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Diagnostic Accuracy of DW-MRI in Detecting Parametrial Invasion in Cervical Cancer Patients, Taking Histopathology as Gold Standard

Zara Shaukat[1], Anis Ur Rehman[1], Ammar Zahid Sheikh[1], Hooria Shumail[1]

[1]Shaukat Khanum Memorial Cancer Hospital and Research Centre, Lahore, Punjab, Pakistan.

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Correspondence to: Zara Shaukat, Shaukat Khanum Memorial Cancer Hospital and Research Centre, Lahore, Punjab, Pakistan.
Email: zarashaukat09@gmail.com

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ABSTRACT

Introduction: When it comes to separating locally progressed or late-stage illness, that needs chemoradiotherapy, from early-stage disease that can be treated surgically, MRI plays a crucial role. Prognostic variables which include tumor size, parametrial infiltration, pelvic wall invasion, adjacent organ invasion, and lymph node metastases are also evaluated by MRI. **Study Design:** Cross-sectional (validation) study. **Settings:** Radiology Department of Shaukat Khanum Memorial Hospital, Lahore. **Methodology:** The study comprised 141 cervical cancer patients with ages ranging from 20 to 60. Patients with contraindications for MR imaging and women with a history of cervical cancer treatment, including surgery, chemotherapy or radiation were not included. Diffusion weighted magnetic resonance imaging was performed on each patient. The histopathological report was linked with the DWI-MRI data. **Results:** In my study, DW-MRI sensitivity was (89.86%), specificity (88.89%), PPV (88.57%), NPV (90.14%) and diagnostic accuracy (89.36%) in detecting parametrial invasion in cervical cancer patients. **Conclusion:** According to the study's findings, DW-MRI is an extremely sensitive and precise imaging technique for identifying parametrial invasion in patients with cervical cancer.

INTRODUCTION

The most frequent cancer in women is cervical carcinoma.[1] An estimated 371,200 instances of carcinoma cervix are diagnosed worldwide each year, accounting for 9.8% of all female cancer cases.[2] Pakistan and other developing nations have the highest rates of invasive cervical cancer.[2] Although there is no reliable data on the incidence of cervical cancers in Pakistan, one institutional study reports 65 new instances per year.[3] Worldwide, invasive cervical malignancies are the leading cause of death. Approximately 190,000 people die worldwide each year.[2]

The presence of parametrial invasion (PMI), a powerful predictor of patient prognosis, is thought to be one of the determining elements in cervical cancer staging and therapy planning.[4] PMI is frequently linked to cancer metastases, recurrence, and a lower likelihood of survival.[5] Treatments include primary or adjuvant chemotherapy, radiation, and total hysterectomy. Because the parametrial tissue next to the cervix is removed, radical hysterectomy is linked to higher morbidity and mortality even though surgery is beneficial in treating the tumor locally.[6] A study has shown the prevalence of parametrial involvement as 75.0%.[7] DW-MRI for parametrial involvement detection has shown 83.3% sensitivity and 98.8% specificity.[8] In another study, the sensitivity is 100% and specificity is 100% of DW-MRI in detecting parametrial invasion in cervical cancer patients.[9]

To determine the diagnostic accuracy of DW-MRI in detecting parametrial invasion in patients with cervical cancer, I have decided to employ histology as the gold standard in this study. In addition to offering local facts, my investigation will contribute to the body of existing material. Furthermore, this technique might be regularly used in our practice for pre-operative evaluation of cervical carcinoma in order to take appropriate surgical care to lower the morbidity and mortality of these specific patients if its diagnostic accuracy is found to be high.

METHODOLOGY

This descriptive, cross-sectional study was conducted on 141 patients aged 20 to 60 years presenting to the radiology department of Shaukat Khanum Memorial Hospital, Lahore from February 2025 to May 2025, and who had cervical cancer (presence of contact bleeding after sexual activity is one of the most common forms), dysperunia (pain during sexual activity), and cervical cancer on PAP smear for a duration of more than three months. The sample size of 141 cases with a 95%

confidence level, a prevalence of 75.0%[7] and a 7% intended precision for sensitivity of 88.0%[10] and specificity of 81.0%[10] with a 13% margin of error. Using a non-random consecutive sampling strategy, the patients were chosen. Patients with MR imaging contraindications (stents, claustrophobia, metallic prosthesis, pacemakers) and women with a history of cervical cancer treatment were not allowed to participate in the study.

