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Comparison of Pelvic MRI Findings with Surgical Histopathology in Patients with Cervical Carcinoma

Muhammad Awais Niaz[1], Shehla Irfan[2], Kiran Mumtaz[3*], Hamid Nawaz Khokhar[4], Muhammad Kaleem[5], Umaima Majeed[6]

[1]Associate Professor, Pathology Department, Alnafees Medical College, Islamabad
[2]Consultant Radiologist, Rafiqui Shaheed Welfare Hospital, Shorkot Cantt
[3]Assistant Professor, Pathology Department, Nishtar Medical University, Multan
[4]Assistant Professor, Pathology Department, Sahara Medical College, Narowal
[5]Assistant Professor, Radiology Department, Ch. Pervaiz Elahi Institute of Cardiology, Multan
[6]Assistant Professor, Pediatric Radiology, The Children's Hospital and Institute of Child Health, Multan
***Corresponding Author:** Kiran Mumtaz, Assistant Professor, Pathology Department, Nishtar Medical University, Multan
Email: Kiran.m.056@gmail.com

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ABSTRACT

Objective:

To compare preoperative pelvic magnetic resonance imaging (MRI) findings with final surgical histopathology in women with cervical carcinoma.

Methods:

A retrospective, multicenter diagnostic accuracy study was carried out at three hospitals in Pakistan. Women with biopsy-proven cervical carcinoma who had pelvic MRI followed by primary surgery were included. MRI tumour size and MRI assessment of deep stromal invasion, parametrial invasion, vaginal involvement and pelvic lymph nodes were compared with the final surgical pathology report. Parametrial invasion was the primary outcome. Nodal accuracy was analyzed only in patients whose pelvic nodes had been removed and examined.

Results:

Of 132 records screened, 114 met the inclusion criteria. Squamous cell carcinoma was the most common histological type (90 patients, 78.9%). The median tumour diameter was 37 mm on MRI and 35 mm on pathology, but 24 patients (21.1%) had a difference of 10 mm or more. For parametrial invasion, MRI had a sensitivity of 70.0% (95% CI 48.1–85.5) and a specificity of 91.5% (95% CI 84.1–95.6). Sensitivity and specificity were 81.8% and 86.4% for deep stromal invasion, and 68.8% and 93.9% for vaginal involvement. In the 100 patients with surgically assessed nodes, MRI detected pelvic nodal metastasis with 60.0% sensitivity and 87.5% specificity.

Conclusion:

MRI was better at ruling out parametrial and vaginal spread than at detecting it. Sizeable tumour-size differences in individual patients and missed nodal metastases are worth keeping in mind when multidisciplinary teams plan treatment.

Keywords: cervical carcinoma, magnetic resonance imaging, parametrial invasion

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INTRODUCTION

Cervical cancer remains a major cause of illness and death worldwide, and the burden falls hardest where access to screening, diagnosis and treatment is uneven.[1] Once invasive disease is confirmed, the size of the tumour and how far it has spread largely decide the treatment plan.[2] Whether the cancer is still confined to the cervix or has reached the surrounding tissues often determines whether a woman is offered primary surgery or chemoradiotherapy.[3] Getting this assessment right before treatment therefore matters to both gynaecologists and oncologists.

Pelvic MRI is now the main tool for assessing tumour size, stromal depth, parametrial extension, vaginal involvement and pelvic lymph nodes.[4] Its soft-tissue contrast shows the tumour against the cervical stroma in several planes. T2-weighted and diffusion-weighted sequences form the core of current protocols, while contrast-enhanced sequences are added depending on the clinical question and local practice.[5] A structured report that describes the site and extent of disease makes it easier for clinicians to weigh the imaging alongside examination and biopsy findings.[6] Imaging is firmly established in modern staging, yet MRI and the surgical specimen answer slightly different questions.[7]

Tumour diameter is particularly important in early-stage disease, where a few millimetres can change the treatment offered. MRI measures the tumour in place, whereas the pathologist measures it after removal, fixation and processing, so the two can differ even when both are done carefully.[8] In a large international cohort of early-stage cervical cancer, MRI and final pathology differed by 10 mm or more in a meaningful proportion of patients.[9] Small tumours can also be hard to see or measure on MRI, which makes a seemingly precise figure less certain.[10] A good correlation between two sets of measurements does not, on its own, show that they agree closely enough to guide decisions for an individual patient.

