Original Research Article

A study on sensitivity and specificity of MRI in detection of female pelvic pathologies

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Abstract

Background: Magnetic Resonance Imaging (MRI) has recently become a useful tool for the evaluation of female pelvic pathologies owing to certain benefits over ultrasonography. This modality, in the long run would be helpful in improving early diagnosis and clinical management of many patients. Therefore, this study evaluates the role of MRI in detection, staging and decision making in various female pelvic pathologies. **Methodology:** It was a cross-sectional study carried out at Department of Radio-Diagnosis of a tertiary care teaching hospital in Mumbai among patients referred to the MRI department for assessment of female pelvic organ pathologies. Appropriate MRI sequences and multiplanar imaging were performed for every patient and findings noted in a pre-designed proforma. All the patients were followed up through their clinical work-up to determine the final diagnosis. **Results:** There was a high degree of concordance between pathologies identified on MRI as well as those identified after complete clinical work-up of the patients. MRI could correctly predict 96.5% of the benign lesions and 88.9% of the malignant lesions in our study. It has both sesitivity and specificity of >85% in diagnosing benign and malignant lesions. **Conclusion:** MRI has considerable advantages over USG in imaging female pelvic pathologies. In spite of its ability in accurately detecting female pelvic pathologies, its application is still limited partly due to the expenses involved and partly due to lack of awareness amongst clinicians about its role and utility.

Keywords: Female pelvic pathology, MRI, benign and malignant lesions, sensitivity, specificity, agreement

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INTRODUCTION

A wide variety of pathologies affect the female genital tract. Complaints related to these pathologies such as menstrual irregularities, abnormal pelvic bleeding, pelvic pain, infertility etc. are common place. Apart from the history and clinical examination, imaging plays a key role in the diagnosis and management of these pathologies. Ultrasonography (USG) of the pelvis is the first line imaging test for female patients presenting with such pelvic complaints.[1] It is safe, widely available, relatively inexpensive and has wide patient acceptability. In addition, USG provides real time assessment of pelvic structures and Doppler ultrasound helps in assessing blood flow in pelvic vasculature and pelvic masses. However, there are some shortcomings with this modality such as dependence on the skill and experience of the operator, limited field of view, inherent limitations dependent on patient size, disruption of ultrasound waves by bowel gas and inappropriate assessment of parametrial spread and hence staging.[2] Computed Tomography (CT) plays a limited role in imaging of gynaecologic conditions. Its utility predominantly lies in the diagnosis of extra-pelvic spread of disease and hence is especially useful in the imaging and staging of ovarian carcinoma, which has an early metastatic spread via the peritoneum.

Magnetic Resonance Imaging (MRI) offers high contrast resolution, good soft tissue characterization and provides multiplanar imaging capabilities and a larger field of view

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compared to ultrasonography and hence has recently become a useful tool for the evaluation of female pelvic pathologies.[3,4] MRI has additional advantages such as lack of ionizing radiation and iodinated contrast material, and its ability to differentiate lesion from post-operative scarring in pelvic malignancies. Therefore, MRI is now often used as a problem-solving tool in patients where ultrasound findings are not definitive.[5] Thorough knowledge of the MRI sequences with respect to spectrum of MR imaging features of various physiologic variations and pathologic conditions that affect the female pelvis is essential for establishing an accurate diagnosis. However, in our experience, it is still an underutilized investigation in view of limited availability, lack of awareness amongst the clinicians of its utility and a perception of it being a prohibitively expensive study. This modality if used in a rational manner for appropriate indications, it can be cost-effective and would serve for early diagnosis of many female pelvic conditions which in the long run would be helpful in improving early clinical management of many patients.[6] Considering this background, the study was undertaken to to evaluate the role of MRI in detection, staging and decision making in various female pelvic pathologies.