The institutional ethical review committee's approval was obtained. After obtaining informed consent and relevant medical history, each patient underwent a free diffusion-weighted MRI using a 1.5 Tesla MR scanner. For every patient, DW-MR images were obtained. Each sequence was completed with a single breath-hold, two b values (0 mm2/s, 1000 mm2/s), and a scan length of three to four minutes. ADC maps were produced by means of the system software. DW-MRI results were assessed for parametrial invasion involvement. After a biopsy was performed in the relevant ward, the specimen was sent to the pathology lab to be examined by a consultant histopathologist for parametrial invasion. Findings from histology and DW-MRI were contrasted. A proforma that was specially created was used to record all of the data.

Software called SPSS 25.0 was used to evaluate the data that was gathered. For age and symptom duration, the mean and SD or median (IQR) were computed. The frequency and proportion of menopausal status, marital status, and parametrial invasion on DW-MRI and histology were displayed. The diagnostic accuracy of DW-MRI in detecting parametrial invasion in patients with cervical cancer were assessed using a 2x2 contingency table. Stratified variables included age, length of symptoms, marital status and menopausal state.

RESULTS

The study's age range was 20–60 years old, with a mean age of 40.09 ± 9.18 years. According to Table I, the majority of the patients—79, or 56.03%—were in the 20–40 age range. The illness lasted 6.13 ± 1.44 months on average. Table I displays the distribution of patients by menopause and marital status.

Of the patients who tested positive for cervical cancer on DW-MRI, 62 (True Positive) had parametrial invasion, while 08 (False Positive) had no parametrial invasion according to histology. Of the 71 patients who tested negative for DW-MRI, 7 (False Negative) had parametrial invasion in their cervical carcinoma on histology, but 64 (True Negative) did not (p=0.0001), as Table II demonstrates. DW-MRI sensitivity was (89.86%), specificity (88.89%), PPV (88.57%), NPV (90.14%), and diagnostic accuracy (89.36%) in detecting parametrial invasion in cervical cancer patients. Table III displays the diagnosis accuracy stratification by age, symptom duration, marital status, and menopausal state.

Table I

Distribution of patients with other confounding variables (n=141)

Confounding variables		Frequency	%age
Age (years)	20-40	79	56.03
	41-60	62	43.97
Duration of disease (months)	≤6	87	61.70
	>6	54	38.30
Marital status	Unmarried	28	19.86
	Married	100	70.92
	Widowed	13	9.22
Menopausal status	Pre-menopause	112	79.43
	Post-menopause	29	20.57

Table II

Diagnostic accuracy of DW-MRI in detecting parametrial invasion in cervical cancer patients, taking histopathology as gold standard.

	Histopathology (+ive)	Histopathology (-ive)	P-value
DW-MRI (+ive)	62 (True positive)	08 (False Positive)	0.0001
DW-MRI (-ive)	07 (False negative)	64 (True Negative)	

Sensitivity: 89.86%
Specificity: 88.89%
Positive Predictive Value (PPV): 88.57% Negative Predictive Value (NPV): 90.14% Diagnostic Accuracy: 89.36%

Table III

Stratification of diagnostic accuracy with respect to age, duration of symptoms, menopausal status and marital status.

		Sensitivity	Specificity	PPV	NPV	DA	
Age (years)	20-40	91.89%	88.10%	87.18%	92.50%	89.87%	0.001
	41-60	87.50%	90.0%	90.32%	87.10%	88.71%	0.001
Duration (months)	≤6	91.11%	88.10%	89.13%	90.24%	89.66%	0.001
	>6	87.50%	90.0%	87.50%	90.0%	88.89%	0.001
Marital status	Unmarried	90.91%	94.12%	90.91%	94.12%	92.86%	0.001
	Married	90.20%	85.71%	86.89%	89.36%	88.0%	0.001
	Widowed	85.71%	100.0%	100.0%	85.71%	92.31%	0.001
Menopausal status	Pre-meno	90.38%	88.33%	87.04%	91.38%	89.29%	0.001
	Post-meno	88.24%	91.67%	93.75%	84.62%	89.66%	0.001

DISCUSSION

When it comes to separating locally progressed or late-stage illness that need chemoradiotherapy from early-stage disease that can be treated surgically, MRI plays a crucial role. MRI is also used to assess prognostic factors such as tumor size, parametrial infiltration, pelvic wall invasion, neighboring organ invasion, and lymph node metastases.[11,12] Our study aims to highlight the part DWI plays in cervical carcinoma's parametrial invasion.

