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ROLE OF 3 TESLA MRI IN EVALUATION OF UTERINE PATHOLOGIES AND STAGING OF UTERINE CANCERS USING DYNAMIC CONTRAST ENHANCEMENT

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ABSTRACT

MRI with its multiplanar imaging helped in identifying various pathologies, knowing their exact location and extent with great resolution and with minimal or no artifacts. DWI due to excellent tissue contrast based on molecular diffusion and may be able to demonstrate malignant tumors, differentiating normal from cancerous tissues and evaluating response to chemo-radiotherapy. Dynamic contrast-enhanced (DCE)-MR imaging is a noninvasive method that allows evaluation of tumor angiogenesis. DCE-MR enables qualitative and quantitative assessment of tumor status with added value for depth of myometrial and cervical stromal invasion in early cancers as well as in overall FIGO staging. Thus MRI helps in staging of the gynaecological malignancies, in identifying early invasion of adjacent structures as well as lymph nodal infiltration, in assessment of response to chemo/ radiotherapy thus further proved useful in further management of the patient.

KEYWORDS

Dynamic contrast enhanced MRI, Endometrial carcinoma, cervical carcinoma

INTRODUCTION

Cervical cancer is one of leading gynaecological malignancy in our country followed by breast, ovarian and endometrium. Therefore, imaging plays an ever increasing role in gynaecological disorders. MRI with its high contrast resolution, its ability to provide good tissue characterization, and its multiplanar imaging capabilities is increasingly used to evaluate uterine cancers. MRI is particularly effective in staging endometrial carcinoma and in determining myometrial or cervical invasion [1,2]. Therefore, accurate evaluation is mandatory for preoperative planning of surgery. It is also useful in determining parametrial invasion in cervical and endometrial carcinomas [3,4]. In addition to staging, the appearance of the cervical tumor on imaging may be helpful in predicting patient response to nonsurgical therapy and outcome. Tumor volume before and after treatment can be calculated from the largest-diameter measurements on multiplanar images and may help as a prognostic indicator in these patients.

Recently, MR imaging with field strengths of 3.0T has rapidly become clinically available in the body in addition to the brain. In general, 3.0T MR imaging offers a higher signal-to noise ratio (SNR) and higher spectral separation than 1.5T MR imaging. The quantitative evaluation of the apparent diffusion coefficient (ADC) in DWI helps in distinguishing between malignant and benign tissues and for monitoring therapeutic outcomes[5] and asssessing response to treatment. ADC values have been noted to increase with treatment.

There are challenges in determining depth of myometrial invasion especially in post menopausal woman as the myometrial thickness reduces, there may be poor tumor to myometrium contrast. Similarly in cases of adenomyosis, leiomyomas, polypoid tumor causing myometrial compression and cornual involvement there is poor tumor myometrial contrast. In view of this additional techniques such as DWI and DCE MRI are useful to increasing the accuracy of MRI.

Dynamic contrast enhanced MRI (DCE-MRI) is a dynamic MR technology, focusing on the enhancement behaviors at different time points and reflecting the characteristics of tumour blood supply. This is based on angiogenesis of malignant tumours. Increased tumor enhancement suggests increased vascularity and oxygenation, which may indicate increased radiosensitivity and delivery of therapeutic drugs.

This study is selected because of the important role of MR imaging in the investigation of female pelvic diseases. Hence the proposed study is an endeavor to study the imaging characteristics of uterine cancers and to evaluate the role of newer techniques like DWI and dynamic contrast study in further characterization and local staging of the disease process.

ASSESSMENT OF PRIMARY TUMOR -On MRI endometrial CA is intermediate in signal intensity on T2WI relative to normal endometrium which is hyperintense.. Tumor invading the myometrium is seen as hyperintense irregular invading tissue disrupting low intensity junctional zone. The accuracy of non contrast MRI in demonstrating myometrial invasion is 55 – 77 %. DWI in endometrial carcinoma demonstrates restricted diffusion and reduced ADC values and helps to detect of drop metastases in cervix, vagina & extrauterine spread to peritoneum lymph nodes[6]. After IV contrast medium administration, the normal inner myometrium shows avid enhancement earlier than the outer myometrium [7,8]. The maximum contrast between the inner and outer layers of the myometrium occurs at 50 seconds [8,9].

