved in 100% cases. Only in 14.0% of cases, the vagina was involved (Table II).

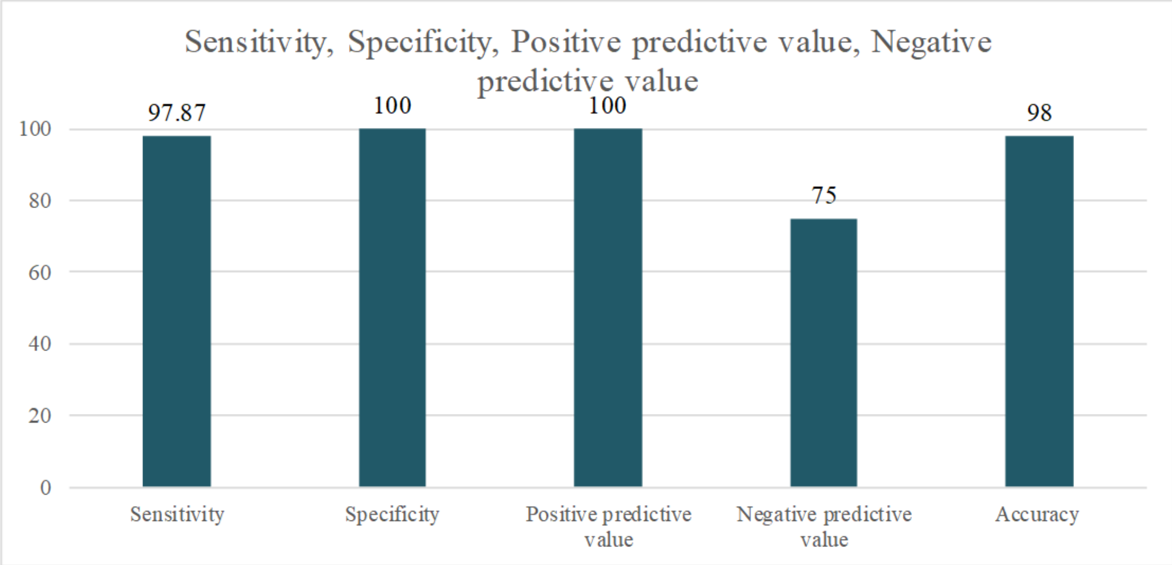

Figure 1: Sensitivity, Specificity, Positive predictive value, and Negative predictive value of MRI for size of the tumor determination

Figure 1, depict that, considering clinical examination the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MRI scan to determine the size of the tumor (<4 cm) in patients with early cervical cancer, was found 97.87% (CI: 88.71% to 99.95%), 100.00% (CI: 29.24% to 100.00%), 100.00% and 75.00% (CI: 30.14% to 95.42%), and 98.00% (CI: 89.35% to 99.95%) respectively, in this study.

