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Radiology Section

Role of Magnetic Resonance Imaging in Evaluation of Uterine Pathologies and its Correlation with Ultrasound

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ABSTRACT

Introduction: The uterine pathologies constitute one of the most common problems among women. The most common of them are adenomyosis, uterine leiomyoma, carcinoma of uterus and cervix and endometrial pathologies including polyp and hyperplasia. Magnetic Resonance Imaging (MRI) and Ultrasound (USG) appears to be important modalities in diagnosing uterine pathologies. Considering the cost and limited availability, physicians and the general radiologists are mostly in a dilemma in finding out the appropriate patients needing a MRI.

Aim: To compare MRI and USG in detection of uterine lesions and also in differentiation and characterization of uterine lesions.

Materials and Methods: A prospective study was done on 92 patients who were referred to radiology department of SRM medical college with suspected uterine pathologies. All patients who had positive or suspicious USG findings were subjected to MRI examination. The uterine pathologies were broadly classified into four categories namely fibroid, adenomyosis, endometrial pathologies including endometrial carcinoma and cervical malignancies. The comparison was made between two modalities for detection and characterization of each of pathologies with histopathology as gold standard. The statistical parameters including sensitivity, specificity, positive and negative predictive value were calculated for both the modalities in all pathologies with chi-square test.

Results: Among 92 patients, majority were diagnosed as fibroids 44 (48%), carcinoma of cervix 20 (22%), adenomyosis 16 (17%) and endometrial lesions 12 (13%). A total of 24 (26%) patients were found to be malignant whereas 68 (74 %) patients were found to be benign. There was significant difference in diagnosing adenomyosis by MRI compared to USG (chi-sq=32, p=0.0001) where MRI diagnosed all 16 patients compared to six patients in USG. MRI was better than USG in detection of number of fibroids. Ninety six fibroids were detected by MRI where as only 68 fibroids were detected by USG and the detection rate was more with smaller and submucosal fibroids. Similarly, MRI was better than USG in diagnosis of cervical carcinoma. MRI had diagnosed all 20 cases (chi-sq=32, p=0.0001) where USG diagnosed only 10 cases (chi-sq=0.85, p=0.358). Among 12 endometrial lesions MRI had diagnosed 10 lesions correctly (chi-sq=17.21, p=0.0001) where USG had diagnosed eight lesions correctly (chi-sq=6.97, p=0.008).

Conclusion: To localize, characterize, and evaluate the number of uterine lesions both benign and malignant along with its staging in pelvic pathologies, MRI was found to be more precise and gold standard in comparison to USG most of the times. MRI had an edge over USG in detecting endometrial invasion in case of endometrial carcinoma and staging in case of carcinoma cervix.

Keywords: Adenomyosis, Carcinoma, Endometrial lesions, Fibroid

INTRODUCTION

MRI appears to be an important modality in diagnosing uterine pathologies with an overall precision rate of 91-93% particularly when contrast techniques are used [1]. MRI with its high resolution and multi planar imaging has the capability to characterize multiple lesions and is becoming the modality of choice to assess the uterine pathologies [2].

Another widely used modality for evaluation of pelvic pathologies is USG. The advantages of USG are promptly available, reduced cost and its safety and simplicity of the examination. However, the drawbacks with this modality include limited field of view, obscuration of pelvis by bowel gas and its dependence on the skill expertise of the radiologists [3,4]. Up to a specific degree, transvaginal ultrasonography aids in diagnosing the lesion, but it is highly dependent on the skill of the operator and a few of lesions may get away from the field of view occasionally [5].

MRI is usually considered as a next step in the evaluation of a lesion after USG. The only drawback of MRI lies in, it not being readily available and expensive compared to USG. It also is not advisable for patients with certain metallic implants and claustrophobic patients [6]. There is always a significant difference between MRI and USG considering the cost of the investigation. Physicians referring cases and the general radiologists are usually in dilemma in choosing the appropriate patients for MRI [7].

