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Original Research Article

COMPARATIVE EVALUATION OF TRANSVAGINAL SONOGRAPHY AND MAGNETIC RESONANCE IMAGING IN THE PRE-TREATMENT STAGING OF CERVICAL CANCER

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Abstract: ***INTRODUCTION***: Cervical cancer continues to represent a major global public health challenge, particularly in low- and middle-income countries, where limitations in screening programs, delayed diagnosis, and restricted access to healthcare contribute to high morbidity and mortality. ***AIM:*** To study the role of transvaginal sonography and magnetic resonance imaging in assessing the locoregional extension of cervical cancer. ***METHODOLOGY***: This was an observational, comparative analytical study conducted in the Department of Radiodiagnosis Sardar Patel Medical College Bikaner. ***RESULT:*** The study demonstrated that while both TVS and MRI are effective in pre-treatment staging of cervical cancer, 3.0 Tesla MRI consistently showed superior diagnostic accuracy for tumor detection, size estimation, stromal depth, parametrial invasion, and assessment of advanced disease. MRI also outperformed TVS in evaluating vaginal extension, sidewall involvement, hydronephrosis, and bladder and rectal invasion, with higher sensitivity, specificity, and interobserver agreement. Although TVS remains a useful, accessible modality, MRI proved to be more reliable and reproducible overall, establishing it as the preferred imaging technique for comprehensive staging of cervical cancer. ***CONCLUSION:*** MRI demonstrated superior accuracy, reproducibility, and overall reliability compared to TVS in the pre-treatment staging of cervical cancer, particularly for assessing stromal depth, parametrial invasion, and advanced disease spread. While TVS serves as a valuable, accessible adjunct, MRI remains the preferred modality for comprehensive and precise staging to guide optimal management.

Keywords: Cervical Cancer, Magnetic Resonance Imaging (MRI),Transvaginal Sonography (TVS)

INTRODUCTION

Cervical cancer continues to represent a major global public health challenge, particularly in low- and middle-income countries, where limitations in screening programs, delayed diagnosis, and restricted access to healthcare contribute to high morbidity and mortality[1]. It is the fourth most commonly diagnosed cancer and the fourth leading cause of cancer-related death among women worldwide, with over 600,000 new cases and more than 340,000 deaths reported annually.[2] In India, cervical cancer remains the second most common malignancy among women, emphasizing the need for effective diagnostic and staging strategies. Accurate early staging is fundamental to optimal management, as assessment

of locoregional extension—including involvement of the cervix, parametria, vagina, bladder, and rectum—directly influences treatment planning and prognosis.[3] The revised FIGO 2018 staging system highlights the growing importance of imaging by formally incorporating radiologic and pathological findings, acknowledging the limitations of clinical examination alone, which often underestimates tumor extent, particularly parametrial invasion and adjacent organ involvement. Magnetic resonance imaging (MRI) is currently recommended as the preferred modality for local staging due to its excellent soft tissue contrast and ability to delineate tumor boundaries; however, MRI is costly, time-consuming, often requires contrast administration, and may not be readily accessible in many healthcare settings[4]. Furthermore, MRI interpretation is performed independently of direct patient examination, potentially limiting clinical correlation. In contrast, transvaginal or transrectal ultrasonography (TVS), when performed by experienced clinicians, has emerged as a reliable alternative, demonstrating diagnostic accuracy comparable to or even exceeding that of MRI in early-stage cervical cancer.[5] Several studies have also shown that ultrasonography performs equally well in advanced disease, particularly in patients undergoing primary chemoradiotherapy, in evaluating locoregional tumor spread[6]. Ultrasonography offers multiple advantages: it is widely available, non-invasive, cost-effective, requires minimal patient preparation, and can be performed during the same clinical visit by the treating gynecologic oncologist, thereby improving workflow efficiency and continuity of care. Given these advantages, ultrasonography has the potential to reduce dependence on MRI without compromising diagnostic accuracy, especially in resource-limited settings[7]. Accurate imaging is also essential for appropriate treatment selection, as the primary management options for cervical cancer include radical surgery with lymphadenectomy or definitive radiochemotherapy. Avoiding unnecessary combined treatment modalities is crucial to minimize treatment-related morbidity, yet inadequate preoperative staging may result in patients undergoing surgery only to require adjuvant radiotherapy due to high-risk pathological features.[8] Advanced surgical concepts such as total mesometrial resection with therapeutic lymph node dissection have further emphasized the importance of precise preoperative assessment of tumor extent and nodal involvement to achieve optimal oncologic outcomes without adjuvant therapy. In this context, reliable, accessible imaging modalities are essential.

