

Diagnostic value of MRI in ovarian masses detection and characterization

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Abstract

Background: Ovarian masses are late symptomatic so early detection and characterization of the ovarian neoplasm is very important for adequate therapeutic procedure, this starts from the physical examination to the imaging technique and laboratory investigations. MRI show high contrast resolution so MRI gives proper detection and differentiation of benign and malignant ovarian masses by the utility of different sequences like conventional MRI imaging, To obtain anatomical data and study the different signal intensities of the ovarian lesions T1 and T2 sequences are needed, T1 SPIR to assess the hemorrhagic and fatty areas, MRI with Gadolinium enhance the MRI ability to differentiate between benign and malignant ovarian masses, tumor staging and follow up. Diffusion-weighted imaging and proton MRI spectroscopy are a functional MRI sequences increase MRI sensitivity and specificity in diagnosis of ovarian lesions.

Conclusion: MRI is considered solving problem imaging modality in early determine the site and characterize the ovarian masses, also it is helpful at ovarian tumor staging.

Keywords: Ovary, Magnetic resonance imaging, Dynamic contrast-enhanced MRI, Diffusion-weighted imaging DWI, Proton MRI spectroscopy.

Introduction

Ovarian masses are more common findings incidentally detected or identified in symptomatic patients in every day work and how to characterize them is real diagnostic challenge; this is of great importance in the preoperative assessment in order to obtain adequate surgical management (Foti et al., 2016).

MRI is a modality of choice in solving this problem due to its high

tissue contrast so MRI has high sensitivity, specificity and accuracy in comparison with other imaging modalities (Taj-Aldean et al., 2017). To obtain anatomical data and study the different signal intensities of the ovarian lesions T1 and T2 sequences are needed, T1 SPIR to assess the hemorrhagic and fatty areas, MRI with Gadolinium enhance the MRI ability to detected enhanced septae, soft tissue content, tumor staging and follow up

(Iyer and Lee et al., 2010). Also MRI diffusion as a qualitative analysis of ovarian masses increases the sensitivity and specificity of MRI in ovarian masses detection, characterization, and staging and follows up. Apparent diffusion coefficient (ADC) is a quantitative assessment of the ovarian masses (Rajasri et al., 2016).

MRI imaging Protocol

Imaging of ovarian masses is performed by phased array body coil while the patient is supine. Coronal localizer using a fast sequence gives anatomic overview of the abdomen and pelvis. Then we gain the following sequences:

- Axial T1 weighted image and axial T1 fat suppressed sequence (T1 SPIR)
- Axial, coronal and sagittal T2 weighted image to evaluate the ovarian stroma, follicles and multiple uterine zones.
- Axial Short T1 Inversion Recovery (STIR) evaluates the fluid and edema, demonstrate the fatty component of the lesion.(Ma, 2004), (Proscia et al., 2010).

Diffusion Weighted Image (DWI) with b value (0, 500, 800, and

1000s/mm²) helpful in differ benign from malignant ovarian masses by restriction (high signal) and low signal at ADC of the septae and soft tissue components of the malignant masses, also it helpful in tumor staging and follow up. quantitative measurement of ADC values in a region of interest is helpful to differentiate benign from malignant ovarian masses (Coats et al., 2009). Multiphase contrast-enhanced imaging is performed to detect the enhanced septae and soft tissue components of the lesion (Namimoto et al., 2009).

Proton MR spectroscopy is additional MRI sequence to differentiate benign from malignant ovarian masses based of the organic compounds of the living tissues (Choi et al., 2001).

MRI criteria of benign ovarian masses:

MRI criteria are: Size of the lesion less than 6 cm, no of few thin septae (< 3 mm), no vegetations, and no soft tissue components. No enhancement post contrast. Lesion hypo intense at T2 and DWI. High ADC value (Fig 1).