On DCEMRI in stage 1 disease endometrial cancer enhances earlier than normal endometrium but later than the adjacent myometrium in the arterial phase, allowing identification of small tumors, even those contained by the endometrium. This phase is particularly useful in assessment degree of myometrial inavsion thus differentiating stage Ia from stage Ib. The maximum tumor–myometrium contrast occurs during the equilibrium phase [10]. On delayed images 90 – 150 seconds after administration of contrast the tumor appears hypovascular as compared to endometrium.

In stage 2 endometrial cancers cervical stromal invasion is seen as replacement of nomal hypointense cervical stroma by an intermediate signal intensity lesion. On DCE delayed images are particulary useful in evaluating cervical stromal invasion as presence of an intact enhancing cervical mucosa excludes stromal invasion.

In Stage 3A the tumor disrupts smooth hypointense outline of serosa on T2W1. This may also be seen as a subtle irregularity of uterine contour. On DCE there is discontinuity in the enhancing outer margin of myometrium. In stage 3B there is invasion of the vagina as demonstrated by disruption/invasion of hypointense vaginal wall on T2W1 or extension to parametria (Figure 1).

In stage 4 cancer, preservation of the normal fat plane between the bladder and rectum excludes involvement while tumor abutment or abnormal wall signal intensity are suspicious for disease.

The hallmark of cervical cancer is a focal solid mass arising within the cervical stroma, best depicted on transaxial and sagittal T2WI, which appear as a hyperintense lesion against low signal intensity normal fibrovascular stroma, and appears isointense on T1WI (Figure 2). The integrity of the cervical stroma can be assessed. An intact ring of hypointense tissue on T2-weighted images has a high NPV for parametrial invasion. Disruption of the stromal ring, contour irregularity, and vessel abutment are suspicious for parametrial disease. On DCE tumor enhances earlier then the cevical stroma and appear hypointense on delayed images.

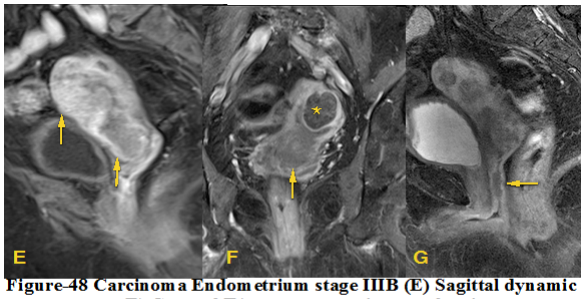

Figure-48 Carcinoma Endometrium stage IIIB (E) Sagittal dynamic post contrast (F) Coronal T1 post contrast images showing hyperenhancing mass with myometrial and cervical canal invasion (vertical arrow). a hypoenhacing myoma(*) is seen. (G) Sagittal T1 post contrast images showing vaginal extension (horizontal arrow) of the lesion.

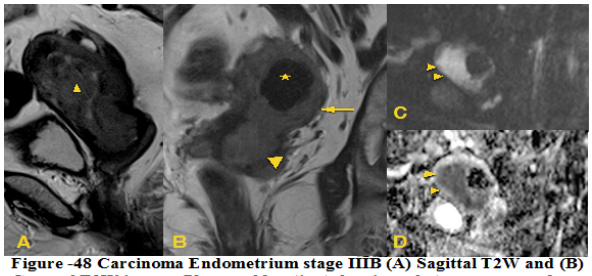

Figure -48 Carcinoma Endometrium stage IIIB (A) Sagittal T2W and (B) Coronal T2W images 70 year old patient showing a heterogenous and hyperintense mass in the endometrial cavity (triangle) invading full thickness of the myometrial wall (arrow) as well as extending into the cervical canal (arrowhead). A hypointense myoma(*) is seen in the posterior wall. (C) DWI and (D) ADC images show strongly restricted diffusion (double arrowhead).

FIGURE 1 CARCINOMA ENDOMETRIUM STAGE IIIB

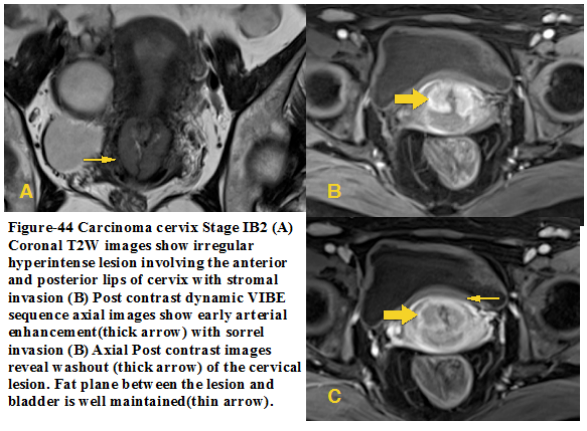

Figure-44 Carcinoma cervix Stage IB2 (A) Coronal T2W images show irregular hyperintense lesion involving the anterior and posterior lips of cervix with stromal invasion (B) Post contrast dynamic VIBE sequence axial images show early arterial enhancement(thick arrow) with sorrel invasion (B) Axial Post contrast images reveal washout (thick arrow) of the cervical lesion. Fat plane between the lesion and bladder is well maintained(thin arrow).

