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RESEARCH ARTICLE

Adnexal Masses in Pregnancy: Added Value of Magnetic Resonance Imaging in Guiding Patient Management—Our Initial Experience

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ABSTRACT

Aim: To assess the role of magnetic resonance imaging in management of adnexal masses encountered during pregnancy.

Materials and methods: A prospective study was conducted in 40 pregnant patients referred for magnetic resonance imaging (MRI) abdomen and pelvis after indeterminate findings on ultrasound examination. Total 13 of these 40 patients with adnexal lesions on both ultrasound and MRI were further studied in detail. The MRI images were acquired on 1.5 T machines. Only patients in whom follow up and final diagnosis were available were included in the study.

Results: The 13 cases of adnexal lesions included 9 benign pathologies and 4 malignant adnexal lesions. MRI had accurately diagnosed malignancy in three of these patients with torsion additionally detected in the fourth patient. The 9 remaining cases were correctly interpreted as benign pathologies on MRI, which included cases of benign serous cystadenomas (n = 2), mature cystic teratomas (n = 2), endometriotic cyst (n = 1), hemorrhagic corpus luteal cyst (n = 1), torsed ovary (n = 1), hyperstimulated ovaries (n = 1) and subserosal fibroid with red degeneration (n = 1). MRI played a definitive role in deciding course of management in all cases of adnexal masses that required further characterization following initial ultrasound. Following MRI, nine patients underwent surgery during the ongoing pregnancy, one patient underwent ovarian cystectomy concurrently at the time of caesarean section, two patients were managed conservatively with imaging follow up and surgery was deferred until after delivery in one case.

Conclusion: Although sonography is the primary imaging tool in evaluating obstetric patients, in selected cases where ultrasound is equivocal or indeterminate, MRI can serve as a problem solving tool to arrive at an accurate diagnosis and guide patient management.

Clinical significance: Adnexal masses discovered in pregnancy present a clinical and imaging challenge. The MRI can decide the course of management by delineating benign and malignant entities and dictating the need for surgical intervention versus feasibility of conservative treatment.

Keywords: Adnexal mass, Magnetic resonance imaging (MRI), Ovarian mass, Pregnancy, Red degeneration, Torsion, Ultrasound.

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INTRODUCTION

A pathological adnexal mass is encountered in 1 to 2% of pregnancies.[1] Adnexal masses diagnosed during pregnancy present a diagnostic challenge as they comprise a wide array of presentations, including both solid and cystic lesions/neoplastic and non neoplastic lesions. Apart from functional cysts, non neoplastic ovarian cysts commonly encountered include endometriotic and hemorrhagic cysts. Among ovarian tumors, cystic teratomas and cystadenomas are the most common benign ovarian neoplasms during pregnancy.[2] Malignancies such as germ cell tumors and invasive epithelial ovarian cancers can also be seen.[3] Uncommon entities that can present as an adnexal mass include broad ligament or pedunculated leiomyomas and ectopic pregnancy.

Majority of these lesions are asymptomatic and discovered incidentally during routine sonogram done for fetal assessment. However, some of the adnexal masses can present with acute abdominal pain secondary to hemorrhage, rupture, rapid increase in size or torsion. Additionally, a malignancy rate of 1 to 8% has been reported amongst adnexal masses diagnosed during pregnancy.[4,5] Hence, accurate characterization by imaging plays an important role in planning patient management and deciding upon potential surgical intervention.

Ultrasound is the preferred mode of imaging among obstetric population, primarily due to availability, portability, lack of ionizing radiation and relatively low cost. However, a comprehensive examination of abdominal organs by ultrasound is often limited by patient's body habitus, bowel gas and small field of view. Although computed tomography (CT) can provide excellent anatomic

detail, its use in pregnancy is undesireable due to the adverse effects of ionizing radiation on the developing fetus.[6] In cases where ultrasound is inconclusive or when further information is required to plan management, another non-ionizing imaging modality such as MRI can be considered. The major shortcomings of ultrasound as mentioned above are overcome by MRI due to its ability to image wide anatomic areas with excellent soft tissue details and multiplanar imaging capability without ionizing radiation.

Although there were initial apprehensions regarding the safety of MRI in pregnancy, the most recent ACR Guidance Document on MR Safe Practices (2013)[7] states that, as the currently available data have not conclusively documented any deleterious effects of MR imaging exposure on the developing fetus, pregnant patients can be accepted to undergo MR scans at any stage of pregnancy, if the risk-benefit ratio to the patient warrants that the study be performed. However, it affirms that MR contrast agents should not be routinely provided as studies have demonstrated that some of the gadolinum-based MR contrast agents readily pass through the placental barrier and enter fetal circulation.