The mean age at presentation for cervical cancer in this study was 40.09 years, with a range of 20 to 60 years. 52.6% of patients experienced postmenopausal vaginal hemorrhage, which was the most prevalent presenting symptom. In women in the reproductive age group (33.4%) and perimenopausal women (14%), it was followed by heavy and irregular vaginal bleeding. SCC was found to be the most prevalent histology in 72% of the cases in a study by Subbarayan S. et al. that included

patients with cervical cancer who were between the ages of 30 and 80 (mean age of 49).[13]

In this study, DW-MRI sensitivity was (89.86%), specificity (88.89%), PPV (88.57%), NPV (90.14%), and diagnostic accuracy (89.36%) in detecting parametrial invasion in cervical cancer patients. DW-MRI for parametrial involvement detection has shown 83.3% sensitivity and 98.8% specificity.[8] Another study has reported sensitivity and specificity of T2W/DWI as 88% and 81% respectively.[10]

For the assessment of parametrial regions, oblique T2WI has been reported to be more effective than axial T2WI.[14] Parametrial invasion is excluded with a strongly negative predictive value when the outer-rim low-SI cervical stroma is preserved on T2WI.[15] Parametrial invasion is not usually indicated by full-thickness cervical stromal invasion. In order to diagnose parametrial invasion, one of the following extra T2WI findings must be present, together with full-thickness cervical stromal invasion: potentially a tumor-to-parametrial contact, a tumor nodule in the parametrium, or the tumor encircling the parametrial vessels.[16]

A study indicated that when assessing parametrial involvement, MRI had lower specificity (70%), PPV (35%), NPV (83%), and accuracy than those reported in the literature.[16-18] At 89.36%, the overall MRI accuracy rate was comparable to the 85–100% found in the literature [18]. However, Thomeer et al.[19] showed in a meta-analysis that MRI showed sensitivity of 84% and specificity of 92%.

MRI showed sensitivity of 76%, specificity 94%, and an accuracy of 94% for the identification of parametrial invasion, according to a recent meta-analysis by Woo et al.[20] The administration of antispasmodic medications, the use of 3T MRI, and the combination of DWI and T2WI were linked to better diagnostic results for detecting parametrial invasion. 20 Research studies examining the DWI showed greater specificity (97% vs. 85%) and sensitivity (81% vs. 75%) than trials that did not use DWI.[21] The gold standard for evaluating parametrial infiltration of cervical carcinoma was MRI, which was compared with two- and three-dimensional transvaginal ultrasound in another investigation.[22] Despite having some similarities to MRI, 2D and 3D ultrasounds have the advantage of being more affordable and accessible than MRI, making them useful tools for the preoperative work-up of cervical cancer.

Certain restrictions should be taken into account since they could affect the lesions' ADC mean value. Overstaging the tumor may result from the tumors' overlap with benign diseases including fibrosis and inflammation, which may similarly exhibit lower ADC values. Imaging protocols, post-processing methods, and MRI equipment can all affect ADC readings. For trustworthy comparisons across research and institutions, standardization is required. Multidisciplinary cooperation is necessary to incorporate ADC mean value assessment into standard clinical practice for cervical cancer. To include the ADC data into patient management plans, radiologists, oncologists, and radiotherapists must collaborate. It is also essential to standardize imaging procedures and provide ongoing training on how to interpret ADC maps.

All things considered, the ADC mean value offers a quantitative, non-invasive tool that improves cervical cancer management, from diagnosis to follow-up after therapy.

CONCLUSION

According to the study's findings, diffusion weighted magnetic resonance imaging is an extremely accurate and sensitive imaging technique for identifying parametrial invasion in patients with cervical cancer. Accurate diagnosis and appropriate pre-operative management regimens for cervical carcinoma have greatly improved patient care. Therefore, in order to lower morbidity and death, we advise that DWI-MRI be utilized as the main imaging modality for precisely identifying parametrial invasion in patients with cervical cancer.