Parametrial invasion is harder still. On MRI, invasion is suggested when the tumour breaks through the low-signal stromal ring into the parametrial fat; on pathology, it is confirmed by finding carcinoma in the resected parametrium. The two can disagree when peritumoral oedema or inflammation mimics invasion, or when minimal extension is simply too small to see.[11] MRI can flag morphologically suspicious pelvic nodes, but micro metastases may sit in nodes of normal size.[12] Diffusion values

and tumour volume have been linked to nodal metastasis and lymphovascular space invasion, although these associations cannot replace microscopic examination.[13]

Data from more than one hospital are useful because scanners, protocols, reporting habits and pathology processing all vary between institutions, and published accuracy figures for MRI staging differ accordingly.[14] Teams in Punjab need local evidence on how well preoperative MRI reflects what is later found in the surgical specimen. This study therefore compared pelvic MRI with final histopathology in women with cervical carcinoma treated surgically at three hospitals, focusing on tumour diameter and on anatomically defined local and nodal findings, with parametrial invasion as the primary comparison.

MATERIALS AND METHODS

This retrospective, multicenter diagnostic accuracy study was conducted in the departments of radiology, pathology and gynaecology of three tertiary care hospitals in Pakistan and covered patients treated from 1 January to 31 December 2025. The records of all patients with biopsy-confirmed primary cervical carcinoma were reviewed. Patients were eligible if they had a pelvic MRI before primary surgery and a final surgical histopathology report. Those who had received chemotherapy or radiotherapy before surgery were excluded, because treatment can change the tumour between imaging and pathology. Records in which the MRI or the necessary pathology information was missing were also excluded. The study was approved by the ethics review committee of all the three hospitals. Because only anonymised, routinely collected records were reviewed, the requirement for individual informed consent was waived.

Only surgically treated patients were included. The diagnostic biopsy confirmed the presence and type of carcinoma, while the resection specimen served as the reference standard for tumour size and local spread. Biopsy findings were not used to classify parametrial or vaginal involvement. Surgical resection specimens were used to assess tumour size and local invasion. Pelvic lymph nodes were surgically assessed in 100 patients. Nodal accuracy was calculated only for patients whose pelvic nodes had been surgically assessed; patients without nodal sampling were not counted as node-negative.

All MRI examinations included multiplanar T2-weighted imaging and diffusion-weighted imaging with apparent diffusion coefficient maps. MRI findings were extracted from the original radiology reports. The maximum tumour diameter, deep stromal invasion, parametrial extension, vaginal involvement and suspicious pelvic nodes were extracted from the MRI reports. Nodal status was recorded per patient: a patient was MRI-positive if at least one pelvic node was reported as suspicious. The definitions used for each paired comparison are listed in **Table 1**.

Definitions used to compare MRI with surgical histopathology

Characteristic	MRI finding	Surgical pathology reference
Maximum tumour diameter	Largest reported tumour dimension (mm)	Largest invasive tumour dimension in the resection specimen
Deep stromal invasion	Tumour involving the outer third of the cervical stroma	Histological invasion of the outer third of the stroma
Parametrial invasion	Tumour extending beyond the cervical stromal boundary	Carcinoma found in the excised parametrial tissue
Vaginal involvement	Contiguous tumour extension into the vagina	Carcinoma found in the resected vaginal tissue
Pelvic node metastasis	One or more pelvic nodes reported as suspicious	Metastasis in surgically removed pelvic nodes

The final pathology reports were reviewed for histological type, grade, maximum invasive tumour diameter, deep stromal invasion, lymphovascular space invasion (LVSI), parametrial and vaginal involvement, and pelvic nodal status. A finding entered the accuracy analysis only when both the MRI and the pathology result were available. The interval between MRI and surgery was also noted, since the tumour may change in the meantime.

