DOI: https://doi.org/10.54393/pjhs.v6i7.3129

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 07 (July 2025)

Original Article

OPEN ACCESS

Assessment of Myometrial Invasion of Endometrial Carcinoma Using Fusion of T2WI and DWI Taking Histopathology as Gold Standard

Sumaiya Muzaffar[1*], Saman Chaudhry[1], Kiran Sarfaraz[1], Mehwish Nizam[1], Sara[1] and Samim Amin[1]

[1]Department of Diagnostic Radiology, Sir Ganga Ram Hospital, Lahore, Pakistan

ARTICLE INFO

Keywords:
Endometrial Carcinoma, Myometrial Invasion, T2-Weighted Imaging, Diffusion-Weighted Imaging

How to Cite:
Muzaffar, S., Chaudhry, S., Sarfaraz, K., Nizam, M., Sara, ., & Amin, S. (2025). Assessment of Myometrial Invasion of Endometrial Carcinoma Using Fusion of T2WI and DWI Taking Histopathology as Gold Standard: Fusion Method to Evaluate Myometrial Invasion. Pakistan Journal of Health Sciences, 6(7), 80-83. https://doi.org/10.54393/pjhs.v6i7.3129

***Corresponding Author:**
Sumaiya Muzaffar
Department of Diagnostic Radiology, Sir Ganga Ram Hospital, Lahore, Pakistan
sumzmz@gmail.com

Received Date: 15th May, 2025
Revised Date: 26th June, 2025
Acceptance Date: 20th July, 2025
Published Date: 31st July, 2025

ABSTRACT

Precise evaluation of myometrial invasion in endometrial carcinoma is crucial. MRI; especially combination of T2WI and DWI has shown great potential as non-invasive method for this assessment. **Objective:** To determine positive predictive value of T2WI and DWI fusion in diagnosis of deep myometrial invasion of endometrial carcinoma taking histopathology as gold standard. **Methods:** This cross sectional study was piloted on 71 patients recruited from Radiology and Gynaecology departments of SGRH, Lahore. All histologically confirmed cases of endometrial carcinoma underwent pelvic MRI, including T2WI and DWI were included. The fused T2WI-DWI images were evaluated for presence and depth of myometrial invasion. Final histopathology reports post-surgery were used as gold standard to determine the PPV of the fused approach. **Results:** The positive predictive value of T2WI-DWI for detecting deep myometrial invasion calculated is 94.4%. **Conclusions:** Current findings suggest that, fusion of T2WI and DWI proved to be highly effective tool in diagnosing deep myometrial invasion in cases of endometrial carcinoma, taken histopathology as gold standard. The results indicate that this combined imaging approach offers strong PPV and overall accuracy, supporting its use as reliable, non-invasive method for preoperative evaluation.

INTRODUCTION

Endometrial cancer is most frequently occurring gynecologic malignancy and 4th most common cancer among women in Pakistan, with reported incidence of around 14.4% [1]. Globally, it is considered as 7thmost prevalent malignant condition in women. Its prognosis is highly dependent on stage at diagnosis, with 5-year survival rate of 96% for stage I, compared to 17% for those diagnosed at stage IV [2]. Approximately 75% patients are diagnosed at stage I, when treatment outcomes are generally more favourable [3]. For early-stage disease, treatment options have expanded to include minimally invasive procedures such as laparoscopic surgery and hormonal therapy. In cases with suspected deep invasion into myometrium, experts also recommends surgical lymphadenectomy [4]. Accurately determining the depth of myometrial invasion and properly staging the cancer before surgery is essential, as these factors significantly influence treatment planning and long-term prognosis [5]. In context of endometrial carcinoma, certain studies have indicated that Diffusion-Weighted Imaging (DWI) may outperform dynamic contrast-enhanced MRI in evaluating extent of myometrial invasion. This highlights the need to identify imaging techniques that are not only effective but also simpler and more economical [6, 7]. Integrating T2WI with DWI allows for fusion of structural and functional details, enhancing anatomical identification of lesions,

DOI: https://doi.org/10.54393/pjhs.v6i7.3129

with entire process completed in about 30 seconds [8, 9]. This fusion technique offers several benefits, including ease of use, clear visualization, and non-invasive approach, and has been widely utilized in various research studies [10].

In light of above cites literature use of T2WI-DWI seems highly appealing diagnostic technique and the same should be advocated as non-invasive diagnosing tool. But prior to its advocacy, it is imperative to write that above evidence is limited to two international studies to the best of candidate's knowledge and existing studies have controversy in findings as well. Moreover, Pakistan is limited resource country and therefor judicious and best use of funds allocated to healthcare management system should be done. That is why, purpose of this study was to repeat this trial to further confirm results. Results of this study would help to find out more rapid and non-invasive diagnostic tool and to avoid unnecessary biopsies and unnecessary surgical procedures in future practice.