AIM

To study the role of transvaginal sonography and magnetic resonance imaging in assessing the locoregional extension of cervical cancer.

METHODOLOGY

This was an observational, comparative analytical study conducted in the Department of Radiodiagnosis Sardar Patel Medical College Bikaner. Eligible out-patient and in-patient cases from the Department of Obstetrics and Gynaecology were referred for imaging evaluation. Data collection commenced after approval from the Institutional Research and Review Board and continued until August 2024 or until the required sample size was achieved, followed by two months dedicated to data analysis and thesis preparation. The study population comprised patients presenting to the radiodiagnosis department who fulfilled the inclusion criteria, which included all newly diagnosed (de novo) cases of cervical cancer who provided informed written consent. Patients who had received prior treatment for cervical cancer or had contraindications to MRI—such as metal implants, cardiac pacemakers, or severe claustrophobia—were excluded from the study.

RESULTS

TABLE 1: Demographic Profile of Study Population

Age group (years)	N	%
≤40	18	24.7
41–50	28	38.4
51–60	20	27.4
>60	7	9.5
Total	73	100
Mean± S D	49.13 ± 15.8	

The study included 73 participants with a mean age of 49.13 ± 15.8 years, with most subjects belonging to the 41–50-year age group (38.4%), followed by those aged 51–60 years (27.4%). Participants aged ≤40 years constituted 24.7% of the cohort, while individuals older than 60 years formed the smallest group (9.5%).

TABLE 2: Clinical Presentation of Cervical Cancer Patients

Symptom	N	%
Irregular bleeding	38	52.1
Postcoital bleeding	20	27.4
Vaginal discharge	11	15.1
Pain	4	5.4

Among the 73 participants, irregular bleeding was the most common presenting symptom, reported by 52.1% of patients, followed by postcoital bleeding in 27.4%. Vaginal discharge was noted in 15.1% of cases, while pain was the least frequent symptom, occurring in 5.4% of patients.

TABLE 3: Histopathological Types of Cervical Cancer

Histology	N	%
Squamous cell carcinoma	57	78.1
Adenocarcinoma	13	17.8
Others	3	4.1

Histological analysis of the 73 cases revealed that the majority were diagnosed with squamous cell carcinoma (78.1%), making it the most prevalent type. Adenocarcinoma accounted for 17.8% of cases, while a small proportion (4.1%) fell under the category of other histological types.

Table 4:FIGO Stage Distribution (n = 73)

Stage	N	%
IB	10	13.7
IIA	13	17.8
IIB	25	34.2
III	19	26.0
IVA	6	8.2

In the study population of 73 patients, the most common stage at diagnosis was Stage IIB (34.2%), followed by Stage III (26.0%). Stage IIA accounted for 17.8% of cases, while Stage IB represented 13.7%. A smaller proportion of patients were diagnosed at an advanced stage, with Stage IVA comprising 8.2% of the group.

Table 5. Tumor Detection & Size

Modality	Detection rate (%)	Mean size ± SD (mm)	Δ vs Ref (mm)
TVS	88	34.2 ± 8.6	−3.2
MRI	97	36.5 ± 9.2	−1.1
Reference	100	37.6 ± 9.0	–

All three modalities showed high tumor detection rates, with MRI achieving 97% detection, closely approximating the reference standard (100%), followed by TVS at 88%. The reference mean tumor size was 37.6 ± 9.0 mm; MRI showed minimal underestimation (36.5 ± 9.2 mm), whereas TVS demonstrated a greater negative deviation (34.2 ± 8.6 mm).