The primary outcome was the diagnostic performance of MRI for parametrial invasion, with final histopathology as the reference standard. Secondary outcomes were performance for deep stromal invasion, vaginal involvement and pelvic nodal metastasis, and the difference between MRI and pathological tumour diameter. Tumour grade and LVSI were treated as pathological features to be compared with MRI tumour size, not as findings that routine MRI can diagnose directly.

Continuous variables are presented as median and interquartile range (IQR) and categorical variables as number and percentage. The signed size difference was calculated as MRI diameter minus pathological diameter, and an absolute difference of 10 mm or more was reported separately to show how often large individual discrepancies occurred. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated from the true-positive, false-positive, false-negative and true-negative counts, with 95% confidence intervals (CI) by the Wilson score method. For nodal measures, the denominator was the subgroup with surgical node assessment. Tumour-size and subgroup comparisons were summarised descriptively.

RESULTS

A total of 132 records were screened across the three hospitals and 18 were excluded: eight patients had received treatment before surgery, six had no MRI available and four had incomplete pathology data. The remaining 114 patients formed the study cohort, and all of them contributed to the tumour-size and local-invasion comparisons. Pelvic nodes had been surgically assessed in 100 patients, who made up the nodal analysis group.

The median age was 49 years (IQR 42–57) and the median time from MRI to surgery was 18 days (IQR 12–25). Squamous cell carcinoma was by far the most common histological type. Tumour grade was available for 110 patients, and LVSI was present in 39. Stage IB disease predominated, accounting for 72 patients (63.2%), while 22 patients (19.3%) were classified as stage IIIC1r because of radiologically suspicious pelvic nodes (Table 2).

Patient and final histopathological characteristics

Characteristic	Result
Patients included	114
Age, years, median (IQR)	49 (42–57)
MRI-to-surgery interval, days, median (IQR)	18 (12–25)
Squamous cell carcinoma, n (%)	90 (78.9)
Adenocarcinoma, n (%)	20 (17.5)
Other histological types, n (%)	4 (3.5)
Grade 1 / 2 / 3, n (grade available in 110)	19 / 57 / 34
Pretreatment FIGO 2018 stage IB1 / IB2 / IB3 / IIA1 / IIA2 / IIB / IIIC1r, n (%)	16 (14.0) / 34 (29.8) / 22 (19.3) / 3 (2.6) / 2 (1.8) / 15 (13.2) / 22 (19.3)
Lymphovascular space invasion present, n (%)	39 (34.2)
Pathological parametrial invasion, n (%)	20 (17.5)
Pelvic node metastasis, n/N (%)	20/100 (20.0)

Stage IIIC1r indicated radiologically identified pelvic nodal involvement. Seven patients in this category also had MRI-reported parametrial invasion. The median maximum tumour diameter was 37 mm on MRI and 35 mm on pathology, with a median signed difference of 2 mm. Although the group medians were close, 24 patients had a difference of at least 10 mm: MRI overestimated the tumour by 10 mm or more in 14 patients and underestimated it by the same margin in 10 (**Table 3**). Because the errors ran in both directions, the individual discrepancies are more informative than the small gap between the medians.

MRI and pathological maximum tumour diameter (N = 114)

Measure	Result
MRI diameter, mm, median (IQR)	37 (27–48)
Pathological diameter, mm, median (IQR)	35 (26–46)
MRI minus pathology, mm, median (IQR)	2 (−3 to 7)
Absolute difference ≥10 mm, n (%)	24 (21.1)
MRI larger by ≥10 mm, n (%)	14 (12.3)
MRI smaller by ≥10 mm, n (%)	10 (8.8)

MRI correctly identified 14 of the 20 patients with pathological parametrial invasion and correctly classified 86 of the 94 without it, giving a sensitivity of 70.0% and a specificity of 91.5%. The NPV was 93.5% and the PPV 63.6%. Results for deep stromal invasion and vaginal involvement are shown in **Table 4** and **Figure 1**. MRI missed 10 patients with deep stromal invasion and five with vaginal involvement. Because the number of pathologically positive cases differed by site, the predictive values should be read with those prevalences in mind.