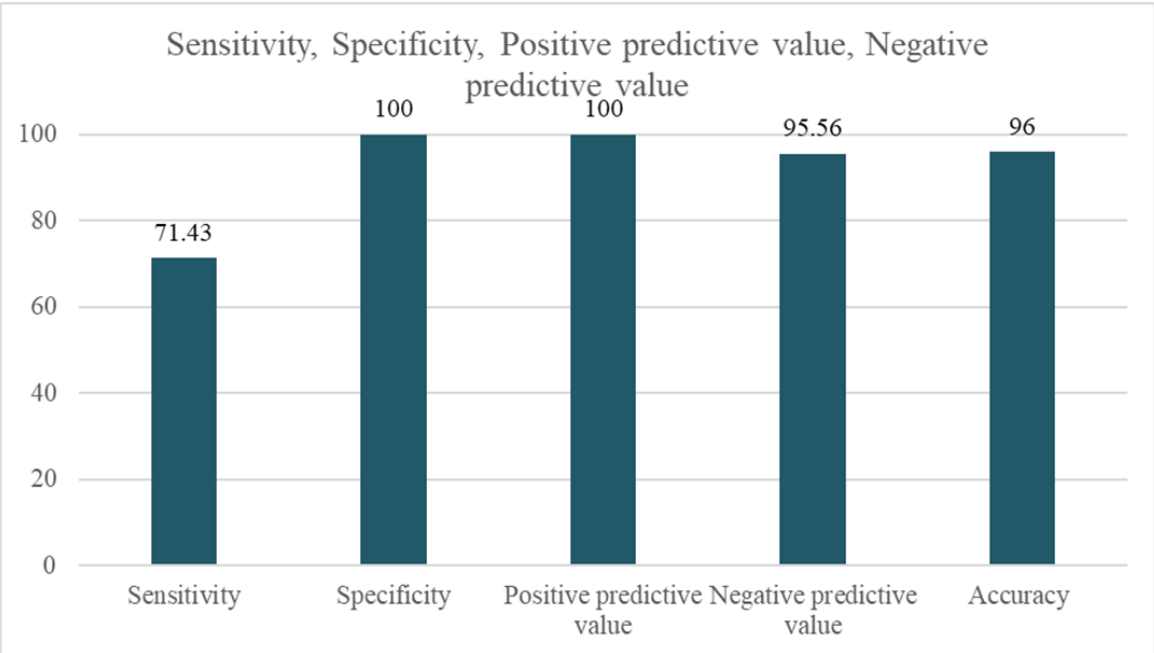

Figure 2: Sensitivity, Specificity, Positive predictive value, and Negative predictive value of MRI for vaginal extension

Figure 2, depict that, in this study considering clinical examination, the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MRI scan to determine the vaginal involvement in patients with early cervical cancer were found 71.43% (CI: 29.04% to 96.33%), 100.00% (CI: 91.78% to 100.00%), 100.00%,95.56% (CI: 86.95% to 98.58%) and 96.00% (CI: 86.29% to 99.51%), respectively.

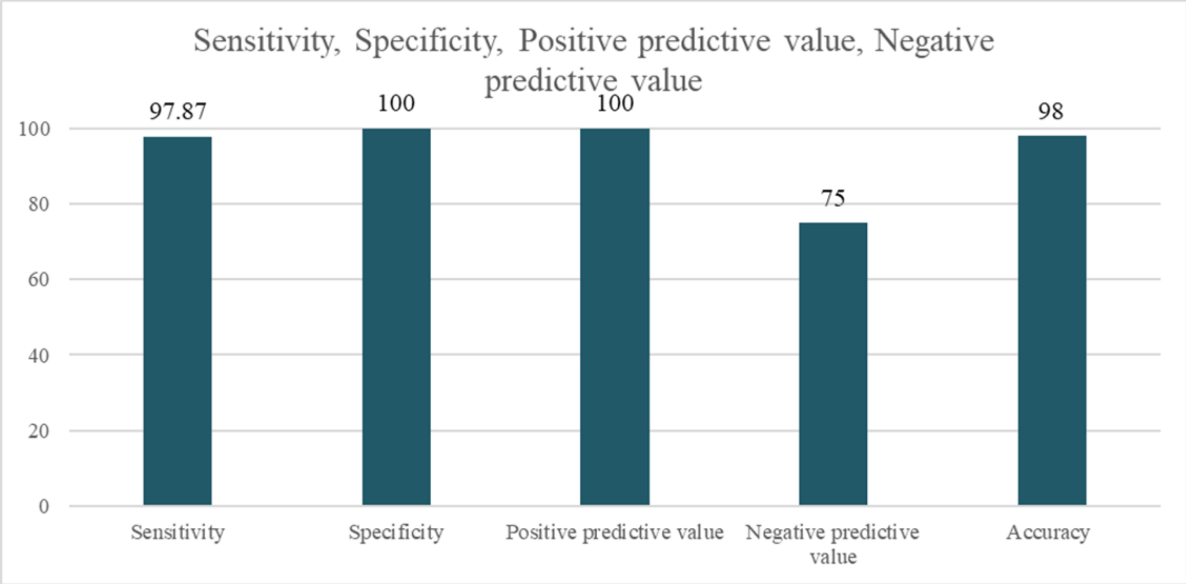

Figure 3: Sensitivity, Specificity, Positive predictive value, and Negative predictive value of MRI for size of the tumor determination

Figure 3, depict that, considering Histopathology as a gold standard test to determine the size of the tumor (<4 cm) in patients with early cervical cancer, the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MRI scan was found 97.87% (CI: 88.71% to 99.95%), 100.00%(CI: 29.24% to 100.00%), 100.00%and 75.00% (CI: 30.14% to 95.42%), and 98.00% (CI: 89.35% to 99.95%) respectively, in this study.