Among the reproductive age group 15 to 20% of the women are said to have lesions of uterus [8]. In this study, detailed evaluation of uterine mass lesions with respect to number, location, size, other measurements, degenerative changes within the lesions, extent of the lesion is performed using transabdominal USG, transvaginal USG and correlated with MRI. Final diagnosis by imaging was compared with histopathological reports.

The main aim of the study was to compare MRI and USG in detection of uterine lesions and to compare MRI and USG in differentiation and characterization of uterine lesions. Although, there are many studies comparing USG and MRI in detecting adenomyosis and fibroids individually, most of them have not included all the uterine pathologies. This is a comprehensive study of detecting intermodal correspondence across all spectrums of uterine pathologies. This would be useful for both radiologists

and referring clinicians for correct identification of the modality needed for diagnosis of specific uterine pathologies.

MATERIALS AND METHODS

A prospective study was done on 92 patients who were referred to radiology department with suspected uterine pathologies. The study was conducted after getting approval from our institution's ethical committee and after obtaining written informed consent from the patients. The study was conducted from period of January 2016 to August 2017 in Department of Radiology, SRM Medical College Hospital and Research Centre, Kattankulathur, Kanchipuram district, Tamil Nadu, India. All patients were subjected to USG. Those patients who had positive or suspicious findings in USG were subjected to MRI examination. Final correlation with histopathology was done in available subjects.

USG imaging was performed using GE logic F8 USG machine. Transabdominal USG was done using a probe (3.5-5 Mhz) and tranvaginal USG was done using a probe (10 Mhz). Transabdominal USG was done with full bladder with optimal settings. Transvaginal USG was done with an empty bladder. The following parameters were noted in USG examination including size and contour of uterus, endometrial thickness, lesions in endometrial cavity and myometrium along with its characteristics and lesions in cervix with extension if present. The details about ovary, adenexa and fallopian tube were also studied.

MRI was performed using 1.5 Tesla Siemens Magnetome Essenza machine. The following sequences were done including T1 WI, T2 WI, T2 WI fat sat and STIR in axial plane, T2 WI fat sat and STIR in coronal plane and T2 WI and STIR in sagittal plane. Contrast and other special sequences like diffusion and gradient imaging were used as and when required. Apart from USG findings, maximal junctional zone thickness was measured and junctional zone to myometrial thickness was measured using MRI. Extent of lesion was noted in carcinoma cervix and level of myometrial invasion was noted in case of endometrial lesions.

The uterine pathologies were broadly classified into four categories namely fibroid, adenomyosis, endometrial pathologies including endometrial carcinoma and cervical malignancies. The comparison was made between USG and MRI for detection of each of pathologies with histopathology as gold standard. In case of fibroids, in patients who were not operated, MRI was considered gold standard and comparison was done between USG and MRI for detection of fibroids. The statistical parameters including sensitivity, specificity, positive and negative predictive value were calculated for both the modalities in all pathologies along with chi-square test.

Inclusion Criteria

All patients referred to the Department of Radiology with clinically suspected uterine lesions and found to have uterine pathology in USG was enrolled for the study.

Exclusion Criteria

All patients who had normal USG findings; All patients in whom histopathology reports could not be obtained as patients didn't undergo surgery; Pregnant patients; Patients who had medical contraindications for surgery; All patients who had contraindications to MRI including those with metallic fixations, cardiac pacemakers and claustrophobic patients. All unmarried women were excluded from TVS examination.

STATISTICAL ANALYIS

The data was analysed by using SPSS software version 19.0. Descriptive analysis such as frequency, percentage were used to describe the data and inferential statistics such as chi-square test, sensitivity, specificity, positive and negative predictive value were used to analyse the data.

RESULTS

Among 92 study participants majority of them were in the age group 31-40 years -31patients (33.6%) and followed by 41-50 years -30 patients (32.6%). Majority of them were in pre menopause period 63 (68.5%) and the rest in the post menopause period 29 (31.5%). Among them 68 (74.7%) suffered with pain, 23 (25.3%) suffered with abnormal bleeding and 26 (29.1%) were suffering from irregular periods.