MRI compared with surgical pathology for local invasion (N = 114)

Finding	TP	FP	FN	TN	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)
Deep stromal invasion	45	8	10	51	81.8 (69.7–89.8)	86.4 (75.5–93.0)	84.9 (72.9–92.1)	83.6 (72.4–90.8)
Parametrial invasion	14	8	6	86	70.0 (48.1–85.5)	91.5 (84.1–95.6)	63.6 (43.0–80.3)	93.5 (86.5–97.0)
Vaginal involvement	11	6	5	92	68.8 (44.4–85.8)	93.9 (87.3–97.2)	64.7 (41.3–82.7)	94.8 (88.5–97.8)

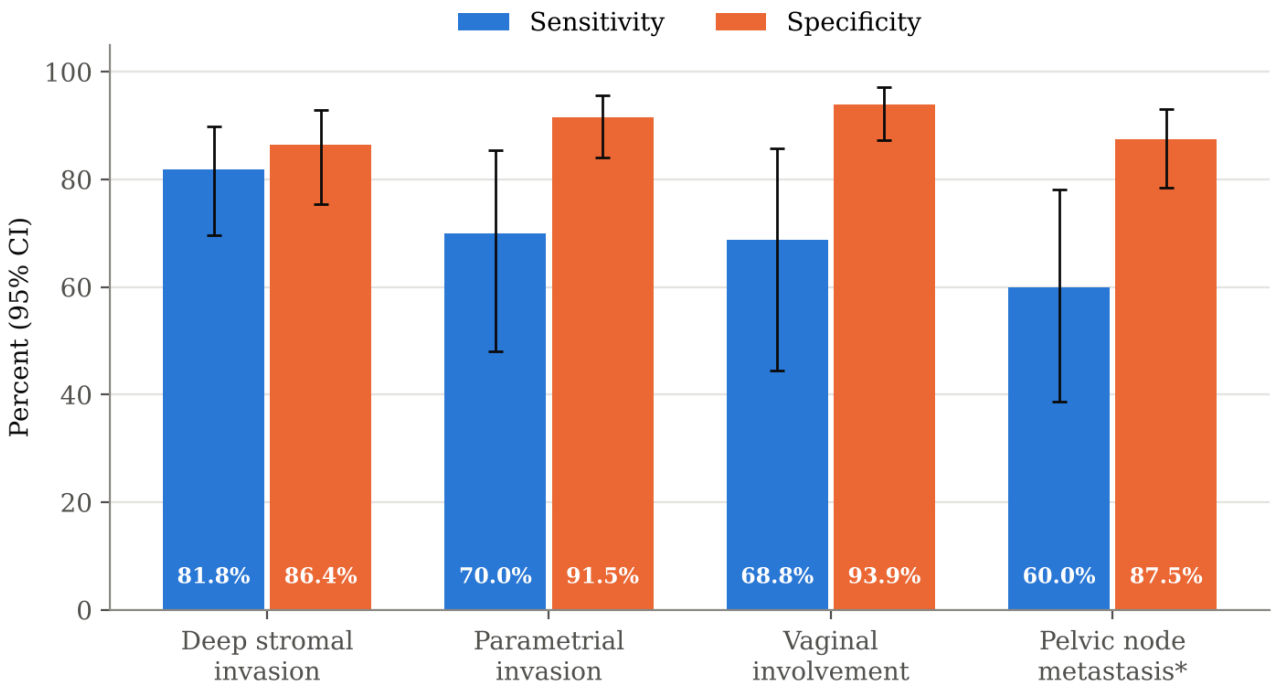
TP, true positive; FP, false positive; FN, false negative; TN, true negative; PPV, positive predictive value; NPV, negative predictive value; CI, confidence interval (Wilson score).