MATERIALS AND METHODS

It was a prospective study in which we studied 40 pregnant patients in whom MRI abdomen and pelvis had been done following equivocal findings at ultrasound. This included patients who had presented with acute abdomen in pregnancy as well as in whom incidental findings had been detected on routine screening ultrasound. 13 of these 40 patients referred had adnexal lesions on both ultrasound and MRI and were analyzed in detail.

Patients who had contraindications to MR imaging such as pacemaker, ferromagnetic surgical clips/staples, cochlear implant or any metallic foreign bodies were excluded from the study.

Prior institutional ethics committee clearance was obtained and informed consent was obtained before every MRI study. MR Images were acquired using GE Signa HD XT 1.5T or Siemens magnetom avanto 1.5T scanners. The sequences performed included T1WI, T2WI, FS T1WI, GRE and DWI in addition to fast sequences such as FS FIESTA/TRUFI, HASTE/SSFSE and SPGR performed in multiple planes. Gadolinum contrast agents were not utilized for any of the cases included in the study.

All patients with adnexal masses were followed up and clinical course and final diagnosis were noted. Total 11 of the 13 patients were operated upon and the histopathological diagnosis obtained. Two patients with obviously benign lesions on MRI were managed conservatively and followed-up till the postpartum period.

RESULTS

Adnexal lesions were present in 13 of the 40 pregnant patients (32.5%) in whom ultrasound and MRI abdomen and pelvis had been performed. The 13 patients with adnexal lesions were studied in detail and findings at ultrasound and MRI compared and compared with follow-up.

A little more than half of the 13 patients (53%, n = 7) presented during the second trimester,followed by 38% patients (n = 5) in the first trimester, with a mean gestational age of presentation at 17.6 weeks

Total 9 of the 13 patients had abdominal pain/discomfort which was the primary indication for ultrasound while in four patients an adnexal mass was incidentally diagnosed during routine antenatal ultrasound assessment. The patients were referred to MRI for further characterization of the adnexal lesions detected on sonography.

The organ of origin of the adnexal pathology was correctly identified by MRI in all patients, while ultrasound was able to correctly localise the organ of origin in 61% of cases (8/13) (Table 1). Of the 12 ovarian lesions, ultrasound was able to definitively establish the ovarian origin in only seven cases, primarily due to non visualization of ovaries in the remaining cases.

Ultrasound findings in 13 patients included 10 cases presenting with complex cystic lesions, two with solid lesions and one patient who was referred with bilateral enlarged multicystic ovaries.

Of the 10 patients with complex adnexal cysts, seven patients were reported as having benign appearing ovarian lesions on MRI. Of these, five were confirmed at surgery, including two cases each of serous cystadenoma and mature cystic teratoma and one endometriotic cyst. One patient with hemorrhagic corpus luteal cyst diagnosed on MRI was managed conservatively. Another case which had the appearance of a complex cyst on ultrasound was revealed to be a torsed ovary on MRI, a finding confirmed at surgery.

Three patients with sonographically detected complex cysts showed features of malignancy on MRI which were established subsequently with histopathological correlation, namely a case each of clear cell carcinoma, borderline serous and borderline mucinous neoplasms.

Both the patients who had solid adnexal lesions on ultrasound had clinically presented with abdominal pain. On ultrasound a large heterogenous solid lesion separate from the ovaries was seen in one of the cases, raising the possibility of a subserosal fibroid. MRI additionally revealed the presence of red degeneration within the fibroid (Fig. 1), thus explaining the etiology of the pain.

Table 1: Comparative findings of ultrasound and MRI in correlation with final diagnosis including histopathological diagnosis and follow-up

S. no	*Ultrasonography (USG) findings*	*MRI findings*	*Final diagnosis*	*Management and follow up*
1.	Right complex ovarian cyst	Malignant right ovarian neoplasm	Right clear cell carcinoma	Salpingo oopherectomy. MTP
2.	Right ovarian complex cyst	Right endometriotic cyst	Right endometriotic cyst	Cystectomy done at time of caesarean section
3.	Right ovarian complex cyst	Right ovarian cystic lesion - likely malignant	Right borderline mucinous tumor	Oopherectomy, term delivery
4.	Right ovarian complex cyst	Right ovarian dermoid	Right mature cystic teratoma	Oopherectomy, term delivery
5.	Left complex adnexal cyst	Benign left ovarian cyst	Left benign serous cystadenoma	Laparoscopic cystectomy term delivery.
6.	Large midline pelvic cyst - ? ovarian origin	Benign right ovarian cyst	Right benign serous cystadenoma	Cystectomy, term delivery
7.	Right ovarian cyst with ? torsion	Malignant right ovarian cyst with torsion	Right borderline serous tumour with torsion	Cystectomy, term delivery
8.	Left adnexal complex cyst	Left ovarian dermoid	Left mature cystic teratoma	Cystectomy, term delivery
9.	Right adnexal complex cyst	Right ovarian torsion	Right ovarian torsion	Oopherectomy, term delivery
10.	Right ovarian complex cyst	Right hemorrhagic corpus luteal cyst	Right hemorrhagic corpus luteal cyst	Conservative management with imaging follow-up term delivery
11.	Heterogeneous lesion in pelvis - ? ovarian origin	Left ovarian mass with torsion	Left immature teratoma with torsion	Oopherectomy followed by chemotherapy. IUD
12.	Large heterogeneous subserosal fibroid	Red degeneration of subserosal fibroid	Red degeneration of subserosal fibroid	Term delivery Myomectomy done after delivery
13.	Bilateral hyperstimulated ovaries	Bilateral hyperstimulated ovaries	Bilateral hyperstimulated ovaries	Conservative management with imaging follow up term delivery