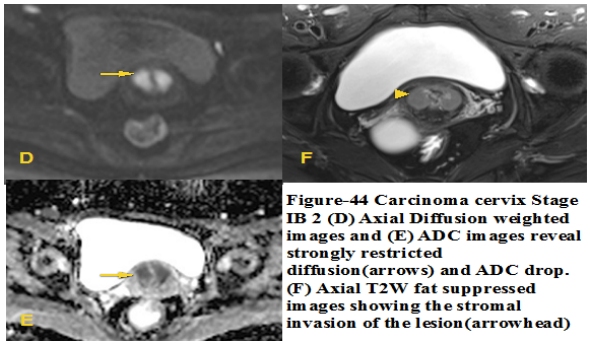

Figure-44 Carcinoma cervix Stage IB 2 (D) Axial Diffusion weighted images and (E) ADC images reveal strongly restricted diffusion(arrows) and ADC drop. (F) Axial T2W fat suppressed images showing the stromal invasion of the lesion(arrowhead)

FIGURE 2 CA CERVIX STAGE 1B2

AIMS & OBJECTIVES

1. Describe the role of 3T MRI in diagnosis and characterization of uterine pathologies
2. Describing the role of dynamic CE MRI in diagnosis and local staging of uterine malignancies.

MATERIALS & METHODS

This prospective study was done in deparment of Radiodiagnosis, MGM medical college & M.Y. hospital, Indore. The study group comprised of 47 patients diagnosed with or with suspicion of gynaecological disease with 3 Tesla, signa GE system using a dedicated pelvic coil. T1, T2, T2 FATSAT, SWI,DWI (Diffusion Weighted Imaging), POST CONTRAST T1 and VIBE sequences were included in the protocol. Informed consent was taken prior to the study. Study included patients of all age group with gynaecological complaints, patients with suspicion of disease on clinical examination, ultrasound or multiphasic contrast enhanced CT. Patients with pelvic floor pathology, prolapse, bowel pathologies, trauma and patients with general contraindication to MRI were not taken up for study.

RESULTS

ON MRI- following results were obtained- In our study,

- 6 patient showed congenital lesions(7.5%)
- 21 patients had benign lesions(62.5%)
- 20 patients had malignant lesions(38.8%)

- **ON SURGICAL / HISTOPATHOLOGICAL** follow up- In our study,
- 18 patients had benign lesions (56.3%)
- 19 patients had malignant lesions which also include 1 operated congenital lesion (Bicornuate uterus with endometrial carcinoma with rudimentary horn of Communicating variety).
- For 10 patients histopathological followup was not available as these conditions were benign treated medically and no surgery was indicated.
- All uterine masses were correctly diagnosis by MRI except for 1 mass which was misdiagnosed as malignant neoplasm while the histopathological follow up revealed a broad ligament fibroid. This was due to heterogenity of the mass because of its large size. In the study conducted by P. Balan et al, sensitivity MRI for identification of tissue of origin were 94% which supports this study.
- **DIAGNOSTIC EFFICACY-** In our study, the diagnostic efficacy of MRI for benign and malignant uterine pathologies is as follows (Table 1)-

EFFICACY PARAMETER	BENIGN	MALIGNANT
SENSITIVITY	94.4%	100.0%
SPECIFICITY	100.0%	94.4%
POSITIVE PREDICTIVE VALUE	100.0%	95.0%
NEGETIVE PREDICTIVE VALUE	95.0%	100.0%
ACCURACY	97.3%	97.3%

Table 1

P values for both benign and malignant lesions were significant <0.01 Discrepancy between mri findings and histopathological follow up was seen in one patient. Agreement was calculated for MRI and histopathological discrepancy and was calculated as 95.7%.

Significant agreement was abserved between the two modalities which was significant.