Among the 100 patients who underwent surgical node assessment, pathology confirmed pelvic nodal metastasis in 20. MRI reported suspicious nodes in 22 patients, 12 of whom had confirmed metastasis, while eight patients with metastatic nodes had no suspicious node on MRI (**Table 5**). Patient-level sensitivity was 60.0% and specificity 87.5%. The NPV of 89.7% applies only to this surgically staged subgroup and cannot be extended to patients whose nodes were not sampled.

MRI assessment of pelvic lymph nodes against surgical pathology (n = 100)

MRI finding	Pathology positive	Pathology negative	Total
Suspicious pelvic node(s)	12	10	22
No suspicious pelvic node	8	70	78
Total	20	80	100

Sensitivity 60.0% (95% CI 38.7–78.1); specificity 87.5% (95% CI 78.5–93.1); PPV 54.5% (95% CI 34.7–73.1); NPV 89.7% (95% CI 81.0–94.7).



*Pelvic nodes: n=100 with surgical node assessment; local findings: N=114. Error bars = Wilson 95% CI.

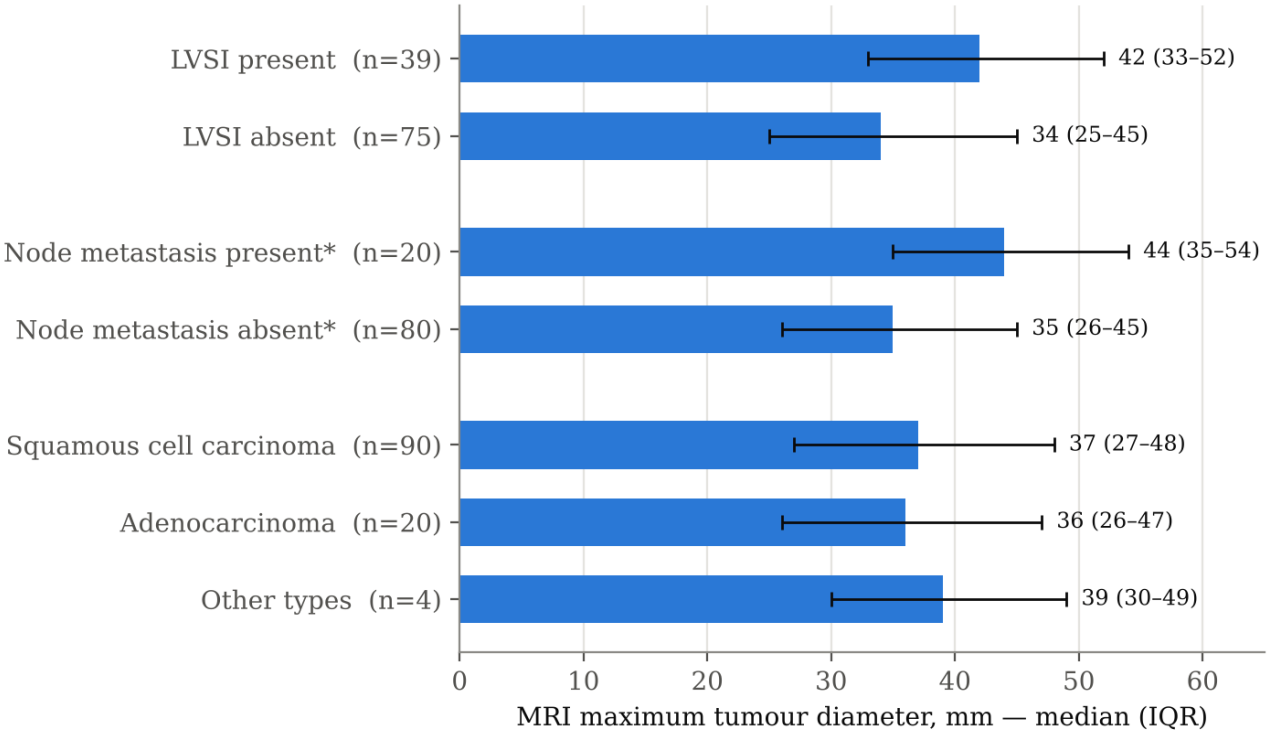
Sensitivity and specificity of MRI for local invasion (N = 114) and pelvic nodal metastasis (n = 100) against surgical histopathology. Error bars show 95% confidence intervals.