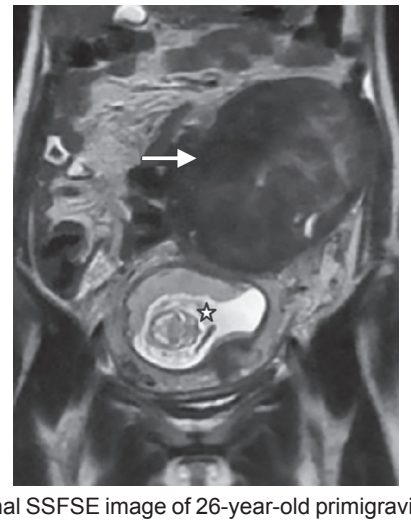

Fig. 1: Coronal SSFSE image of 26-year-old primigravida presenting with acute abdomen shows a large subserosal fibroid with red degeneration (white arrow) abutting the gravid uterus (star). A heterogeneous subserosal fibroid was detected on ultrasound, MRI ad

Fig. 2: Coronal MRI of 22-year-old primigravida in second trimester presenting with abdominal pain. Ultrasound had showed a heterogenous solid pelvic lesion, both ovaries could not be visualized separately. Coronal FS TRUFI image shows a left ovarian

The other patient who presented with solid heterogenous lesion on ultrasound showed a twisted left malignant ovarian mass with solid, cystic and hemorrhagic areas at MRI (Fig. 2) which was subsequently found to be an immature teratoma with changes secondary to torsion. A primigravida who had undergone ovulation induction for primary infertility and presented with abdominal pain in the first trimester was diagnosed to have bilateral enlarged multicystic ovaries on ultrasound raising the possibility of hyperstimulation. In view of persistent pain, the patient was referred to MRI to rule out the possibility of torsion and MRI confirmed the presence of hyperstimulated ovaries and excluded torsion.

Of the three patients finally diagnosed with torsion, ultrasound raised the possibility of torsion in only one patient, whereas MRI detected features of torsion in all three.

Following MRI, nine patients underwent surgery for removal of lesion during the ongoing pregnancy before childbirth, ovarian cystectomy was performed concurrently at the time of caesarean section in one patient and surgery was deferred until after delivery in another case. Two patients were managed conservatively with imaging follow-up till the postpartal period; this included a case of hyperstimulated ovaries and one case of hemorrhagic corpus luteal cyst.

Of the 13 patients, eleven patients had otherwise uneventful pregnancies with subsequent delivery of healthy fetus. This included patients with borderline serous and mucinous tumors who had undergone successful tumor resection during pregnancy. The 23 year old primi with clear cell carcinoma underwent medical termination of pregnancy in the first trimester. The patient with torsed immature teratoma suffered intrauterine fetal demise while under chemotherapy regimen after surgery.

DISCUSSION

With widespread prevalence of antenatal ultrasound, the number of adnexal masses detected during pregnancy has increased, presenting a clinical challenge to the obstetrician. Ultrasound may not always provide adequate information required to plan the further course of management, whereas MRI can provide additional data to overcome the limitations of ultrasound. The utility of MRI in characterization of adnexal masses in nonpregnant women in whom ultrasound is indeterminate has been widely demonstrated.[8-9] In 2006, Saroja et al. assessed the ability of MRI to characterize sonographically indeterminate adnexal masses. They analyzed the origin of the mass, tissue content and characteristics of benignity *vs* malignancy. They reported sensitivity of MRI for detecting malignancy at 100% and specificity for identifying benignity at 94%. Excellent correlation was seen between MRI findings and the final diagnosis of lesion origin and tissue content in comparison to sonography which had poor agreement with the final diagnosis.[10] In pregnancy, MRI plays an even more vital role as it decides the feasibility of expectant management versus need for surgical intervention.