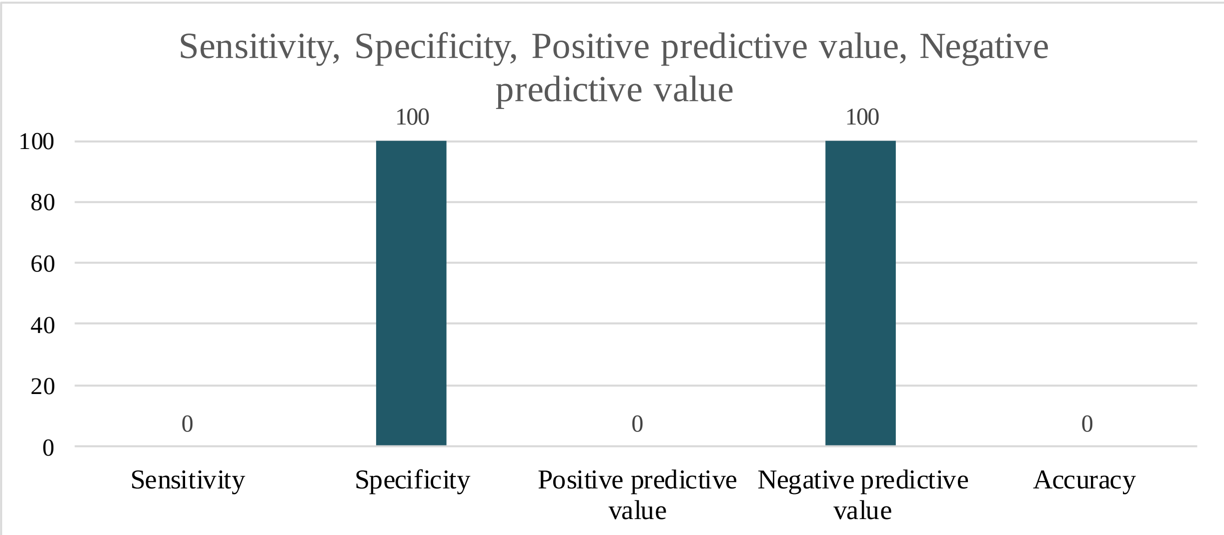

Figure 4: Sensitivity, Specificity, Positive predictive value, and Negative predictive value of MRI for parametrium involvement determination

Figure 4, depict that, considering Histopathology as a gold standard test to determine parametrium involvement in patients with early cervical cancer, the specificity, negative predictive value of MRI scan was found 100% (CI: 92.89% to 100.00%) and 100% respectively, in this study.