Among 92 patients, majority were diagnosed with fibroids 44 (48%), 20 (22%) were diagnosed with carcinoma of cervix, 16 (17%) had adenomyosis and 12 (13%) had endometrial lesions. Endometrial lesions (51.2±8.2) and carcinoma of cervix (50.8±9.4) were reported mostly in the post menopausal periods. Fibroids (39.6±8.4) and adenomyosis (38.1±4.2) were reported in middle age. However, there is no significant difference in age for final diagnosis.

A total of 24 (26%) patients were found to be malignant whereas 68 (74%) patients were found to be benign. Out of 24 patients, 20 (83.3%) patients were diagnosed with carcinoma cervix and 4 (16.6%) patients were diagnosed with endometrial carcinoma. Out of 24 patients, USG had correctly diagnosed malignancy in 11 (45.8%) patients. Ten cases of carcinoma cervix and one case of endometrial carcinoma were diagnosed confidently in USG. Three patients had thickened endometrium, however didn't have features of invasion to suggest malignancy. MRI had correctly diagnosed malignancy in 22 (91.6%) patients. Two patients who didn't have endometrial invasion could not be diagnosed with MRI.

Out of 16 cases of adenomyosis detected by histopathology, MRI detected 12 (75%) as diffuse adenomyosis, two as adenomyosis with fibroid uterus and two as focal adenomyosis. On the other hand USG detected six as adenomyosis six as bulky uterus with heterogeneous myometrium suspicious for adenomyosis or leiomyoma, two as focally thickened myometrium and two as bulky uterus with fibroid. Out of 16 cases USG could detect only six has adenomyosis and other 10 were suspicious for adenomyosis. In addition four cases diagnosed by USG as adenomyosis turned out to be fibroid in MRI.

This explains that there is significant difference in diagnosing adenomyosis by USG and MRI (chi-sq=32, p=0.0001). Among 16 cases of adenomyosis MRI detected all cases (100%) with sensitivity, specificity, positive and negative predictive value about 100%. On the other hand USG was positive only in six cases; in this USG false negatives were 10 with sensitivity-37.5%, specificity-0%, PPV-60%, NPV-0% [Table/Fig-1].

USG Diagnosis	MRI Diagnosis			Total	Chi-sq	p-value
	Adenomyosis	Adenomyosis with fibroid uterus	Focal adenomyosis			
Bulky uterus	6	0	0	6	32.00	0.0001
Bulky uterus with fibroid	0	2	0	2		
Focal myometrial thickening	0	0	2	2		
Adenomyosis	6	0	0	6		
Total	12	2	2	16		

[Table/Fig-1]: Comparison of USG diagnosis with MRI diagnosis for Adenomyosis.

Out of 32 samples USG picked up 18 cases as positives where HPE picked up 20 cases of Ca Cervix. The true positives were 10 and true negatives were four, there were eight false positives and 10 false negatives by the diagnosing test in USG. There is no significant association detected (chi-sq=0.85, p=0.358). The sensitivity-50%, specificity-33.3%, PPV-55.5%, NPV-28.6% is calculated.

Out of 32 samples MRI and HPE picked up 20 cases of Ca Cervix. The true positives were 20 and true negatives were 12. There is significant association detected (chi-sq=32, p=0.0001). with

sensitivity, specificity, positive and negative predictive value about 100%. Out of 20 cases of carcinoma cervix, 12 cases were stage1, six were stage 2 and 3 and two were stage 4. Out of 10 cases correctly diagnosed by USG only 2 were in stage 1 where as remaining 8 were higher stages.

Out of 32 samples USG picked up 12 cases as positives where HPE picked 12 cases of endometrial lesions. The true positives were eight and true negatives were 16, there were four false positives and four false negatives by the diagnosing test. There is no significant association detected (chi-sq=6.97, p=0.008). Sensitivity=67%, specificity=80%, positive predictive value=67%, negative predictive value = 80% is calculated.