MATERIAL AND METHODS

It was a cross-sectional study carried out at the Department of Radio-Diagnosis of a tertiary care teaching hospital in Mumbai from June 2013 to May 2014 among patients referred to the MRI in department for assessment of female pelvic organ pathologies. Patients with abnormal vaginal bleeding, infertility, suspected pelvic congenital anomalies and known case of pelvic malignancy for staging and follow up, referred for MRI of the pelvis by the Gynecology Department were included in the study. Also, patients in whom the ultrasound findings were inconclusive or to confirm those findings or MRI was anticipated to provide additional relevant clinical or pathological information were included. However, claustrophobic patients, patients not willing for MRI, having contraindications for MRI (Patients with Brain Aneurysm Clip, Implanted neural stimulator, Implanted cardiac pacemaker or defibrillator, Cochlear implant, Ferromagnetic Ocular foreign body, implanted medical devices like Swan Ganz catheter or an Insulin pump, Metal shrapnel or bullet, patients with surgery of uncertain type where the presence of metal clips or wire) were excluded from the study. Also, patients with renal insufficiency (serum creatinine levels beyond 1.8 mg/dl) in whom contrast (Intravenous gadolinium) could not to be administered were excluded. All the patients referred for MRI Pelvis from June 2013 to May 2014 and fulfilling the inclusion and exclusion criteria were included in the study sample. A pre-designed proforma was used for collecting data. Information on patient age and clinical presentation was noted. MRI of the pelvis was performed on a 3T Philips Achieva MRI scanner. Appropriate MRI sequences and multiplanar imaging were performed for every patient. A phased array torso surface coil was strapped around the lower abdomen and pelvis of the patient. A slice thickness of 4mm with a slice gap of 1mm was selected. A saturation band was placed along the anterior abdominal wall to reduce the motion artifacts produced due to respiratory movements.

Following was the protocol of MRI sequences conducted: T2 Weighted Turbo Spin Echo (T2W TSE) Sagittal. T2W TSE Axial. T2W TSE Coronal. T1W TSE Axial. T1 W TSE with Fat Saturation Axial.

In few patients few additional sequences were obtained: Post-Gadolinium T1W TSE with Fat Saturation. Dynamic post – gadolinium T1 TSE with Fat Saturation. 3D T2W sequence. Diffusion Weighted Imaging. T2W TSE with Fa Saturation.

A true anatomical sagittal scan was first obtained by planning on the 3 plane survey images. If Uterus was the organ of interest, then Coronal and Axial scans were obtained along the uterine axis and perpendicular to it. If there was no specific organ of interest or an irregular adnexal lesion, then true anatomical coronal and axial scans were obtained.

All the patients included in this study were followed up through their clinical work-up, including histopathology and surgical evidence done at the clinician's discretion, until the final diagnosis was established. This information was noted as Final diagnosis in our study proforma. Data analysis and generation of graphs was done using MS-Excel. Quantitative and qualitative data was represented in form mean (SD) and frequency (%) respectively. Diagnostic efficacy of MRI in diagnosing female pelvic pathologies was calculated through Sensitivity, Specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV). Cohen's κ (kappa) was run to determine if there was agreement between classification of lesion as benign or malignant on imaging and final diagnosis.

RESULTS

The present study was conducted among 75 female patients who came to the radiology department with pelvic pathologies. The mean age of the study patients was 35.5 ± 16.0 years [Range 1.2 months – 80 years]. In this study, a large number of patients i.e. 23 (30.7%) were in age group 20 – 29 years and around 64% of the patients were in age group 20 – 49 years. The most common clinical presentation was pelvic pain seen in 38 (50.7%) patients followed by menstrual disturbances in 26 (34.7%) and bleeding PV in 19 (25.3%) patients. [Chart 1]

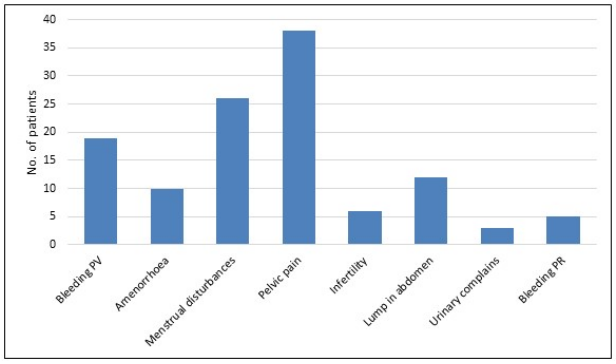

Chart 1: Clinical presentation of study patients

On MRI, 46 (61.3%) patients had uterine pathology, 32 (42.7%) patients had adnexal pathology and 10 (13.3%) patients had vaginal pathology. Tubal pathologies were noted in 3 (4.0%) patients, urinary bladder pathology in 1 (1.3%) patient and rectal pathology in 5 (6.7%) patients. The concordance and discordance rates between diagnosis on imaging and final diagnosis are given in Table 1.