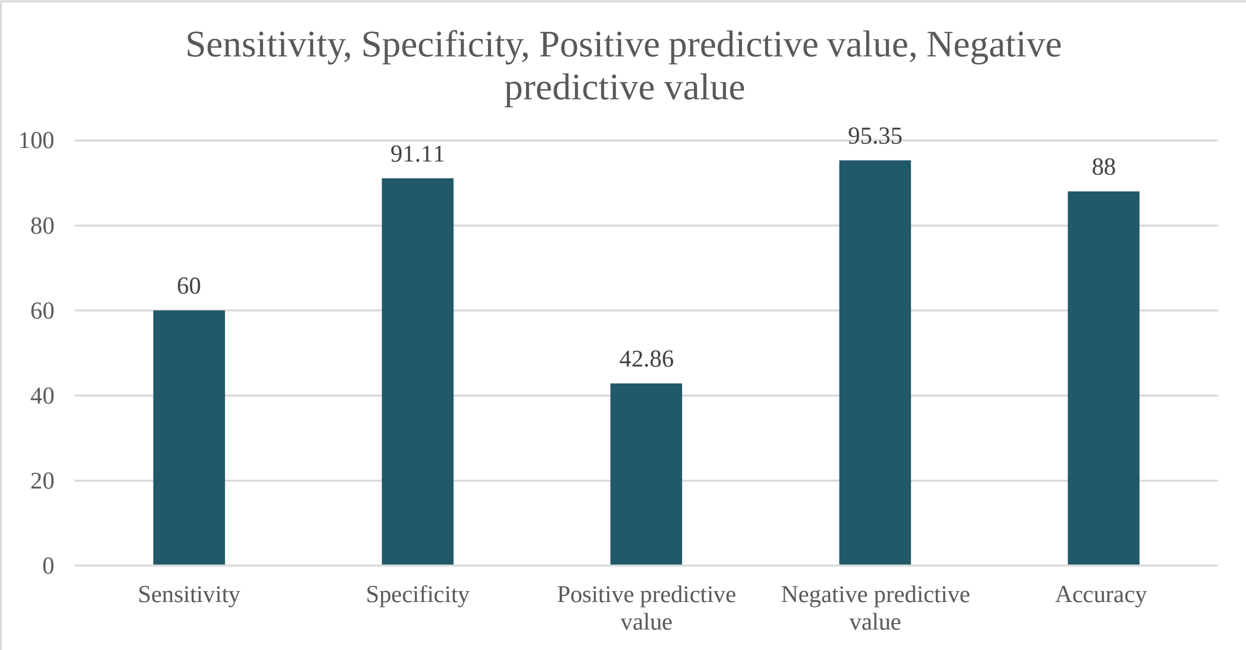

Figure 5: Sensitivity, Specificity, Positive predictive value, and Negative predictive value of MRI for lymph node involvement determination

Figure 5, depict that, considering Histopathology as a gold standard test to determine lymph node involvement in patients with early cervical cancer, the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MRI scan were found 60.00%(CI: 14.66% to 94.73%), 91.11%(CI: 78.78% to 97.52%), 42.86% (CI: 18.76% to 70.89%) and 95.35% (CI: 87.47% to 98.37%), and 88.00% (CI: 75.69% to 95.47%) respectively, in this study.