Out of 32 samples MRI picked up 12 cases as positives where HPE picked 12 cases of endometrial lesions. The true positives were 10 and true negatives were 18, there were two false positive and two false negative by the diagnosing test. There is significant association detected (chi-sq=17.21, p=0.0001). Sensitivity=83%, specificity=90%, positive predictive value=83%, negative predictive value=90% Out of 12 patients four patients had endometrial carcinoma, two had hyperplasia and six had polyp on histopathology where two patients were diagnosed with endometrial carcinoma, four with hyperplasia and six patients with polyp on MR. The two patients were misdiagnosed on MR as hyperplasia as there were no signs of myometrial invasion. On USG six patients had thickened endometrium four patients had polyp and two patients had suspicious polyp. Out of six patients with thickened endometrium one patient had features of myometrial invasion suggesting carcinoma.

There is significant association between USG and MRI (chi-sq=51.33, p=0.0001) with respect to detection of fibroids. There was no discrepancy when only one fibroid was there. But however when more than one fibroid was present MRI was better than USG in detecting number of fibroids. MRI was taken as gold standard in cases of fibroid [Table/Fig-2]. The sensitivity, specificity, positive and negative predictive value of USG and MRI are shown in [Table/Fig-3]. The USG and MRI images of adenomyosis, fibroid uterus, carcinoma cervix and endometrial pathologies are shown in [Table/Fig-4-7].

USG fibroid no.	MRI fibroid no.				Chi-sq	p-value
	1	3	4	Total		
1	24	0	0	24	51.33	0.0001
2	0	8	8	16		
3	0	0	4	4		
Total	24	8	12	44		

[Table/Fig-2]: Comparison of number of Fibroid by USG and MRI.

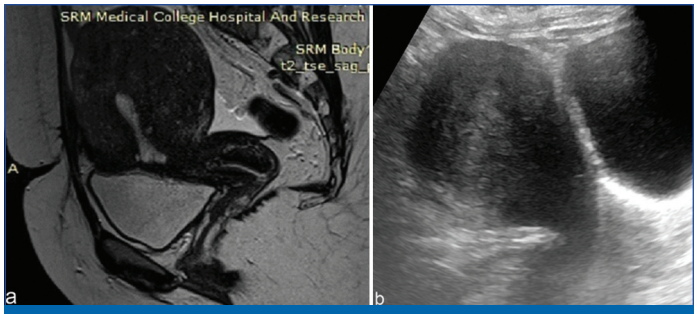
	Sensitivity		Specificity		Positive predictive value		Negative predictive value	
	Ultra sound	MRI	Ultra sound	MRI	Ultra sound	MRI	Ultra sound	MRI
Adenomyosis	37.5	100	0	100	60	100	0	100
Cervical Malignancy	50	100	33.3	100	55.5	100	28.6	100
Endometrial Lesions	67	83	80	90	67	83	80	90

[Table/Fig-3]: Sensitivity, specificity, positive and negative predictive value of USG and MRI.

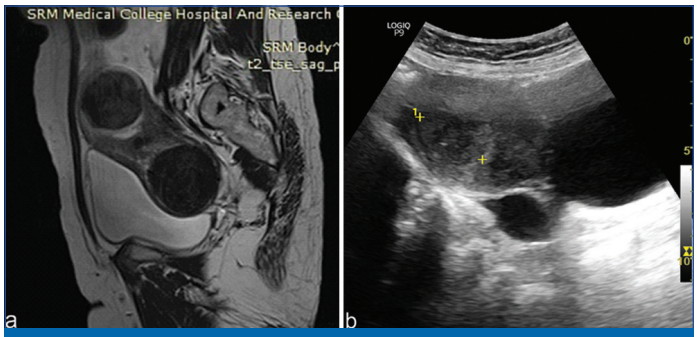
DISCUSSION

USG and MRI was performed in 92 patients who were referred to the Department of Radiology with clinically suspected uterine lesions. Patients were evaluated for uterine and cervical lesions in which USG and MRI was done and correlated.