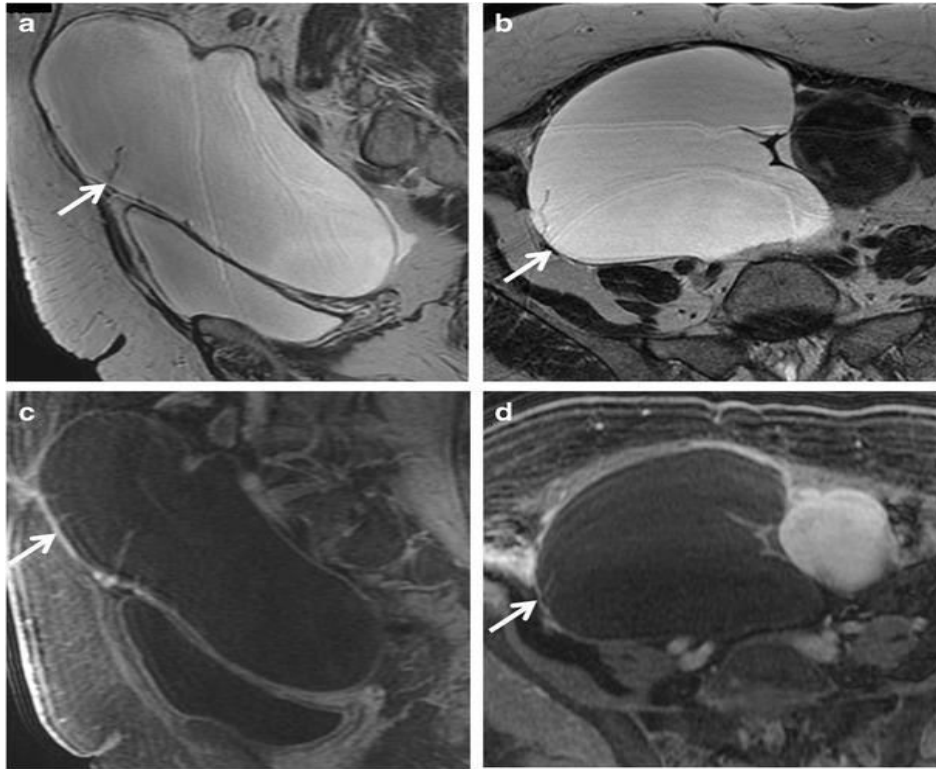


Fig.1. Serous cystadenoma in a 64-year-old woman. (a) Sagittal and (b) axial T2-weighted images show a hyper intense unilocular cystic mass (*white arrows*). On (c) sagittal and (d) axial contrast-enhanced fat-suppressed T1-weighted images, the cyst wall shows poor contrast enhancement (*white arrows*) without vegetations, nodularity, or solid components (Foti et al., 2016).

MRI criteria of malignant ovarian masses

MRI criteria are: size of the lesion more than 6 cm, presence of septation (> 3 mm) thickness. Presence of vegetations (> 3 mm). Presence of soft

tissue components. Enhancement of septae/soft tissue component post contrast. Lesion intermediate signal at T2 and hyper intense at DWI. Low ADC value (Fig. 2).

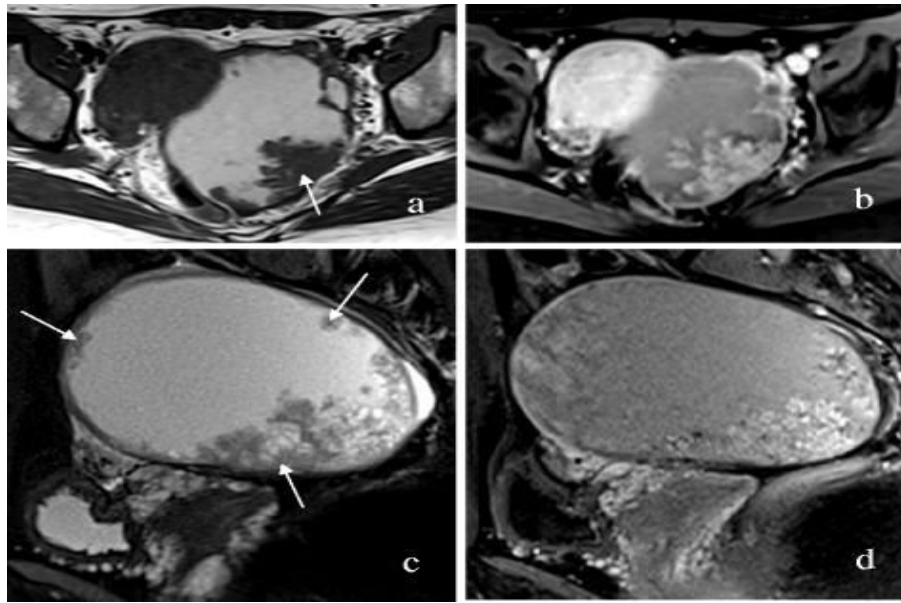


Fig. 2. A 32-year-old woman with left-sided ovarian epithelial carcinoma. Axial and sagittal T2WI (a, c) demonstrate a mainly cystic mass with multiple mural nodules (arrows). Axial and sagittal contrast-enhanced T1WI with fat suppression (b, d) show that the nodules are moderately enhanced (Li et al., 2015).