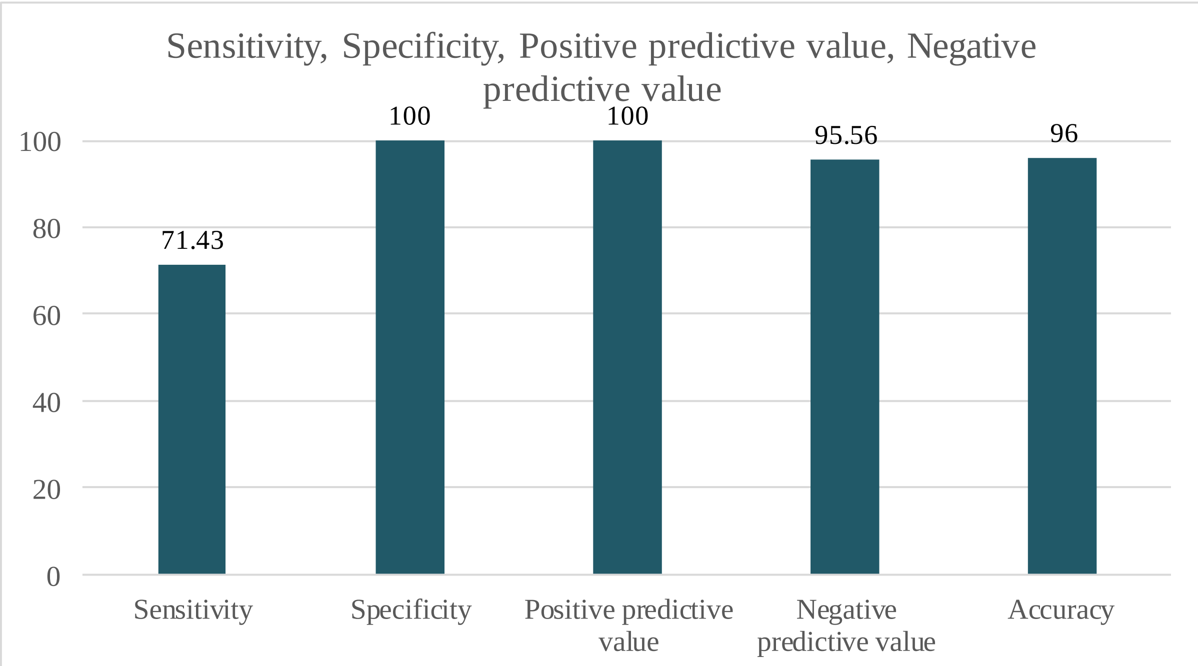

Figure 6: Sensitivity, Specificity, Positive predictive value, and Negative predictive value of MRI for vaginal extension determination

Figure 6, depict that, in this study considering histopathology as a gold standard test to determine Vaginal extension in patients with early cervical cancer, the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MRI scan were found 71.43% (CI: 29.04% to 96.33%), 100.00%

(CI: 91.78% to 100.00%), 100.00%,95.56% (CI: 86.95% to 98.58%)and 96.00% (CI: 86.29% to 99.51%), respectively.

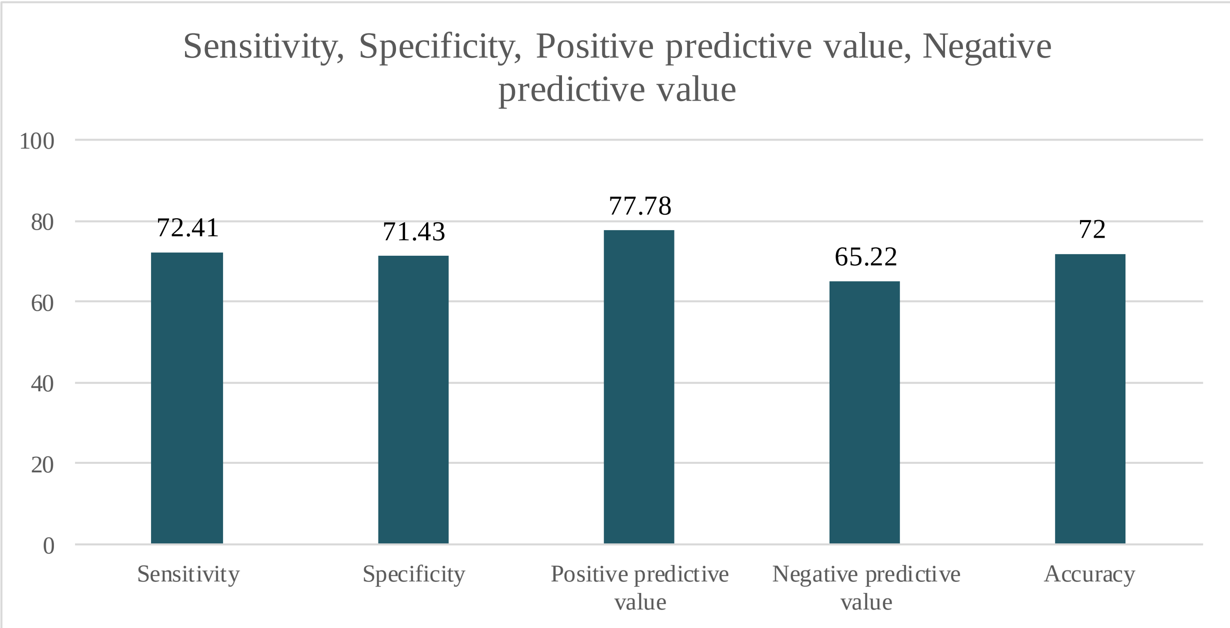

Figure 7: Sensitivity, Specificity, Positive predictive value, and Negative predictive value of MRI for Deep stromal penetration determination

Figure 7, depict that, considering Histopathology as a gold standard test to determine Deep stromal penetration in patients with early cervical cancer, the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MRI scan were found 72.41% (CI: 52.76% to 87.27%), 71.43% (CI: 47.82% to 88.72%), 77.78% (CI: 63.19% to 87.71%) and 65.22% (CI: 49.50% to 78.20%), and 72.00% (CI: 57.51% to 83.77%) respectively, in this study.