Table 6 . Depth of Stromal Invasion

Category	Reference (%)	TVS correct (%)	MRI correct (%)
Inner ⅓	30	68	81
Middle ⅓	35	72	85
Outer ⅓	35	76	89

Both TVS and MRI demonstrated good accuracy in assessing cervical stromal involvement compared with the reference standard, with MRI consistently outperforming TVS across all categories. MRI showed higher accuracy for inner (81% vs 68%), middle (85% vs 72%), and outer one-third involvement (89% vs 76%), indicating greater reliability for precise tumor localization.

Table 7. Parametrial Invasion (n=73)

	Reference +	Reference –	Sensitivity %	Specificity %	Accuracy %
TVS +	18	9	59	83	73
TVS –	12	34			
MRI +	24	4	80	92	88
MRI –	6	39			

MRI demonstrated superior diagnostic performance over TVS in detecting parametrial invasion, with higher sensitivity (80% vs 59%), specificity (92% vs 83%), and overall accuracy (88% vs 73%). These findings indicate that MRI is more reliable than TVS for assessing parametrial involvement in cervical cancer.

Table 8. Vaginal , Uterine Corpus, Sidewall & Hydronephrosis involvement and Bladder/Rectal Invasion

Site	Reference n	TVS detection (%)	MRI detection (%)
Vaginal Upper third	12	68	85
Vaginal Middle/lower	6	58	80
Uterine corpus	64	84	14
Sidewall contact	10	Not assessable	93
Hydronephrosis	8	80	100
Bladder	5	Not assessable	92
Rectum	3	Not assessable	91

MRI consistently outperformed TVS in evaluating vaginal, uterine corpus, sidewall, hydronephrosis, and adjacent organ involvement, demonstrating higher detection rates across all assessable parameters. While TVS provided useful information in selected areas, MRI proved to be more comprehensive and reliable, particularly for assessing lateral extension, hydronephrosis, and bladder and rectal invasion, making it superior for accurate staging.

Table 9: Nodal Assessment

Reference n	MRI sensitivity %	MRI specificity %	MRI accuracy %
15 positive	62	90	82

In the evaluation of nodal involvement (n = 15 positive cases), MRI demonstrated moderate sensitivity but high specificity and good overall accuracy. Specifically, MRI achieved a sensitivity of 62%, indicating it correctly identified a little over half of the nodal-positive cases.

Table 10. Inter-observer Agreement

Feature	TVS κ (95% CI)	MRI κ (95% CI)
Tumor visibility	0.68 (0.56–0.79)	0.82 (0.74–0.90)
Stromal depth category	0.64	0.80
Parametrial invasion	0.60	0.85
Vaginal involvement	0.58	0.82
Corpus involvement	0.62	0.81
Nodal status	–	0.78

Interobserver agreement was consistently higher for MRI than for TVS across all evaluated parameters, with MRI demonstrating near-perfect to substantial agreement for tumor visibility, stromal depth, parametrial invasion, vaginal and uterine corpus involvement. These findings confirm that MRI provides superior reliability and consistency compared to TVS, reinforcing its role as the preferred modality for accurate cervical cancer staging.

Table 11. Diagnostic Accuracy of TVS vs MRI Across Subgroups

Subgroup	TVS accuracy %	MRI accuracy %	p-value
Tumor ≤4 cm	78	91	0.01
Tumor >4 cm	70	87	0.02
SCC histology	75	89	0.01
Adenocarcinoma histology	72	86	0.05

Subgroup analysis showed that MRI had significantly higher diagnostic accuracy than TVS across all categories, including tumors ≤4 cm (91% vs 78%, p = 0.01) and >4 cm (87% vs 70%, p = 0.02). MRI also outperformed TVS in both squamous cell carcinoma (89% vs 75%, p = 0.01) and adenocarcinoma (86% vs 72%, p = 0.05), demonstrating consistently superior performance.

DISCUSSION

The present study was designed as a comparative analytical evaluation of transvaginal sonography (TVS) and magnetic resonance imaging (MRI) in the pre-treatment staging of cervical cancer, with histopathology and surgical findings serving as the reference standard. A total of 73 newly diagnosed patients were enrolled, and multiple demographic, clinical, and imaging parameters were analysed to determine the diagnostic performance of both modalities.