REFERENCES

1. Kumaran, Y. (2021). Association between MRI findings and histopathological examination in carcinoma cervix: A retrospective study. *INTERNATIONAL JOURNAL OF ANATOMY RADIOLOGY AND SURGERY*. https://doi.org/10.7860/ijars/2021/46070.2642
2. Woo, S., Suh, C. H., Kim, S. Y., Cho, J. Y., & Kim, S. H. (2017). Magnetic resonance imaging for detection of parametrial invasion in cervical cancer: An updated systematic review and meta-analysis of the literature between 2012 and 2016. *European Radiology*, *28*(2), 530-541. https://doi.org/10.1007/s00330-017-4958-x
3. Zhang, H., Yu, R., Zhang, L., Wang, R., & Xiao, L. (2022). Chemotherapy versus chemoradiotherapy for FIGO stages IB1 and IIA1 cervical squamous cancer patients with lymphovascular space invasion: A retrospective study. *BMC Cancer*, *22*(1). https://doi.org/10.1186/s12885-022-09309-6
4. Abd elsalam, S. M., Mokhtar, O., Adel, L., Hassan, R., Ibraheim, M., & Kamal, A. (2020). Impact of diffusion weighted magnetic resonance imaging in diagnosis of cervical cancer. *Egyptian Journal of Radiology and Nuclear Medicine*, *51*(1). https://doi.org/10.1186/s43055-020-0144-2
5. Rockall, A. G., Barwick, T. D., Wilson, W., Singh, N., Bharwani, N., Sohaib, A., ... & Cook, G. J. (2021). Diagnostic accuracy of FEC-PET/CT, FDG-PET/CT, and diffusion-weighted MRI in detection of nodal metastases in surgically treated endometrial and cervical carcinoma. *Clinical Cancer Research*, *27*(23), 6457-6466. https://doi.org/10.1158/1078-0432.CCR-21-1834
6. Li, X., Lin, T., Liu, B., & Wei, W. (2020). Diagnosis of cervical cancer with Parametrial invasion on whole-tumor dynamic contrast-enhanced magnetic resonance imaging combined with whole-lesion texture analysis based on T2- Weighted images. *Frontiers in Bioengineering and Biotechnology*, *8*. https://doi.org/10.3389/fbioe.2020.00590
7. MARWA, A., NORHAN, A. H., & SHEBRYA, M. (2020). Value of Diffusion Weighted Magnetic Resonance Imaging in Diagnosis of Cervical Carcinoma. *The Medical Journal of Cairo University*, *88*(December), 2311-2319. https://dx.doi.org/10.21608/mjcu.2020.125463
8. Qu, J., Qin, L., Li, X., Luo, J., Li, J., Zhang, H., Wang, L., Shao, N., Zhang, S., Li, Y., Liu, C., & Li, H. (2018). Predicting Parametrial invasion in cervical carcinoma (Stages IB1, IB2, and IIA): Diagnostic accuracy of T2-weighted imaging