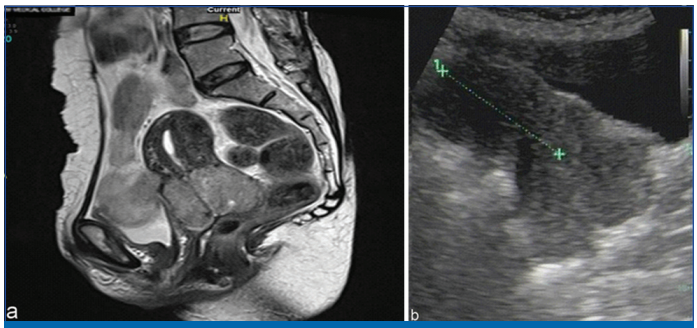
All the patients in our study were subgrouped into 4 categories based on underlying pathology:1) fibroids - 44 patients; 2) adenomyosis – 16 patients; 3) Carcinoma cervix – 20 patients; 4) endometrial lesions – 12 patients. Sensitivity and specificity were calculated for each modality in each subgroup and was compared.



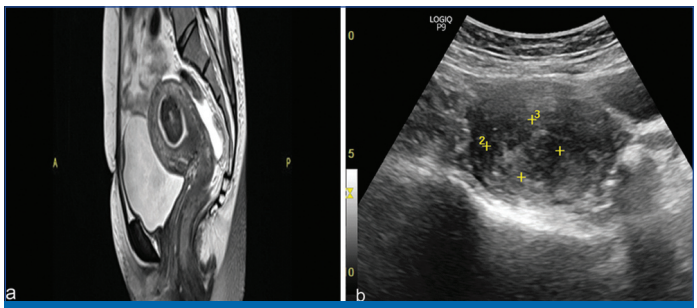
[Table/Fig-4]: (a) Sagittal T2 weighted MRI image in which the junctional zone appears predominantly hypointense in signal, thickened and shows few cystic areas c/w adenomyosis. (b) Sagittal USG image with bulky uterus, thickened and heterogenous myometrium suspicious for adenomyosis.



[Table/Fig-5]: (a) Sagittal T2 weighted MRI image shows the presence of both submucosal and subserosal fibroids. (b) Sagittal USG image of fundal region showing submucosal fibroid.



[Table/Fig-6]: (a) Sagittal T2 weighted MRI image shows hyperintense mass in the endo cervical canal. (b) Trans-abdominal sagittal USG image shows thickening of both lips of cervix.



[Table/Fig-7]: (a) Sagittal T2 weighted MRI image shows pedunculated lesion in the endometrial cavity which turned out as submucosal fibroid. (b) Transverse USG image showing hypoechoeic lesion within endometrial cavity.

Togashi K et al., did a study on 93 patients, among them 71 had fibroid, 16 had adenomyosis, six had both fibroid and adenomyosis [9]. In our study among 92 patients 44 patients had fibroid and 16 patients had adenomyosis where as two patients had both adenomyosis and fibroid. In their study, MR diagnosis was correlated with surgical/pathologic findings. The cause of uterine enlargement was correctly diagnosed in MR images in 92 of the 93 cases. They concluded that MRI is highly accurate in helping to distinguish between adenomyosis and leiomyoma in cases of enlarged uterus.

In our study, MR had sensitivity and specificity of 100% for diagnosis of adenomyosis. Out of 16 cases detected by USG, definite diagnosis of adenomyosis was noted in only six patients whereas an indefinite diagnosis was noted in 10 patients, this explains that there is a significant difference in diagnosing adenomyosis by USG and MRI (chi-sq=32, p=0.0001). In USG false negatives were 10 (62%) with sensitivity (38%). The low sensitivity in diagnosing adenomyosis in USG was mainly due to misdiagnosis as leiomyoma in USG.

Byun JY et al., conducted a study on 45 cases where 30 cases (66.6%) had diffuse adenomyosis and 15 cases (33.3%) had focal adenomyoma [10]. The Junctional Zone (JZ) in diffuse adenomyosis varied from 7-37 mm in T2 weighted images with average of 16 mm and diameter of 2-7 cm in cases of focal adenomyoma with mean 3.8 cm. High-signal-intensity foci were observed on T2-weighted images only in nine cases and on both T1- and T2-weighted images in three cases. High signal intensity foci were noted in all cases of focal adenomyosis, either on T2-weighted images only (four cases) or on both T1- and T2-weighted images (11 cases). In comparison to this in our study 12 cases was diagnosed of diffuse adenomyosis and four of focal adenomyosis. Jz thickness varied from 10 to 22 mm with mean average of 17 mm and 22 mm in focal adenomyosis. In our study among 16 patients of adenomyosis, high-signal-intensity foci were observed on T2-weighted images only in 12 cases and on both T1- and T2-weighted images in nine cases. In our study all the patients had junctional zone of more than 11 mm.