METHODS

This cross sectional study was done at Diagnostic Radiology Department, Sir Ganga Ram Hospital, Lahore after taking synopsis approval from CPSP (CPSP/REU/RAD-2021-059-3495). Study was done from 16 November 2024 to 16 April 2025. Sample size of 71 cases was considered with 95% confidence level and 7% margin of error while taking expected percentage of positive predictive value of T2WI and DWI fusion in diagnosis of deep invasion of endometrial carcinoma to be 90.0% taking histopathology as gold standard [10]. Non-probability, consecutive sampling method was employed to enrol participants. Total 71 female patients, aged between 30 and 70 years, who were diagnosed with deep myometrial invasion due to endometrial carcinoma on T2W1-DWI and categorized as American Society of Anesthesiologists (ASA) status I or II, were included. Patients were excluded if they had not undergone surgical treatment, had received preoperative neoadjuvant chemotherapy or radiotherapy, or had contraindications to MRI, such as the presence of cardiac pacemakers, metal implants, vascular clips, or other incompatible devices. Prior to inclusion, informed written consent was obtained, along with comprehensive medical history. All MRI scans were interpreted by single radiologist with 15 years of experience in gynecologic imaging, who was blinded to the patients' clinical and pathological data. The MRI images were evaluated using post-processing software on Siemens Syngo 2010A workstation. Myometrial invasion and cancer staging were assessed using both T2WI and fused T2WI-DWI sequences. The radiologist evaluated several criteria: (a) depth of myometrial invasion, (b) involvement of cervical stroma, (c) presence of disease in bilateral adnexa, other pelvic organs, (d) detection of enlarged lymph nodes, and (e) signs of distant metastasis. Deep myometrial invasion was defined as tumor infiltration of at least 1 mm into 2-mm thick myometrium. Irrespective of these findings, all patients underwent surgical procedures in accordance with the hospital's standard protocol. The operating team was blinded to T2WI-DWI imaging results. Myometrial invasion in endometrial carcinoma was labelled as 'deep invasion' on histopathology when more than 50% of the myometrial thickness, measured from the endometrial surface, was involved. The histopathological samples were obtained during surgery and appropriately labelled for analysis. All the findings were recorded by the researcher herself using pre-designed proforma. All the collected data was entered and analysed through SPSS version 26.0. Numerical variables were presented by mean±SD, and categorical variable i-e deep myometrial invasion of endometrial carcinoma on histopathology, true positive and true negative were presented by frequency and percentage. Positive predictive value of T2WI-DWI was calculated using formula;

$$PPV = \frac{TP}{TP + FP} x\ 100$$

To assess whether age modified the predictive performance of T2WI-DWI, stratification was done by age groups (≤55 years and >55 years). After stratification, the chi-square test was applied to assess the statistical significance of any observed differences. A p-value of ≤0.05 was considered statistically significant. Confidence intervals (95% CI) for PPV were also calculated for each age group.

RESULTS

Mean of study participants found to be 53.61 ± 5.03 years, among them 77.5% belongs to ASA status I and 22.5% belongs to ASA status II. On the basis of T2WI-DWI for detecting deep myometrial invasion taking histopathology gold standard 94.4% found to be TP, and 5.6% FP, as shown in table 1.

Table 1: Summary of Qualitative and Quantitative Variables (n=71)

Variables	Mean ± SD/Frequency (%)
Age (Years)	
Mean ± SD	53.61 ± 5.03
Minimum	45
Maximum	62
ASA Status	
I	55 (77.5)
II	16 (22.5)
Diagnostic Outcome	
True Positive (TP)	67 (94.4)
False Positive (FP)	4 (5.6)

The positive predictive value of T2WI-DWI for detecting deep myometrial invasion calculated is 94.4%, as shown in table 2.

DOI: https://doi.org/10.54393/pjhs.v6i7.3129

Table 2: PPV and Accuracy of T2WI-DWI for Deep Endometrial Invasion Prediction Taking Histopathology as Gold Standard

Statistic	Value (%)	95% CI
Positive Predictive Value	94.4	84.49 to 96.83

PPV for predicting deep myometrial invasion using T2WI-DWI in patients aged up to 55 years is 90%, and in those aged over 55 years, it is higher 96%, however, p-value=0.317, indicating that there is no statistically significant difference in PPV between different age groups as shown in table 3 that represents 2×2 contingency table 3.

