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Original Article

Diagnostic Accuracy of Magnetic Resonance Imaging (MRI) in Evaluation of Cervical Carcinoma

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A B S T R A C T

Objective: To determine the diagnostic accuracy of Magnetic resonance imaging in evaluation of cervical carcinoma keeping histopathological findings as the gold standard.

Methodology: This descriptive cross-sectional study was conducted at department of Radiology, Dow University of Health Sciences, Civil Hospital, Karachi, from March 2018 to September 2018. Patients with clinically suspected cervical carcinoma and referred to the radiology department and underwent biopsies for histopathological findings were included. MRI images were taken from renal hilum till pubic symphysis or beyond in T1, T2, and post gadolinium sequences in sagittal, axial and coronal sections. Histopathological results were then collected and correlated by MRI findings. Sensitivity, specificity and diagnostic accuracy of MRI were calculated using histopathological finding as gold standard.

Results: Mean age of the patients was 50.42±5.31 years, mean symptoms duration was 9.10±2.91 months and mean tumor size was 3.26±1.66 mm. Out of all 43.2% cases were diagnosed positive by MRI and 56.1% cases through histopathology. The results showed that 60 patients were true positive, correctly diagnosed and 61 patients were true negative, correctly diagnosed. Sensitivity, Specificity, PPV, NPV and accuracy were 93.8%, 72.6%, 72.3%, 93.8%, and 81.7% respectively.

Conclusion: The results showed 93.8% sensitivity, 72.6% specificity, and 81.7% diagnostic accuracy, indicating that the MRI is a substitute for invasive histopathology in screening of cervical cancer.

Keywords: Diagnostic Accuracy, Magnetic Resonance Imaging, Cervical carcinoma, Histopathological Findings.

Introduction

Cervical cancer represents a significantly high rate of cancer-associated mortality occurring among women around the world. In 2022, it was documented as fourth ranking disease in terms of incidence and mortality, accounting for roughly 7% and 8% respectively, with high numbers of fresh cases (661,000) and deaths (348,000).[1,2] During the same year, Asia was recorded as the continent with highest burden of cervical cancer-associated incidence and mortality (60% and 57.3% respectively).[2,3] Cervical cancer-associated deaths are more common in low- and middle-income countries (LMICs), where every 2 minute an unfortunate woman dies of this cancer. Up till now, LMICs are lagging far behind the high-income nations in terms of prevention and elimination of cervical cancer.[3]

Pakistan lies in the list of LMICs, where cervical cancer in women has been recorded as the 3rd most frequently encountered cancer and ranks 2nd among women aged between 15 to 44 years.[3,4] In this part of the world, cervical cancer among women accounts for annual diagnosis rate of around 5000 cases and death rate of 3200 cases, highlighting the urgency of prompt detection and appropriate management strategies.[4] Although, cervical cancer is

associated with persistent infection with human papilloma virus (HPV) in about 95% of cases, its multifactorial nature influenced by lifestyle, environmental, and genetic factors, complicates the prevention and management of cervical cancer.[5,6] The scenario is even worse in developing nations where including Pakistan where late-stage presentation is common due to limited screening infrastructure, socioeconomic barriers to early healthcare access and due delayed diagnosis result in very high mortality rates.[6]

Precise pre-treatment staging is the cornerstone of management, as it exactly guides the choice between surgical intervention, radiotherapy, and the parallel chemoradiation; though, the only clinical examination even under anesthesia has well-documented limitations in accurately evaluating the parametrial invasion, involvement of the lymph node and adjacent organ extension. Additionally, the Pap smear, cytology, and HPV testing are effective in early detection of cervical cancers, their effectiveness is limited by challenges in sensitivity, specificity, and reproducibility.[7]

Imaging modalities, including CT and MRI, have shown promising results in evaluating the extent of cervical carcinoma in suspected cases. In this context, preference of MRI as an imaging modality is attributable to superior performance in low-contrast resolution and proficiency in assessing tumor extent. [8,9] MRI is particularly useful in assessing location and size of tumor, sidewal and parametrial extension, vaginal involvement, tumor invasion into bladder and rectum, and detecting lymph node involvement.[10] Moreover, histopathological examination is considered a touchstone in the diagnosis of cervical carcinoma.[11] Therefore, correlating MRI findings with histopathological findings can validate the diagnostic performance of imaging modalities.

Methodology

This descriptive cross-sectional study was conducted at the Department of Radiology, Dow University of Health Sciences, Civil Hospital Karachi. Study was conducted from 27th April 2018 to 26th October 2018. The calculated sample size was 148, by taking the prevalence of cervical carcinoma as 80%, specificity as 87.5% and sensitivity as 88.7% of Magnetic resonance imaging in evaluating the tumor. Margin of error (d) was 10% and confidence interval 95%. Non-probability consecutive sampling was used for the study. Female patients with the age group of 40-60 years with clinically suspected cervical carcinoma having any of the following signs and symptoms for duration of more than three months, abnormal vaginal bleeding such as postmenopausal bleeding, irregular menses, heavy menstrual flow, painless menorrhagia and postcoital bleeding, abnormal cervical mass on per speculum or per vaginal examination and referred to the radiology department of Dow University of Health Sciences for MRI were included. However, the patients with known cervical cancer, prior history of surgery, chemotherapy or radiotherapy for cervical cancer, patients contraindicated for MRI and those who were not agreeing to take a part of study were excluded.