Kang S et al., did a study on adenomyosis to investigate the specificity of the criterion stating that a diagnosis of adenomyosis can be made confidently from MR images of the uterus when the junctional zone is thicker than 5 mm [11]. A 5 mm is not the upper limit of normal because it may cause high false positivity. The study showed 10 mm is the minimum. Our study showed junctional zone of 12 mm as the minimum and 17 mm as the average.

Ascher SM et al., did a prospective study on 20 women with clinically suspected adenomyosis who underwent MRI and transvaginal sonography [12]. The correct diagnosis was achieved with MRI in 15 out of 17 cases whereas nine out of 17 cases were diagnosed with transvaginal sonography. They concluded that MRI is significantly better than transvaginal sonography (p<0.02).

Bazot M et al., did a prospective study on 120 patients to compare the accuracy of transabdominal, transvaginal sonography and MRI for the diagnosis of adenomyosis [13]. Sensitivity, specificity and positive and negative predictive values of MRI were 77.5, 92.5, 83.8 and 89.2% respectively. The sensitivity, specificity and positive and negative predictive value of transabdominal, transvaginal sonography were 32.5 and 65.0%, 95.0 and 97.5%, 76.4 and 92.8% and 73.8 and 88.8%. They concluded that transvaginal sonography is as efficient as MRI for the diagnosis of adenomyosis in women without myoma, while MRI could be recommended for women with associated leiomyoma.

Hashad AM et al., did study on 77 patients where 67 (87%) were positive for adenomyosis by 3D TVUS, confirmed in 46 (59.74%) by histopathology, while 52 (67.53%) were positive by MRI, confirmed in 39 (50.64%) by histopathology [14]. A 3D transvaginal sonography was able to diagnose adenomyosis in 67 (87%) patients, while MRI was able to diagnose adenomyosis in 52 (67.5%) patients. They concluded that 3D transvaginal USG is highly accurate as MRI in diagnosing adenomyosis. In contrary in our study MRI was better than transvaginal ultrasonography for diagnosis of adenomyosis, however in our study we had used 2D sonography.

In our study of leiomyomas, a total of 96 fibroids were diagnosed with MRI, where 48 intramural fibroids were noted, 12 submucosal fibroids were noted, 14 subserosal fibroids were noted and 10 of them were both submucosal and intramural and 12 were both subserosal and intramural.

In comparison, USG detected 68 fibroids where 44 were found to be intramural, four were found to be submucosal, 10 were subserosal and eight of them were subserosal and intramural and two lesions were found in submucosal and intramural locations. The main advantage with MR was of picking up additional number of fibroids. The main reason for reduced deduction of fibroids with USG was due to reduced pick up of submucosal fibroid by USG. Also, the average size of fibroid missed by USG was about 1 cm or less than it.

Dudiak CM et al., did a study on 11 infertile women with uterine leiomyomas and compared the MR with transvaginal sonography [15]. Among nine patients who underwent MR and USG the sensitivity (85%) and accuracy (94%) of MR imaging was significantly better than that of USG (sensitivity-69%, accuracy-87% p-.043). Specificity of these modalities did not significantly differ and hence they concluded that MRI is superior to USG and HSG in preoperative localization. In our study, sensitivity of MRI was found to be 81.25% and superior as it could delineate the number and location of fibroids better than USG.

Audrey LS et al., on his study of 122 fibroids found correlation between MRI and USG findings of size of the fibroid but poor correlation of location and number of fibroids with additional fibroids found in MRI [16]. Study proved that additional information in considerable amount was detected in MRI compared to USG. This correlated with our study where 68 out of 96 fibroid lesions were detected in USG in correlation with MRI, in which based on location, lesions were missed in USG.