Table 1: Comparison of Imaging Diagnosis with Final Diagnosis

Pathology	Imaging diagnosis that agrees with Final diagnosis (Concordance Rate)	Imaging diagnosis that does not agree with Final diagnosis (Discordance Rate)	Total
Uterine pathology	44 (95.7%)	2 (4.3%)	46 (61.3%)
Adnexal pathology	29 (90.6%)	3 (9.4%)	32 (42.7%)
Other pathologies (Vaginal / Tubal / Urinary bladder / Rectal)	16 (100%)	0 (0%)	16 (21.3%)

Table 2 shows that diagnosis of benign and malignant pelvic lesions on MRI is in good agreement with final diagnosis on complete work-up of the patients (κ = 0.854). MRI could correctly predict 96.5% of the benign lesions and 88.9% of the malignant lesions. However, 11.1% of the malignant lesions and 3.5% of the benign lesions were wrongly classified on MRI.

Table 2: Comparison of type of lesion on Imaging diagnosis and Final diagnosis

Lesion type on Imaging diagnosis	Lesion type on Final diagnosis		Total
	Benign	Malignant	
Benign	55 (96.5%)	2 (11.1%)	**57 (76.0%)**
Malignant	2 (3.5%)	16 (88.9%)	**18 (24.0%)**
Total	**57 (76.0%)**	**18 (24.0%)**	**75 (100%)**
Cohens κ = 0.854			

Table 3 shows the performance of MRI in diagnosing benign and malignant lesions compared to final diagnosis after complete work-up of patients. MRI has sensitivity and specificity of 96.5% and 88.9% respectively in diagnosing benign lesions. Whereas, the sensitivity and specificity of MRI in diagnosing malignant lesions was 88.9% and 96.5% respectively.

Table 3: Performance of MRI in diagnosing benign and malignant lesions compared to Final diagnosis

	Percentage	Lower 95% CI	Upper 95% CI
Benign lesions (n=57)			
Sensitivity	96.5%	87.8%	99.5%
Specificity	88.9%	65.2%	98.6%
Positive predictive value	96.5%	87.8%	99.5%
Negative predictive value	88.9%	65.2%	98.6%

Malignant lesions (n=18)			
Sensitivity	88.9%	65.3%	98.6%
Specificity	96.5%	87.8%	99.5%
Positive predictive value	88.9%	65.3%	98.6%
Negative predictive value	96.5%	87.8%	99.5%

There was high level of agreement on classification of lesion as benign or malignant based on MRI and final diagnosis for different female pelvic pathologies as Cohens κ was 0.982, 0.739 and 1.0 for uterine and cervical, adnexal and rest of the pathologies taken together respectively. [Table 4]

Table 4: Agreement on type of lesion by Imaging diagnosis and Final diagnosis for different pelvic pathologies

Imaging diagnosis	Final Diagnosis		Kappa (κ)
	Benign	Malignant	
Uterine pathology (n=46)			
Benign	37 (100%)	1 (11.1%)	0.928
Malignant	0 (0.0%)	8 (88.9%)	
Adnexal pathology (n=32)			
Benign	23 (92.0%)	1 (14.3%)	0.739
Malignant	2 (8.0%)	6 (85.7%)	
Other pathologies (n=16)			
Benign	12 (100%)	0 (0.0%)	1.0
Malignant	0 (0.0%)	4 (100%)	