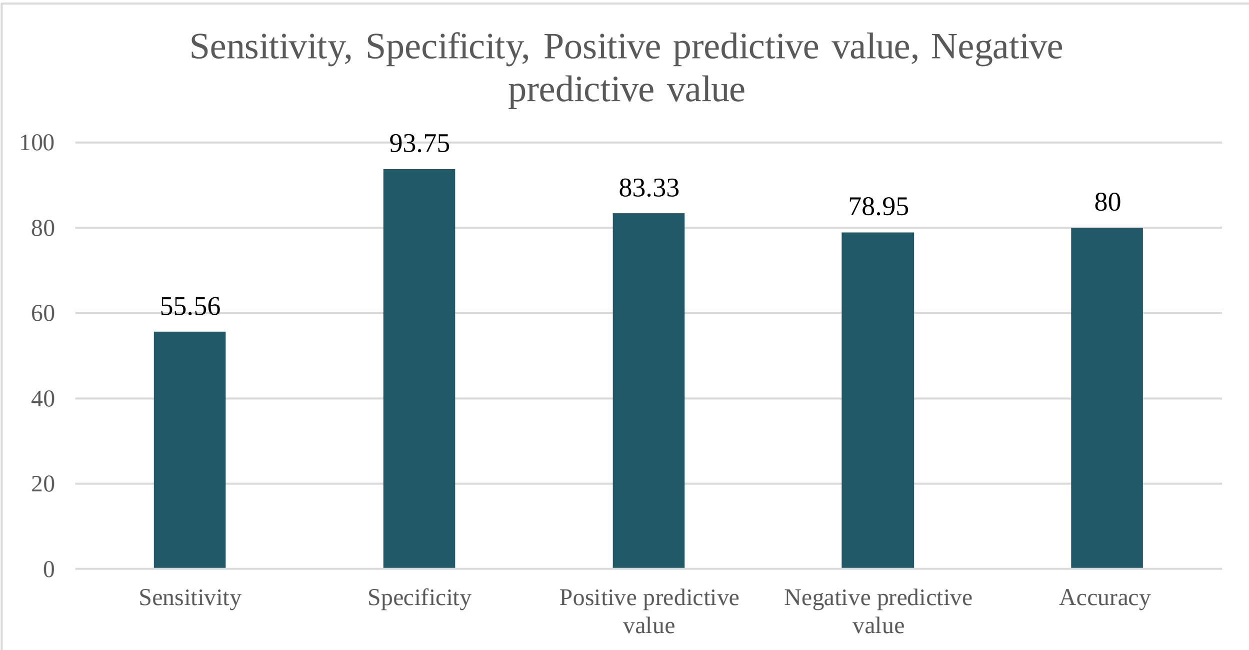

Figure 8: Sensitivity, Specificity, Positive predictive value, and Negative predictive value of MRI for Corpus extension determination

Figure 8, depict that, in this study considering histopathology as a gold standard test to determine corpus extension in patients with early cervical cancer, the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MRI scan were found 55.56% (CI: 30.76% to 78.47%), 93.75% (CI: 79.19% to 99.23%), 83.33% (CI: 55.12% to 95.32%), and 78.95% (CI: 68.95% to 86.37%), and 80.00% (CI: 66.28% to 89.97%), respectively.

DISCUSSION

This prospective and cross-sectional study was conducted in Gynecological Oncology Unit, Dhaka Medical College & Hospital, Dhaka, from June 2021 to May 2022. A total 50 patients with early cervical cancer were included in this study based on the inclusion and exclusion criteria. The aim of this study was to determine the role of preoperative MRI in assessing the surgical-pathological factors in cervical cancer.