Correlation of MRI staging based on clinical FIGO staging versus surgical / histopathological staging (Table 2) -

No of patients in which MRI staging correlated with surgical/Histopathological staging	17	89.5%
No of patients in which MRI staging didnot correlate with surgical/Histopathological staging	2	10.5%
Total	19	100%

Table 2

DISCUSSION

In the present study, the most common age group encountered was the fifth decade, with mean age of 45 years. The most common presenting complaint with which the patients presented was lower abdomen pain, which was present in 32.5% of the patients in the study followed by bleeding per vaginum in 28.8% patients. These findings are in accordance with Keiichi Fujiwara (11) et al, Marc et al and Byrne et al.

Congenital uterine lesions were seen at younger age group of patinets in their second and third decades. Benign lesions were commonly seen in younger and middle age group of patients between second to fourth

decade. Malignancies were more commonly seen around fifth decade and above.

Myometrium was most frequently involved(44%) followed by endometrium(31 %) and cervix(25 %). Of the 46 patients with uterine lesions 6 patients(13%) had congenital pathologies, 21 patients(45%) had malignant lesions and 20 patients (42%) had benign lesions. 1 patient had endometrial carcinoma in the horn of bicornuate communicating variety uterus Of the congenital uterine lesions, most common anomalies in our study were hypoplastic and bicornuate uterus(33.3% each). This finding is also seen in study conducted by Sarvelos et al and Hasan et al which supports our study.

Of the benign uterine lesions myomas were the most commonly seen incidental lesions (46.5%) with intramural myomas as the most commonly subtype. This finding is in accordance with Rieber et al. Also similar findings are seen in concordance with Rosa Moghadam et al. 25% of the uterine myomas showed degeneration. Endometrial polyps were the most common benign lesions arising in endometrium(11%)

20 patients in our study had uterine malignancies of which endometrial carcinoma was the most common malignancy overall and accounting for 60% of the patients (12 patients) diagnosed with uterine malignancy, followed by carcinoma cervix(35%) (7 patients). 5% of the patients (1) had uterine sarcoma.66.7 % of the patients having endometrial carcinoma (8) were Stage I tumors under Revised FIGO staging of carcinoma endometrium. 8.3 % of patients (1) had stage 2 and 25%(3) had stage 3 endometrial carcinoma. These findings are concordant with Ortashi et al, Kim SH et al No patients of stage 4 disease were encountered in our study. 43% of the patients (3) diagnosed with cervical carcinoma in our study were stage I tumors as per FIGO stating of carcinoma cervix. Stage 2, stage 3 and stage 4 cervical ca was seen in 7% of the patients (1), 7%(1) and 43%(3) respectively.

33% of the benign lesions(7) showed restricted diffusion. These lesions were pyometra, degenerated myomas with internal haemorrhage, infected polyps and adenomyomas with focal haemorrhage. The presence of fresh blood products and formed abscess in endometrial cavity was the reason for showing resticted diffusion. All uterine malignancies (20) showed restricted diffusion within the lesions. These findings are in accordance with Naganawa et al and McVeigh et al.

Heteregenous pattern of enhancement was seen in 30% of benign lesions such as degenerated myomas, polyps with cystic degeneration, large myomas and adenomyosis. Homogenous pattern of enhancement was seen in most of the myomas. The most common pattern of enhancement in malignant lesions was early enhancement i.e before the enhacement of endometrium and inner myometrium in endometrial lesions and cervical stroma in cervical lesions. These findings were consitent with the study of Sironi et al and k kinkel et al.

CONCLUSIONS

- In patients with congenital uterine anomalies MRI allows accurate morphologic demonstration and classification of uterovaginal anomalies thereby indicating the appropriate treatment and planning the surgical approach.
- Imaging characterstics of MRI play important role in differentiating adenomyomas from fibroids as the line of treatment for both the conditions differs.
- MRI is particularly useful in determining fibroid location and size which are important factors for treatment approach as submucosal fibroids may best be removed by hysteroscopic resection, whereas pedunculated subserosal fibroids may be appropriately treated by myomectomy. Intact blood supply of the fibroids is needed for undergoing Uterine artery embolisation.(UAE) or MR guided focussed ultrasound. Degenerated leiomyomas tend to respond poorly to UAE, a preoperative MRI thus is needed for better interventional or surgical planning.
- Diffusion weighted imaging has its role in determining the high cellularity tumor dense areas within complex masses, thereby guiding appropriate biopsy from the lesion.
- MRI with use of dynamic contrast enhancement is particularly effective in staging of endometrial carcinoma and in determining myometrial or cervical invasion. It is also useful in determining parametrial invasion in cervical carcinoma. Thus in guiding the tumour operability, deciding treatment options, assessing response to chemoradiotherapy and tumor recurrance.

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