The most frequent presenting complaint was irregular bleeding (52.1%), followed by postcoital bleeding (27.4%), vaginal discharge (15.1%), and pain (5.4%). This clinical profile is consistent with

earlier Indian and global reports, which emphasize abnormal vaginal bleeding as the leading symptom of cervical cancer.

Histologically, squamous cell carcinoma accounted for 78.1% of cases, adenocarcinoma for 17.8%, and rare histology for 4.1%. This mirrors the established epidemiological distribution, where squamous histology is the most common, followed by adenocarcinoma . Tumor grading revealed that the majority were moderately differentiated (56.2%), with a significant proportion being poorly differentiated (31.5%), reflecting aggressive disease biology. Most patients presented at locally advanced stages (IIB: 34.2%, III: 26.0%), consistent with findings from Mitchell et al. 9 and Bhatla et al. 6, where delayed diagnosis is common in low- and middle-income settings.

Both imaging modalities achieved high tumor detection rates; however, MRI (97%) was superior to TVS (88%). Tumor size estimation was more accurate with MRI (mean deviation –1.1 mm) compared with TVS (–3.2 mm). Testa et al. 10 similarly noted that although 3D TVS is useful, MRI consistently provides superior size delineation due to its multiplanar capability and superior soft tissue contrast.

Assessment of stromal depth is critical for staging and operability. In our study, MRI outperformed TVS across all categories, especially for outer-third stromal invasion (MRI 89% vs TVS 76%). Parametrial invasion detection was markedly better with MRI (80% sensitivity, 92% specificity, 88% accuracy) compared with TVS (59%, 83%, 73%). Similarly, Yun et al. 11 confirmed MRI's superiority in a meta-analysis (sensitivity 82%, specificity 91%). By contrast, TVS has shown variable performance, often limited by operator dependency and a narrower field of view.

For vaginal extension, MRI demonstrated higher detection rates (upper third: 85%, middle/lower: 80%) than TVS (68% and 58%, respectively). This is in agreement with Balleyguier et al. 12, who reported MRI sensitivity of 82–86% and specificity of 90–95% in corpus involvement assessment.

MRI was clearly superior in assessing advanced disease spread. For bladder and rectal invasion, MRI achieved >90% accuracy (bladder 92%, rectum 91%), whereas TVS was not accessible. For sidewall contact, MRI detection was 93%, while TVS again could not be evaluated. Hydronephrosis detection was higher with MRI (100%) than with TVS (80%). Mitchell et al. 9 similarly documented MRI sensitivity of 85–90% and specificity of 92–97% for bladder/rectal invasion, underscoring MRI's critical role in evaluating locally advanced disease.

Nodal involvement is a key prognostic factor in cervical cancer. In our study, MRI achieved 62% sensitivity, 90% specificity, and 82% accuracy. While MRI reliably excluded nodal disease (high specificity), its modest sensitivity indicates limited ability to detect micrometastases. This is consistent with Choi et al. 13, who reported MRI sensitivity of 55–65% but specificity of 85–95%. Bhatla et al. 6 also emphasized that PET-CT outperforms MRI in nodal staging due to its superior sensitivity (>85%). Therefore, MRI, while useful, cannot replace histopathological confirmation or PET-CT in nodal evaluation.

Interobserver agreement (κ statistics) was consistently higher with MRI, ranging from 0.78–0.85, compared with TVS (0.58–0.68). Tumor visibility achieved κ = 0.82 with MRI versus 0.68 with TVS, while parametrial assessment showed κ = 0.85 versus 0.60. These findings mirror those of Cibulaset al.14 who emphasized MRI's superior reproducibility.

CONCLUSION

This study demonstrates that MRI consistently provides higher diagnostic accuracy compared to TVS in cervical cancer staging. MRI was superior in tumor detection, stromal invasion, parametrial involvement, vaginal and corpus spread, and adjacent organ evaluation. While TVS retains clinical value for preliminary assessment, MRI should be considered the preferred imaging modality for accurate staging and treatment planning.

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