Table 3: Data Stratification with Respect to Age

Age	TP Frequency (%)	FP Frequency (%)	PPV (%)	95% CI (%)	p-Value
Upto 55 Years	18 (90)	2 (10)	90	73.7- 100	0.317
> 55 Years	49 (96)	2 (4)	96	89.5- 100	

DISCUSSION

Detecting the depth of myometrial invasion in endometrial cancer is crucial for accurate staging, treatment planning, and prognostic evaluation [11]. It plays key role in determining the extent of surgical intervention and the need for adjuvant therapy [12]. Accurate preoperative assessment helps guide individualized management strategies, and ultimately improving patient outcomes [13]. According to current study findings, PPV of T2WI-DWI for detecting deep myometrial invasion found to be 94.4%, with TP and FP were 66.1% and 4.2%, respectively. Gil *et al.*, in their study reported nearly similar, 95% PPV of combined T2WI-DWI imaging for detecting deep myometrial invasion [14]. In line with current observation, it was found by Neves *et al.*, that fused T2WI-DWI images demonstrated significantly higher diagnostic accuracy for assessing myometrial invasion compared to T2WI alone, while T2WI alone accurately identified 82.1% of cases against 92.1% cases detected by the fused imaging approach [7]. However, in current study results were not compared against any single radiological modality. Locally conducted study by Anjum *et al.*, reported PPV of 98.4%, which is comparatively higher than current observation [15]. It was further found by that combined DWI-T2WI had 100% PPV for detecting myometrial invasion [16]. However, Arian *et al.*, reported its PPV 90% [17]. Nurdillah *et al.*, have also demonstrated lower PPV 83.33% in detecting deep myometrial invasion [9]. Furthermore, Raja *et al.*, reported 88.9% PPV of combined DWI-T2WI [18]. Combination of DWI and T2WI has been shown to significantly enhance PPV for detecting deep myometrial invasion [19].This combination also outperformed DCE-MRI, even pairing of DCE-MRI with T2WI did not exceed the diagnostic performance of DWI + T2WI [20]. This study was conducted at single tertiary care center, which may limit the generalizability of results to other populations. The sample size was relatively small, and interobserver variability in MRI interpretation was not assessed. Additionally, only patients eligible for surgery were included, potentially introducing selection bias.

CONCLUSIONS

Current findings suggest that, fusion of T2WI and DWI proved to be highly effective tool in diagnosing deep myometrial invasion in cases of endometrial carcinoma, taken histopathology as gold standard. The results indicate that this combined imaging approach offers strong PPV and overall accuracy, supporting its use as reliable, non-invasive method for preoperative evaluation.

Authors Contribution

Conceptualization: SM
Methodology: SM, S
Formal analysis: KS, S, SA
Writing, review and editing: SM, SC, KS, MN, S, SA

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

REFERENCES

[1] Pervez SN, Junaid M, Alam S, Baloch FA, Khan P, Bibi N. Prevalence and Histopathological Findings of Endometrioid Carcinoma and Associated Risk Factors: A Cross-Sectional Study: Prevalence and Histopathology of Endometrioid Carcinoma. Pakistan Journal of Health Sciences. 2024 Nov: 13-8. doi: 10.54393/pjhs.v5i11.2320.

[2] Lu KH and Broaddus RR. Endometrial cancer. New England Journal of Medicine. 2020 Nov; 383(21): 2053-64. doi: 10.1056/NEJMra1514010.

[3] Restaino S, Paglietti C, Arcieri M, Biasioli A, Della Martina M, Mariuzzi L *et al.* Management of patients diagnosed with endometrial cancer: comparison of guidelines. Cancers. 2023 Feb; 15(4): 1091. doi: 10.3390/cancers15041091.

[4] Wang J, Xu P, Yang X, Yu Q, Xu X, Zou G *et al.* Association of myometrial invasion with lymphovascular space invasion, lymph node metastasis, recurrence, and overall survival in endometrial cancer: a meta-analysis of 79 studies with 68,870 patients. Frontiers in Oncology. 2021 Oct; 11:762329. doi: 10.3389/fonc.2021.762329.

[5] Jónsdóttir B, Marcickiewicz J, Borgfeldt C, Bjurberg M, Dahm-Kähler P, Flöter-Rådestad A *et al.* Preoperative and intraoperative assessment of myometrial invasion in endometrial cancer-A

DOI: https://doi.org/10.54393/pjhs.v6i7.3129

Swedish Gynecologic Cancer Group (SweGCG) study. Acta Obstetricia et Gynecologica Scandinavica.2021 Aug; 100(8): 1526-33. doi: 10.1111/aogs.14146.

[6] Koskas M, Amant F, Mirza MR, Creutzberg CL. Cancer of the corpus uteri: 2021 update. International Journal of Gynecology and Obstetrics.2021Oct;155: 45-60. doi: 10.1002/ijgo.13866.