DISCUSSION

In this study, the mean age of the study population was 35.5 years. A study by Schwartz *et al.*, exploring the role of pelvic MRI to differentiate among the histologic subtypes of uterine pathologies was also conducted similarly aged patients.[7] Based on MRI, 61.3% of our study patients had uterine pathology and 42.7% patients had adnexal pathology. The patients with other female pelvic pathologies constituted about 21%. There was a high degree of concordance between pathologies identified on MRI as well as those identified after complete clinical work-up of the patients. The patients in our study were followed up until the final diagnosis was established based on clinical work up, histopathology or surgical evidence. Benign pathologies (76%) were more common in our study patients than malignant pathologies (24%). In these patients, MRI could correctly predict 96.5% of the benign lesions and 88.9% of the malignant lesions on final diagnosis. MRI has both sesitivity and specificity of >85% in diagnosing these lesions. Also, there was high level of agreement on classification of lesion as benign or malignant based on MRI and final diagnosis for for uterine and cervical, adnexal and rest of the pathologies taken together respectively. In our study, among the benign uterine pathologies, Congenital Anomalies were most common (37%) followed by leiomyoma (26%) and adenomyosis (8%). Among the congenital uterine anomalies, Type I Mullerian Duct Anomaly was most common finding in our study and sagittal and axial planes were most important in diagnosing these anomalies. All the uncomplicated leiomyoma seen in our patients had low signal intensity compared to myometrium on T2WI. This is in accordance with a study by Mark AS *et al.* which demonstrated that MRI is not limited by the location or size of the leiomyoma and can demonstrate accurately tumours as small as 5mm.[8] The same was supported by a study by Murase E *et al.* which found that MRI is ideal in demonstrating the proximity of a myoma to the bright endometrial echo complex.[9] Fat suppressed T1W images are essential in differentiating between red degeneration of fibroid and fatty changes, as fibroids having red degeneration will maintain their hyperintense signal even on fat suppressed images. On MRI, the diffuse form of adenomyosis presented with thickening of the junctional zone. Areas of adenomyosis were seen as bright foci and cyst-like high signal intensity areas which represent heterotopic endometrial glands or hemorrhagic foci. Focal adenomyosis was seen as a hypointense focal uterine lesion abutting the junctional zone. [Illustration 1] In comparison to leiomyomas, it was less well-defined and poorly marginated. It contained high signal intensity foci within on T2W and occasionally on T1W imaging as well. MR can usually differentiate between focal adenomyosis and a leiomyoma. Togashi K in their study revealed that MRI successfully differentiates between Adenomyosis and leiomyoma.[10] Out of total 75 patients included in this study, 18 patients (24%) had malignancy. Most common malignancy in our study was cervical followed by endometrial and ovarian malignancies. Cervical cancer is the second most common gynecological malignancy worldwide. MR imaging has proven to be an excellent modality to evaluate tumour size, extent, and nodal involvement.[11] The real strength of MR imaging for cervical carcinoma is the high negative NPV of 95% for parametrial invasion.[12] Similarly, our study has also

demonstrated a NPV of 96.5% in diagnosing malignant pathologies. [Illustration 2] Another study has documented 100% negative predictive value of MR imaging for bladder or rectal invasion, suggesting that MR imaging can obviate invasive procedures, such as cystoscopy, proctoscopy, and sigmoidoscopy, and thus can reduce staging costs and morbidity.[13] For the detection of advanced stage disease, sensitivities for MR imaging (53%) and CT (42%) are much higher than FIGO clinical staging (29%).[14] We also noted two cases of Uterine Arterio-venous Malformation (AVM). In one patient, MRI revealed a post iatrogenic Slow Flow AVM in the posterior myometrium and in the other patient MRI revealed Uterine and Pelvic AVM with a large Pelvic hematoma. MRI was very useful in diagnosing Uterine and Pelvic vascular Malformations. This is in accordance to the study done by Burrows PE.[13] Out of the 75 patients studied, 32 patients (42.7 %) had adnexal pathology either primary or secondary. In our study, Simple Ovarian Cysts were the most common pathology. All the simple cysts appeared hypointense on T1W images and hyperintense on T2W images. All of them were incidental findings. There were 2 patients of Dermoid cyst. Accurate diagnosis was achieved in these cases on MRI because of the characteristic appearance of fat on T1WI, T2WI and suppression of signal on fat suppressed images. The same was supported by a study by Zanoboni F *et al.* which described numerous pitfalls in the USG diagnosis owing to the varied appearance of cystic teratomas.[15]