The MRI can clearly identify the site of origin of an adnexal mass by delineating the uterine, ovarian or tubal origin. In our study, MRI was able to localize the origin in all cases, including five ovarian lesions in whom ultrasound was unable to definitively establish the ovarian origin primarily due to ovarian non visualization in advanced gestational age.

The morphological characteristics of a complex cystic or solid adnexal lesion are better described on MRI studies. The most important advantage offered by MRI is in characterizing lesions as benign or malignant which will ultimately help in deciding patient management (ie. deciding between conservative and surgical intervention).

Features suggesting benignity of a complex cystic lesion on MRI include, smooth, featureless walls, presence of thin septa and fat fluid levels and lack of mural nodules.

Hemorrhage within an adnexal lesion or cyst may present a solid appearance on ultrasound examination. MRI using sequences like GRE and FS T1 WI can accurately identify hemorrhage which is extremely useful in the diagnosis of endometriotic or hemorrhagic cysts and hence determine patient management. The presence of T2 shading (due to blood products of different ages) and T2 dark spot (chronic hemorrhage) have been found to have high specificity in distinguishing endometriomas from non-endometriotic hemorrhagic cysts which otherwise have similar signal characteristics on T1 and T2 weighted images.[11] Similarly, in our study, one case each of endometriotic and hemorrhagic corpus luteal cysts were identified based on high signal on T1WI and presence of T2 shading.

Demonstration of fat or fat- fluid level within the ovarian lesion on MRI using T1, T1 fat saturation sequences and chemical shift imaging allows characterization of the lesion as a teratoma.[12] At MR imaging, fat components show high signal intensity on T1 weighted images which gets suppressed on fat suppression sequences (unlike the T1 hyperintensity of a hemorrhagic cyst). In our study, two patients had ovarian lesions with fat fluid levels based on which diagnosis of dermoid was made, a finding later confirmed with histopathological examination. In such cases of benign teratomas without additional solid or hemorrhagic components (which would suggest malignancy), the timing of surgical intervention can be decided upon based on other patient factors such as gestational age, while keeping in mind potential complications such as rupture and torsion.

The presence of an exophytic T1 and T2 hypointense lesion raises the possibility of a subserosal or pedunculated fibroid. Moreover, features of red degeneration such as peripheral or diffuse high signal intensity on T1-weighted images secondary to hemorrhage can also be conclusively demonstrated. In our study, MRI detected the presence of red degeneration in a primigravida presenting with abdominal pain.

Recognition of mural nodule, papillary projections, thick septations or solid components within an ovarian cyst on MRI favors the likelihood of malignant etiology.[13] Three cases in our study showed such features on MRI

Fig. 3: MRI of 23-year-old primigravida with incidentally detected complex ovarian cyst on early pregnancy scan. Sagittal FRFSE image shows large right ovarian cystic lesion(star) with mural nodules and papillary projections(white arrows)along the periph

(Fig. 3) raising the possibility of malignancy, which warranted early surgical intervention due to risk of tumour spread.

Thomassin-Naggara et al. in 2016 studied 36 adnexal lesions in 31 pregnant women in whom MRI had been performed following detection of an adnexal lesion on ultrasound. This included 27 benign and nine malignant lesions. They reported increased sensitivity and specificity of MRI as compared to ultrasound in the evaluation of these adnexal lesions. No malignancy was categorized as benign using MR criteria.[14]

Both benign and malignant lesions can be complicated by torsion. The identification of the twisted ovarian/tubo-ovarian pedicle is the most specific sign of torsion which can be clearly demonstrated on MRI due to its multiplanar capability. Three cases of ovarian torsion were diagnosed by MRI by identification of enlarged ovary with twisted pedicle. Associated parenchymal hemorrhage was also identified in one of the cases.

In our study, MRI played a crucial role in deciding the course of management in all cases that required further characterization of a sonographically detected adnexal lesion in pregnancy. Gadolinum contrast agents were not utilized for any of the cases. The relatively small sample size was the primary limitation to our study.

CONCLUSION

Adnexal masses discovered in pregnancy present a clinical and imaging challenge. Although sonography is the primary imaging tool in evaluating obstetric patients, in selected cases where ultrasound is equivocal or indeterminate, MRI can serve as a problem solving tool to attain accurate diagnosis, delineate benign and malignant entities and guide patient management.

CLINICAL SIGNIFICANCE

In obstetric patients requiring further characterization of adnexal masses discovered during ultrasound, MRI can help decide the course of management by delineating benign and malignant entities and dictating the need for surgical intervention versus feasibility of conservative treatment.

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