In this study observed that majority (40.0%) of the patients were in 41-50 years of age group, followed by 51-60 years and ≤40 years where the proportion of the patient was 30% and 20%, respectively. The mean± SD age of the participants was 48.84±9.19. Mean± SD age of patients suffering from squamous cell carcinoma (50.05±9.36) was significantly higher than patients of adenocarcinoma (42.50±4.81). Sozzi et al., reported that median age was 53 years with range from 28–87 years.[6] Bleker et al., observed that the mean age of study population was 43.0 years (range, 23-69 years).[7] Ferdous et al., reported the majority of the patients suffering from cervical cancer were of mean age of 45.21 years with SD±9.75 (range 26-80 years).[8] More than 45% were within the age range of 36-45 years.

In this study, cauliflower like growth was found in 60% cases whereas ulcerative growth was found in 30% cases. Ferdous et al., found exophytic growth in 71.2% patients, ulcerative growth in 17.3% and endophytic growth in 11.5% cases.[8] Only in 14.0% cases vagina was involved. In this study, in 94% cases, tumor size is <4cm which ranged from .5cm to 4.1 cm, at pathological evaluation. Xie et al., observed tumor size <4cm is 84.7% cases with ranged from 0.5 cm to 4.2 cm at pathologic evaluation.[9] The 5 year survival rate declines to 91.6% (95% CI 90.4% to 92.6%) for patients with tumors ≤2 cm, 83.3% (95% CI 81.8% to 84.8%) for tumors >2 to ≤4 cm, and 76.1% (95% CI 74.3% to 77.8%) for >4 cm tumors.[10] Studies have found that primary tumor size >2 cm predicts parametrial invasion (p=0.001) with 13% parametrial involvement in patients with tumors >2 cm and 1.3% in those with tumors <2 cm.[11]

In this study observed that, considering histopathology as a gold standard test to determine size of the tumor (<4 cm) in patients with early cervical cancer, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI scan was found 97.00% (CI:88.71%-99.95%),100.00% (CI: 29.24% -100.00%), 100.00%, 75.00%(CI:30.14%-95.42%), and 98.00% (CI: 89.35-99.95%) respectively. Roh et al., reported over diagnosis, a tumor cut-off size of 2.9 cm (approximated on T2W images) was observed with 80% sensitivity and 53% specificity.[12] Chen et al., reported in the detection of advanced stage (>IIB), the sensitivity, specificity, NPV, and PPV for MRI were 53%, 74%, 85%, and 37%, respectively.[13] Their study showed tumour size measured on MRI could be a potential alternative way for preoperative distinguishing of nodal stage and identifying LVSI in resectable cervical cancer patient with cutoff value of 2.75 and 2.90 cm respectively and at least 25 mm tumour size at MRI could be a risk factor for parametrial invasion in cervical cancer.

In this study observed that considering histopathology as a gold standard test to determine parametrial invasion in patient with early cervical cancer, the specificity and negative predictive value of MRI was found 100% (CI-92.89%-100.00%) and 100% respectively.As in all cases clinically, in preoperative MRI and histopathologically parametrium was not involved so sensitivity, PPV, and accuracy of MRI could not be detected. Roh et al., showed the sensitivity, specificity, NPV, and PPV of 3T multiparametric MRI to predict pathologic parametrial invasion were 62%, 88%, 91%, and 53%, respectively.[12] Unni et al., reported, MRI was shown to have a sensitivity of 100%, specificity of 60%, PPV of 88,5%, NPV of 100%, and accuracy of 90.1% for assessing the parametrial invasion.[14] Some reports have demonstrated the accuracy of MRI in the evaluation of the stage of cervical cancer ranged from 70% to 85%.