Patients with LVSI had a larger median MRI tumour diameter than those without it, and the same pattern was seen for patients with versus without nodal metastasis. Median MRI diameter was much the same for squamous cell carcinoma and adenocarcinoma (**Table 6**, **Figure 2**). These subgroup comparisons are descriptive; no significance testing was performed.

MRI tumour diameter by selected histopathological characteristics

Pathological characteristic	Group	Patients	MRI diameter, mm, median (IQR)
Lymphovascular space invasion	Present	39	42 (33–52)
	Absent	75	34 (25–45)
Pelvic node metastasis*	Present	20	44 (35–54)
	Absent	80	35 (26–45)
Histological type	Squamous cell carcinoma	90	37 (27–48)
	Adenocarcinoma	20	36 (26–47)
	Other	4	39 (30–49)

*Nodal comparison limited to the 100 patients with surgical node assessment.



*Nodal groups limited to the 100 patients with surgical node assessment. LVSI = lymphovascular space invasion. Descriptive only.

Median MRI maximum tumour diameter (bars) with interquartile range (whiskers) by pathological subgroup. Descriptive comparison only.

DISCUSSION

In this cohort MRI was quite specific for parametrial and vaginal involvement but considerably less sensitive. The raw counts tell the clinical story best: six women with pathological parametrial invasion were called negative on MRI, while eight women reported as MRI-positive had no tumour in the excised parametrium. Recent studies of MRI staging have likewise shown that accuracy varies with the anatomical site being assessed and the population studied.[15] An MRI report is therefore most useful when its individual findings, and their uncertainty, are read together with the clinical picture rather than condensed into a single stage.

The median difference between MRI and pathological diameter was only 2 mm, yet more than one in five patients (21.1%) had a discrepancy of 10 mm or more. A small average difference across the cohort clearly does not exclude a clinically important error for an individual woman. Other studies, including one from Pakistan, have also found differences between preoperative assessment and final pathology.[16,17] In this cohort the errors went both ways, with MRI substantially overestimating the tumour in some and underestimating it in others, which is why both directions were reported rather than relying on the average alone.

Of the three local findings, deep stromal invasion had the highest sensitivity, although MRI still missed 10 pathologically positive cases. Vaginal involvement had a high NPV but was missed in five of the 16 patients in whom it was confirmed. Definitions and reported accuracy for these MRI staging features vary across the literature.[18] Small-volume disease, acquisition technique and reader interpretation may all contribute, but the summary data cannot show which factor explains any particular disagreement.

MRI performed worse for pelvic nodes than for local disease: eight of the 20 patients with surgically proven nodal metastasis had no suspicious node on MRI. This fits the known limitation of relying on node size and shape to detect what may be microscopic disease. Diffusion-based and morphological parameters have been studied as ways to improve nodal assessment, but so far a negative routine MRI cannot be equated with negative surgical pathology.[19] The nodal results are restricted, appropriately, to patients who actually had their nodes examined.

Larger MRI tumour diameters were seen in patients with LVSI and in those with nodal metastasis. This supports paying close attention to tumour size at multidisciplinary review, but these descriptive data do not show that size is an independent predictor. Apparent diffusion coefficient measurements have been explored as markers of LVSI,[20] yet such imaging associations are not a substitute for the pathological diagnosis, and histological type and grade still require tissue.

The study was strengthened by its multicenter design, use of surgical histopathology as the reference standard, and assessment of tumour size, local invasion, and pelvic nodal involvement. Its retrospective design and restriction to surgically treated patients' limited generalizability.

CONCLUSION

Compared with surgical histopathology, preoperative pelvic MRI was good at ruling out parametrial and vaginal involvement but missed some patients with local invasion and with pelvic nodal metastasis. A small difference in median tumour size across the cohort concealed larger errors in individual patients. MRI is most informative when tumour measurements, each anatomical site and the degree of uncertainty are reviewed together with clinical and pathological findings.

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