combined with DWI at 3 T. *American Journal of Roentgenology*, *210*(3), 677-684. https://doi.org/10.2214/ajr.17.18104
9. Mansour, S. M., & Raafat, M. (2017). Is there an added role for diffusion weighted imaging in the staging of cervical carcinoma? *The Egyptian Journal of Radiology and Nuclear Medicine*, *48*(4), 1131-1139. https://doi.org/10.1016/j.ejrnm.2017.08.010
10. Mongula, J. E., Bakers, F. C. H., Mihl, C., Van Gorp, T., Kruitwagen, R. F. P. M., & Slangen, B. F. M. (2019). Assessment of parametrial invasion of cervical carcinoma, the role of T2-weighted MRI and diffusion weighted imaging with or without fusion. *Clinical Radiology*, *74*(10), 790-796. https://doi.org/10.1016/j.crad.2019.07.003
11. Liu, L., Wang, S., Yu, T., Bai, H., Liu, J., Wang, D., & Luo, Y. (2022). Value of diffusion-weighted imaging in preoperative evaluation and prediction of postoperative supplementary therapy for patients with cervical cancer. *Annals of Translational Medicine*, *10*(2), 120-120. https://doi.org/10.21037/atm-21-5319
12. Rizescu, R. A., Salcianu, I. A., Ionescu, A., Serbanoiu, A., Ion, R. T., Florescu, L. M., Iana, G., Bratu, A. M., & Gheonea, I. A. (2024). The added role of diffusion-weighted magnetic resonance imaging in staging uterine cervical cancer. *Cureus*. https://doi.org/10.7759/cureus.75707
13. Subbarayan, S. K., R, D., & Dhanasingh, P. (2024). Magnetic resonance imaging evaluation of carcinoma of the cervix with histopathological correlation in a tertiary care center: Emphasizing the rise of adenocarcinoma in the Indian context. *Cureus*. https://doi.org/10.7759/cureus.71820
14. Woo, S., Moon, M. H., Cho, J. Y., Kim, S. H., & Kim, S. Y. (2019). Diagnostic performance of MRI for assessing Parametrial invasion in cervical cancer: A head-to-head comparison between oblique and true axial T2-weighted images. *Korean Journal of Radiology*, *20*(3), 378. https://doi.org/10.3348/kjr.2018.0248
15. McEvoy, S. H., Nougaret, S., Abu-Rustum, N. R., Vargas, H. A., Sadowski, E. A., Menias, C. O., Shitano, F., Fujii, S., Sosa, R. E., Escalon, J. G., Sala, E., & Lakhman, Y. (2017). Fertility-sparing for young patients with gynecologic cancer: How MRI can guide patient selection prior to conservative management. *Abdominal Radiology*, *42*(10), 2488-2512. https://doi.org/10.1007/s00261-017-1179-3
16. Zhang, A., Song, J., Ma, Z., & Chen, T. (2019). Application of apparent diffusion coefficient values derived from diffusion-weighted imaging for assessing different sized metastatic lymph nodes in cervical cancers. *Acta Radiologica*, *61*(6), 848-855. https://doi.org/10.1177/0284185119879686
17. Sadec, H. M., Awadallah, S. M., Ibrahim, A. M., Abdel-Aziz, A. M., & Sheha, A. S. (2024). Role of multi-parametric magnetic resonance imaging in preoperative staging of cervical carcinoma in females. *Egyptian Journal of Radiology and Nuclear Medicine*, *55*(1). https://doi.org/10.1186/s43055-024-01222-1
18. Lu, H., Wu, Y., Liu, X., Huang, H., Jiang, H., Zhu, C., Man, Y., Liu, P., Li, X., Chen, Z., Long, X., Pang, Q., Deng, S., & Gu, J. (2021). The role of dynamic contrast-enhanced magnetic resonance imaging in predicting treatment response for cervical cancer treated with concurrent Chemoradiotherapy. *Cancer Management and Research*, *13*, 6065-6078. https://doi.org/10.2147/cmar.s314289
19. Thomeer, M. G., Gerestein, C., Spronk, S., Van Doorn, H. C., Van der Ham, E., & Hunink, M. G. (2013). Clinical examination versus magnetic resonance imaging in the pretreatment staging of cervical carcinoma: Systematic review and meta-analysis. *European Radiology*, *23*(7), 2005-2018. https://doi.org/10.1007/s00330-013-2783-4
20. Woo, S., Suh, C. H., Kim, S. Y., Cho, J. Y., & Kim, S. H. (2017). Magnetic resonance imaging for detection of parametrial invasion in cervical cancer: An updated systematic review and meta-analysis of the literature between 2012 and 2016. *European Radiology*, *28*(2), 530-541. https://doi.org/10.1007/s00330-017-4958-x
21. Park, J. J., Kim, C. K., Park, S. Y., & Park, B. K. (2015). Parametrial invasion in cervical cancer: Fused T2-weighted imaging and high-*b*-Value diffusion-weighted imaging with background body signal suppression at 3 T. *Radiology*, *274*(3), 734-741. https://doi.org/10.1148/radiol.14140920
22. Chiappa, V., Di Legge, A., Valentini, A. L., Gui, B., Miccò, M., Ludovisi, M., Giansiracusa, C., Testa, A. C., & Valentin, L. (2015). Agreement of two-dimensional and three-dimensional transvaginal ultrasound with magnetic resonance imaging in assessment of parametrial infiltration in cervical cancer. *Ultrasound in Obstetrics & Gynecology*, *45*(4), 459-469. https://doi.org/10.1002/uog.14637