Hameed AM compared USG and MRI with pathology result for detection of fibroids [17]. The correct detection rate of myoma in USG was low 73.3% and with MRI detection rate was 98.1% with significant p=0.001. Mean number of myomas in US was 1.62±1.07, in MRI was 2.14±1.49 and in pathology was 2.15±1.5. The mean diameter of myomas in pathology was 3.49±2.21, in MRI was 3.58±2.21. Regarding myomas' localization, there is no significant difference between MRI and pathology but there was high significant difference in myomas' localization in US and pathology. The results were similar to our study where MRI was better than USG in detection of number of fibroids predominantly submucosal and small sized fibroids.

Yamashita Y et al., prospectively studied assessment of myometrial invasion by endometrial carcinoma [18]. Classification of myometrial invasion was done based on the contrast enhanced MRI among 40 patients along with transvaginal sonography. A comparison was made among the accuracy of TVS, unenhanced T2 weighted and contrast enhanced T1 weighted imaging and was found that contrast enhanced T1 weighted MRI is significantly superior. In two cases, in our study where MRI diagnosed as endometrial hyperplasia turned out to be endometrial carcinoma by histopathology. This is because no myometrial invasion was noted on those two patients. No myometrial invasion was seen in either T2WI or contrast imaging. Another patient who had invasion in MR could not be diagnosed in transvaginal sonography.

In detecting carcinoma cervix cases in our study and correlating it with USG and MRI, 20 cases were studied. Out of 20 cases of carcinoma cervix, 12 cases were stage1, six were stage 2 and 3 and two were stage 4. Out of 10 cases correctly diagnosed by USG only 2 was stage 1 where as remaining 8 was higher stages.

Shweel MA et al., conducted a study on 30 patients to evaluate diagnostic accuracy of MRI of cervical malignancies and its correlation with histopathology in which it was concluded that staging of cervical carcinoma by MRI was in symmetry with histopathology staging in stages IB and IV A and overstaging in IIA and IIB [19]. In our study only positive cases of carcinoma cervix were included; hence it showed 100% sensitivity and 100% specificity. In our study staging of cervical carcinoma by MRI was in symmetry with histopathology in stages IB and II.

Devimeenal J et al., compared the sensitivity and specificity of MRI, transabdominal, transvaginal sonography in detecting and characterizing the uterine mass lesions [20]. For detection of myometrial mass lesions, the diagonal agreement between the transvaginal sonography and MRI was 96%. In classifying the site of myometrial mass lesions, the diagonal agreement between transvaginal sonography and MRI was 67%. In positive cases of adenomyosis minimal JZ thickness was 9 mm compared to 11 mm in our study. The sensitivity of detecting adenomyosis in TAS, TVS and MRI respectively is 33%, 58% and 92% compared to 37.5% and 100% in our study for USG and MRI.

LIMITATION

- Majority of benign lesions could not be followed by histopathology.
- Lack of transvaginal sonography study in unmarried women and in cases of carcinoma cervix.
- Lack of MRI study in patients with metallic implants and cardiac pacemakers.

CONCLUSION

To characterize, localize and evaluate the number of lesions both benign and malignant along with its staging in pelvic pathologies, MRI is found to be more precise and many a times gold standard in comparison to USG. In cases of adenomyosis, MRI turned out to be more accurate in its diagnosis where USG was found indeterminate in visualizing the junctional zone. In cases of fibroids in aiding their number and location, MRI turned out to be more superior to transabdominal and transvaginal USG. In endometrial lesions, transvaginal sonography can be used as a great screening tool as transabdominal sonography was found to be less specific. MRI was found to be crucial in determining myometrial invasion. In instances of endometrial carcinoma, MRI conclusion alone can't forestall the requirement for endometrial biopsy however as it could not differentiate between early stages of carcinoma and hyperplasia. Extent of carcinoma cervix and its invasion to adjacent viscera was found to be superior in MRI compared to USG. Finally, we conclude that USG lacks its specificity and sensitivity in relation to MRI but acts as a great screening tool in evaluation and further management as it is cost effective and less time consuming. MRI is accordingly a more precise preoperative imaging modality for diagnosing and distinguishing the distinct features of various lesions.

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