[7] Neves TR, Correia MT, Serrado MA, Horta M, Caetano AP, Cunha TM. Staging of endometrial cancer using fusion T2-weighted images with diffusion-weighted images: a way to avoid gadolinium?. Cancers.2022 Jan; 14(2): 384. doi: 10.3390/cancers14020384.

[8] Xie M, Ren Z, Bian D, Li D, Yu L, Zhu F *et al.* High resolution diffusion-weighted imaging with readout segmentation of long variable echo-trains for determining myometrial invasion in endometrial carcinoma. Cancer Imaging. 2020 Sep; 20(1): 66. doi: 10.1186/s40644-020-00346-7.

[9] Nurdillah I, Rizuana IH, Suraya A, Syazarina SO. A comparison of dynamic contrast-enhanced magnetic resonance imaging and T2-weighted imaging in determining the depth of myometrial invasion in endometrial carcinoma-a retrospective study. Journal of Personalized Medicine.2022Jul; 12(8): 1268. doi: 10.3390/jpm12081268.

[10] Mohamed Shatat OM, Fakhry S, Helal MH. The fusion of T2 weighted MRI and diffusion-weighted imaging in evaluating the depth of myometrial invasion in endometrial cancer. Journal of Clinical Practice and Research.2019; 41(4): 375. doi: 10.14744 /etd .2019. 43 815.

[11] Essmat A. Correlation between depth of myometrial invasion and degree of lymph node affection in cases of endometrial cancer. Open Journal of Obstetrics and Gynecology.2021 Apr; 11(4): 360-8. doi: 10.423 6/ ojog.2021.114036.

[12] Concin N, Matias-Guiu X, Vergote I, Cibula D, Mirza MR, Marnitz S *et al.* ESGO/ESTRO/ESP guidelines for the management of patients with endometrial carcinoma. International Journal of Gynecological Cancer. 2021 Jan; 31(1): 12-39. doi: 10.1136/ijgc-2020-002230.

[13] Raffone A, Travaglino A, Raimondo D, Neola D, Renzulli F, Santoro A *et al.* Prognostic value of myometrial invasion and TCGA groups of endometrial carcinoma. Gynecologic Oncology. 2021 Aug; 162(2): 401-6. doi: 10.1016/j.ygyno.2021.05.029.

[14] Gil RT, Cunha TM, Horta M, Alves I. A acurácia do estudo de difusão na avaliação pré-operatória do carcinoma do endométrio. Radiologia Brasileira. 2019 Jul; 52: 229-36. doi: 10.1590/0100-3984.2018.00 54.

[15] Anjum H, Khattak M, Ghayur MS, Rehman M, Iftikhar S. Diagnostic Accuracy Of Diffusion-Weighted Magnetic Resonance Imaging In The Diagnosis Of Myometrial Invasion Among Patients With Endometrial Carcinoma. Journal of Medical Sciences.2024 Mar; 32(1): 35-9. doi: 10.52764/jms. 24 .32.1.7.

[16] Fatma MS, Marwa AE, Nermin YS, Maged RE. Role of Diffusion and T2-Weighted Magnetic Resonance Imaging in Preoperative Assessment of Myometrial Invasion and Staging of Endometrial Carcinoma. The Medical Journal of Cairo University. 2024 Sep; 92(09): 921-9. doi: 10.21608/mjcu.2024.389919.

[17] Arian A, Ahmadi E, Gity M, Setayeshpour B, Delazar S. Diagnostic value of T2 and diffusion-weighted imaging (DWI) in local staging of endometrial cancer. Journal of Medical Imaging and Radiation Sciences. 2023 Jun; 54(2): 265-72. doi: 10.1016/j.jmir.2023 .01.0 02.

[18] Raja S, Sharma PK, Subramonian SG, Ravipati C, Natarajan P. Enhancing Preoperative Assessment of Endometrial Cancer: The Role of Diffusion-Weighted Magnetic Resonance Imaging in Evaluating Myometrial Invasion.Cureus.2024Jun;16(6).doi:10.7 759/cureus.62111.

[19] Wang LJ, Tseng YJ, Wee NK, Low JJ, Tan CH. Diffusion-weighted imaging versus dynamic contrast-enhanced imaging for pre-operative diagnosis of deep myometrial invasion in endometrial cancer: A meta-analysis. Clinical Imaging. 2021 Dec; 80: 36-42. doi: 10.1016/j.clinimag.2021.06.027.

[20] Ibrahim R and Metwally ZI. Unveiling the Impact of Dynamic Contrast-Enhanced and Diffusion-Weighted MRI in Endometrial and Cervical Carcinoma Management. Ain Shams Medical Journal. 2024 Dec; 75(4): 858-73. doi: 10.21608/asmj.2024.326282.1324.