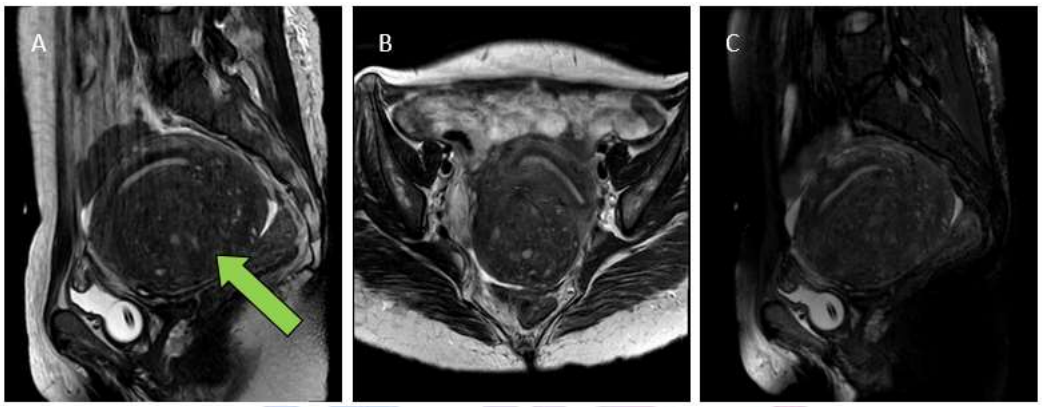

Illustration 1: Adenomyoma MRI T2 sagittal (A), T2 axial (B), T2 SPAIR sagittal (C)reveals Posterior wall Adenomyoma (green arrow)

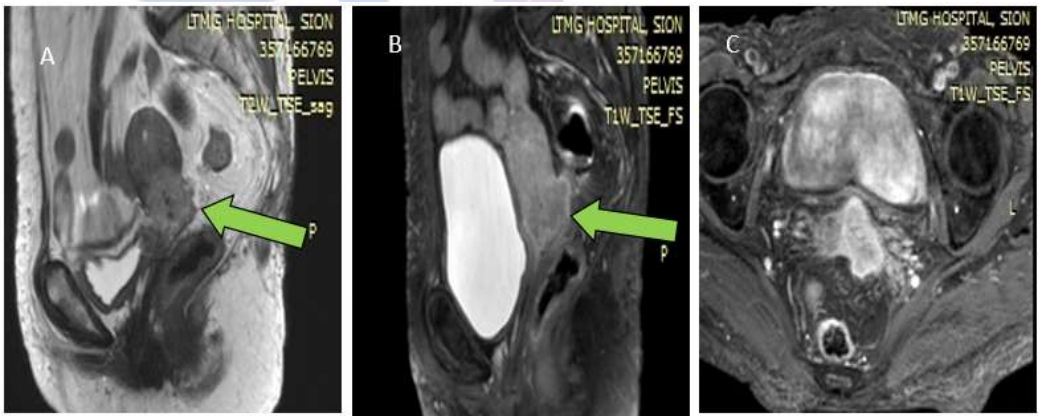

Illustration 2: Ca Cervix MRI T2 sagittal (A) Post Contrast T1 Sagittal and axial (B,C) reveals Heterogenous growth involving the cervix (green arrows)

CONCLUSION

The role of MRI in gynaecologic imaging has been firmly established based on the work in the past two decades. In spite of its ability in accurately detecting female pelvic pathologies, its application is still limited partly due to the expenses involved and partly due to lack of awareness amongst clinicians about its role and utility. MRI offers high contrast resolution, good tissue characterization, multiplanar imaging capabilities and a larger field of view compared to USG which has always been the workhorse in the field of gynaecologic imaging. Also, MRI does not involve the use of ionizing radiation, which is a considerable advantage; particularly in the imaging of females of the reproductive age group. Hence, it has now

become a useful adjunctive tool in the evaluation of female pelvic pathologies. It performs the role of a problem-solving modality when ultrasound and clinical information fail to provide an answer.

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