Informed consent was obtained after explanation of purpose and procedure of study including the risks and benefits. All patients were underwent MRI imaging (1.5T). Images were taken from renal hilum till pubic symphysis or beyond in T1, T2, and post gadolinium sequences in sagittal and axial (perpendicular to the cervical axis) and coronal sections. Images were analyzed by a senior radiologist having at least 5 years post fellowship experience. Relevant data were recorded on the proforma. Histopathology results were then collected from the hospital laboratory and correlated by the researcher. A database was developed on SPSS for windows version 22.0. Mean value and standard deviation were calculated for quantitative variables, while frequency and percentage for qualitative variables. The diagnostic accuracy of magnetic resonance imaging for cervical tumor was calculated in terms of sensitivity, specificity, PPV and NPV using histopathology as gold standard. Post-stratification 2x2 table was used to calculate sensitivity, specificity, NPV, PPV and DA.

Results

Mean age of patients was 50.42±5.31 years,, mean symptoms duration was 9.10±2.91 months and mean tumor size was 3.26±1.66 mm. Among 148 patients,13.5% were single and

86.55 were married while 74.3% females were postmenopausal status. Table I

Table I: Demographic statistics of demographic variables. (n=148)	
Variable	Mean ± SD / Frequency (%)
Age (years)	50.42 ± 5.31
Symptom duration (months)	9.10 ± 2.91
Tumor size (mm)	3.26 ± 1.66
Marital status	Single: 20 (13.5%) Married: 128 (86.5%)
Menopausal status	Pre-menopausal: 38 (25.7%) Post-menopausal: 110 (74.3%)

Table II: Frequency distribution of cervical carcinoma evaluated by MRI and histopathology (n=148)		
Method	Cervical Carcinoma Positive	Cervical Carcinoma Negative
MRI	64 (43.2%)	84 (56.8%)
Histopathology	83 (56.1%)	65 (43.9%)

In our study, 43.2% were diagnosed positively by MRI and 56.1% were diagnosed positive through histopathology as presented in Table II

Sensitivity, Specificity, Predictive values and diagnostic accuracy of MRI in evaluation of cervical carcinoma taking histopathology as gold standard, were calculated. The results showed that 60 patients were true positive, correctly diagnosed and 61 patients were true negative, correctly diagnosed. Sensitivity, Specificity, PPV, NPV and accuracy were 93.8%, 72.6%, 72.3%, 93.8%, and 81.7% respectively as presented in Table III. Stratification showed significant findings according to age and tumor size ($p<0.05$). Table IV

Discussion

The cervical cancer is a leading gynecological malignancy, specifically in developing countries, where late-stage presentation remains a major clinical challenge. The perfect pre-treatment staging is essential for guiding appropriate therapeutic decisions. This study was conducted to estimate the MRI as a highly exact, non-invasive modality for the diagnosis of cervical carcinoma, with imaging findings closely correlating with histopathological findings. The study was conducted on 148 patients with overall mean age of 50.42±5.31 years, months mean duration of symptoms 9.10±2.91 months and mean tumor size as 3.26±1.66 mm. The comparable findings were found in the study of Ditto A et al[12] where mean age was reported as 55 years, with most common FIGP stages being IIB (44.4%) and IB1-2 (30.2%). Similarly, in a study Orakzai ZJ et al[13] reported mean age of 54.46±9.29 years, with most common FIGO stages I B (47%), II A (16%), and II B (16%). The average age of women is consistent with established epidemiological patterns, as cervical cancer predominantly affects women during fifth decade of life and beyond, revealing the cumulative effect of prolonged high-risk infection of HPV, hormonal alteration linked to the peri-menopausal and post-menopausal status, and weakening the immunosurveillance that collectively favor malignant transformation of cervical epithelium over the duration.