In this study observed that, considering histopathology as a gold standard test to determine lymph node involvement in patients with early cervical cancer, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI scan was found 60.00% (CI: 14.66% to 94.73%), 91.11% (CI: 78.78%-927.52%), 42.86% (CI: 18.76%-70.89%) 95.35% (CI: 87.47%-98.37%), and 88.00% (CI: 75.69%-95.42%)respectively. Bourgioti et al., reported MRI cannot discriminate between enlarged inflammatory lymph nodes and metastatic nodes.[15] This results in moderate sensitivity and specificity values for both CT and MRI (43%-73%) for detection of metastatic lymph nodes. Chen et al., observed preoperative LN staging, sensitivity of MRI was 40.5% (region-specific analysis) and 70.6% (patient-based analysis) respectively.[13] MRI produced 66 false-positive interpretations in region-specific analysis, resulting in 91.3% specificity (693 of 759 lymph node regions). The specificity, NPV and accuracy for detecting metastatic LNs with MRI in region-specific analysis were superior to those of patient-based analysis in the study. Kim et al., reported the MR imaging was performed in only 4 patients and showed lymph node involvement in 3 patients.[16]

Accuracy rate for MR imaging was 75%. The accuracy of MRI in detecting lymph node metastasis varies from 75 to 100% with a mean accuracy 86%.[17]

In this study observed that considering histopathology as a gold standard test to determine Vaginal extension in patients with early cervical cancer, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI scan was found 71.43% (CI: 29.04%-96.33%), 100.00% (CI: 91.78%-100.00%), 100.00%, 95.56% (CI: 86.95-98.58%), and 96.00% (CI: 86.29%-99.51%), respectively. Sozzi et al., reported that specificity, PPV, NPV and accuracy of MRI diagnosis evaluation for vaginal extension was 89%, 25%, 20% 91% and 82% respectively.[6]

In this study observed considering histopathology as a gold standard test to determine Deep stromal penetration in patients with early cervical cancer, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI scan was found 72.41% (CI: 52.76%-87.27%), 71.43% (CI: 47.82%-88.72%). 77.78% (CI: 63.19%-87.71%) 65.22% (CI:49.50% to 78.20%) and 72.00% (CI:57.51%-83.77%) respectively. Zamani et al., reported case of cervical stromal involvement in the MRI, all of them had stromal invasion in the pathology report (100% correlation between MRI and pathology).[18] For cervical stromal involvement, the sensitivity, specificity, diagnostic accuracy, positive and negative predictive values and positive and negative likelihood ratios of MRI were 54.54%, 100%, 90.74%, 100%, 89.58%, 2.85 and 0.95, respectively (calculated with 95% confidence intervals). The accuracy of MRI for diagnosing cervical mucosal involvement was lower than cervical stromal involvement, 74.07% in contrast to 90.74%. The overall accuracy and specificity for cervical invasion ranged from 46-98% and 87-100 %, respectively.[13]

In this study observed considering histopathology as a gold standard test to determine corpus extension in patients with early cervical cancer, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI scan was found 55.56% (CI: 30.76%-78.47%), 93.75% (CI:79.19%-99.23%), 83,33% (CI:55.12%-95.32%),78.95% (CI: 68.95%-86.37%), and 80.00% (CI: 66.28%-89.97%), respectively. Though corpus involvement has no role in staging of cervical cancer, but still degree of corpus involvement is sometimes related with lymph node involvement and parametrial invasion.

Limitations of the study

The study population was selected from one selected hospital in Dhaka city, so that the results of the study may not reflect the exact picture of the country. The present study was a cross-sectional study and conducted at a very short period of time. Small sample size was also a limitation of the present study. Therefore, in future further study may be under taken with large sample size.

CONCLUSION

From the findings of the present study and discussion thereof it can be concluded that Magnetic resonance imaging (MRI) is a sensitive and specific modality for accurate staging of cervical cancer in comparison with clinical FIGO criteria considering histopathology as gold standard. Using MRI patients can be more accurately staged and guided towards the correct management options. As MRI shows excellent soft tissue delineation it can be used for more accurate treatment planning. Pre-operative MRI helps to estimate the size, volume, extension, invasion, and metastasis in patients with cervical cancer and to determine whether a tumor is in an early or advanced stage. Therefore, MRI has potential to aid gyneoncologist in preoperative assessment of patients with cervical cancer.

Financial support and sponsorship: No funding sources.

Conflicts of interest: There are no conflicts of interest.

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