In current study, cervical cancer was diagnosed positive in 43.2% cases by MRI and in 56.1% cases through histopathology. Moreover, performance of MRI in cervical carcinoma

Table III: Diagnostic accuracy of MRI for cervical carcinoma evaluation taking histopathology as gold standard (n=148)				
	HISTOPATHOLOGY			P-VALUE
MRI	Positive	Negative	TOTAL	0.000*
Positive	60(93.8)	4(6.3)	64	
Negative	23(27.4)	61(72.6)	84	
TOTAL	83	65	148	
Sensitivity	Specificity	PPV	NPV	Accuracy
93.8%	72.6%	72.3%	93.8%	81.7%

Table IV: Stratification according to age and tumor size.							
Subgroup	n	Sensitivity (%)	Specificity(%)	PPV (%)	NPV (%)	Accuracy (%)	p-value
Age ≤50 years	80	90.2	64.1	72.5	86.2	77.5	0.000*
Age >50 years	68	100	80.0	71.9	100	86.7	0.000*
Tumor size ≤3 mm	84	94.3	77.6	75.0	95.0	84.5	0.000*
Tumor size >3 mm	64	93.1	65.7	69.2	92.0	78.1	0.000*

evaluation taking histopathology as gold standard showed that MRI exhibited 93.8% sensitivity, 72.6% Specificity, 72.3% PPV, 93.8% NPV and 81.7% accuracy. Aligning with these findings, in the study of Hassan S et al.[14] found high sensitivity (89.55%), specificity (88.41%), PPV (88.24%), NPV (89.71%), and diagnostic accuracy (88.97%) of MRI taking histopathology as gold standard. Comparably, in the study carried out by Ahmad N et al.,15 MRI, compared to our findings, revealed slightly lower sensitivity (91.26%), PPV (90.38%), while somewhat higher specificity (89.70%), NPV (90.63%), and diagnostic accuracy (90.50%) in cervical cancer detection, and concluded high accuracy of MRI in stromal invasion detection among patients with early cervical cancer. Similarly, Amin MI et al.[16] also concluded that magnetic resonance spectroscopy is useful in cervical cancer grading, with high sensitivity (100%), specificity (77.8%), and accuracy (90%).

In this study, MRI maintained high diagnostic performance across all age groups and tumor sizes, with statistically significant results in all subgroups ($p < 0.001$). In patients aged ≤50 years, MRI showed 90.2% sensitivity, 64.1% specificity, and overall 77.5% accuracy. However, in patients aged >50 years, MRI achieved 100% sensitivity, with improved specificity (80.0%), and 86.7% overall accuracy, suggesting superior diagnostic reliability in older age patients. Additionally, in tumors ≤3 mm, MRI demonstrated 94.3% sensitivity, 77.6% specificity, and 84.5% accuracy, indicating strong performance in detecting small lesions. On the other hand, in tumors >3 mm, slight decreases occurred in sensitivity (93.1%), specificity (65.7%), and accuracy (78.1%), yet performance remained high. A more recent study conducted by Zhang J et al.[17] also demonstrated that MRI is more accurate and reliable in cervical cancer's clinical staging and diagnosis when compared with CT, with higher sensitivity (95.65% vs. 76.92%), Specificity (75% vs. 60%), and accuracy (93.59% vs.72.22%).

In agreement with these findings, the study conducted by Sultana Z et al.[18]demonstrated that MRI high accuracy in detecting tumors in the size range 2–4 cm and strongly correlated with histopathology ($p = 0.001$). consistently, Hassan S et al.[14] found that MRI revealed around 90% sensitivity for detection 44.1% true positives and 44.8% true negative cases, with statistically significant difference ($p=0.0001$), confirming MRI as a highly reliable modality. In agreement, a most recent study carried out by Dolciami M et al.[19] demonstrated high reliability of MRI in tumor detection among patients with early-stage of cervical cancer, with 78.7% accuracy, 66% sensitivity, 90.9% specificity, 87.5% PPV, and 73.5% NPV. In another study conducted by Sharma U et al.[20] reported that MRI exhibited 63.2% sensitivity and 75% PPV. Lower sensitivity in their study can possibly be attributed to limitations rather than poor MRI performance, as they compared MRI with clinical examination (CE), which itself is less accurate.

Overall MRI revealed acceptable diagnostic in the diagnosis of cervical carcinoma when compared against histopathology as the gold standard. Though, certain limitations must be acknowledged, like single-center design, relatively a limited study sample size, and the lack of dynamic contrast-enhanced or diffusion-weighted MRI sequences which have shown promise in further improving staging specificity in the current literature. Subsequently it is therefore recommended that MRI be adopted as a routine pre-treatment staging tool for cervical carcinoma in clinical practice, alongside histopathology rather than as a standalone diagnostic tool, and further multicenter studies with advanced MRI protocols and larger sample cohorts be conducted to further improve the diagnostic accuracy and support more accurate planning of treatment.

Conclusion

MRI is a non-invasive optimal modality for preoperative evaluation of patients with suspected uterine cervical malignancy, not only for detecting and characterizing the tumor itself, but also for efficient assessment of the tumor invasion and abdominal and pelvic lymphadenopathy, with subsequent more accurate tumor staging and treatment planning. Overall findings showed 93.8% sensitivity, 72.6% specificity, and 81.7% diagnostic accuracy. Hence it was concluded that MRI is a substitute for invasive histopathology in the initial screening of cervical cancer.

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