Dynamic contrast-enhanced MRI

Dynamic contrast enhanced MRI added much to the diagnostic accuracy of ovarian masses as it provide information about the angiogenesis (the blood flow as well as vascular

permeability) of the malignant masses, characterize the internal architecture, demonstrate the septation, soft tissue components and necrotic areas (Fig. 3).(Dogheim et al., 2014), (Priest et al., 2010).

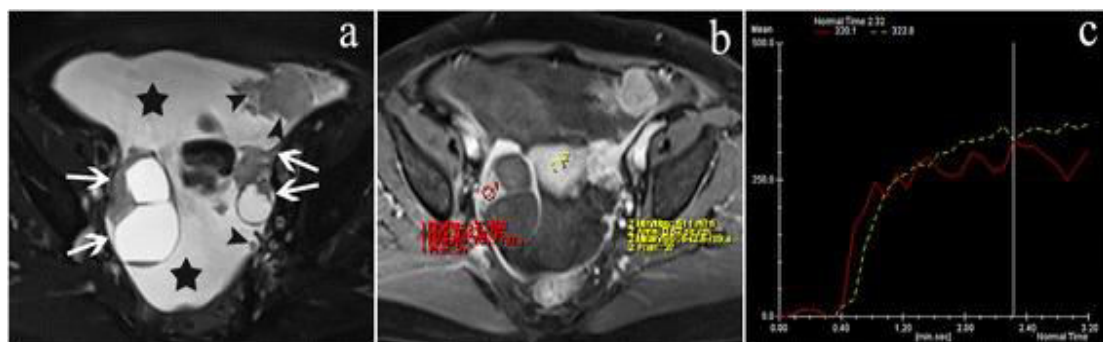


Fig. 3. A 60-year-old woman with ovarian high-grade serous adenocarcinoma. Axial T2WI with fat suppression (a) demonstrated bilateral ovarian masses (white arrow) with peritoneal seeds (black arrowheads) and a large volume of ascites (asterisk). The mural nodule (red ROI) showed obvious contrast enhancement compared with the myometrium (yellow ROI) on contrast-enhanced T1WI with fat suppression (b). The mural nodule showed a curve of type III (a rapid rising and plateau pattern) (c) (Li et al., 2017).

Diffusion-weighted imaging (DWI)

DWI increase the sensitivity, specificity and accuracy of MRI in

differentiating between benign and malignant ovarian masses, detect peritoneal implants, tumor staging and

follow up (Kyriazi et al., 2010). Ovarian lesion intermediate signal at T2 and hyper intense at DWI more likely to be malignant ovarian lesion (Thomassin-Naggara et al., 2009). DWI based on the free movement of the water molecule (the Brownian motion). The strength of the diffusion is the (b) value. Multiple B values are used in scanned the masses of interest (0, 500, 800, and 1000s/mm²), the b value 0 and 500 not assessed due to less diffusion and larger T2 shine through effect however they used to provide ADC map with good resolution and accurate measurement of the ADC value (Coats et al., 2009). Whenever ADC value depend on the free movement of the water molecules, increase tissue cellularity as in malignant tumors will decrease the water molecule movement hence it will reduce the ADC value (Fig. 4), also in abscesses, some endometrioma ADC value is low due to the pus under tension (in abscesses) and deoxyhemoglobin and met hemoglobin (in endometrioma) will decrease the water molecule movement (Tamai et

al., 2008), (Mohaghegh and Rockall et al., 2012), (Imaoka et al., 2006).

The mean ADC for benign ovarian masses was $1.2 + 0.34 \times 10^{-3} \text{ mm}^2/\text{s}$, for borderline masses was $1.1 + 0.06 \times 10^{-3} \text{ mm}^2/\text{s}$, and for malignant tumors $0.83 + 0.15 \times 10^{-3} \text{ mm}^2/\text{s}$ (Mansour et al., 2015). The ADC cut-off of $1.1 \times 10^{-3} \text{ mm}^2/\text{s}$ that discriminate between benign and malignant ovarian lesions (Van Nimwegen et al., 2020).

Proton MRI Spectroscopy

MR Spectroscopy give information about the tumor metabolite that will help in differentiate between benign and malignant tumors, assist the tumor grading and understand the tumor biochemical pathway (Choi et al., 2001).

In benign ovarian masses there is high concentration of N-acetyl-L-aspartic acid (NAA) (Mahon et al., 2004). (Fig. 5). While in malignant ovarian masses higher concentrations of leucine, valine, threonine, lactate, acetoacetate, glutamine and choline and glycoprotein (Hagberg and Siegbahn et al., 1983). (Fig. 6).

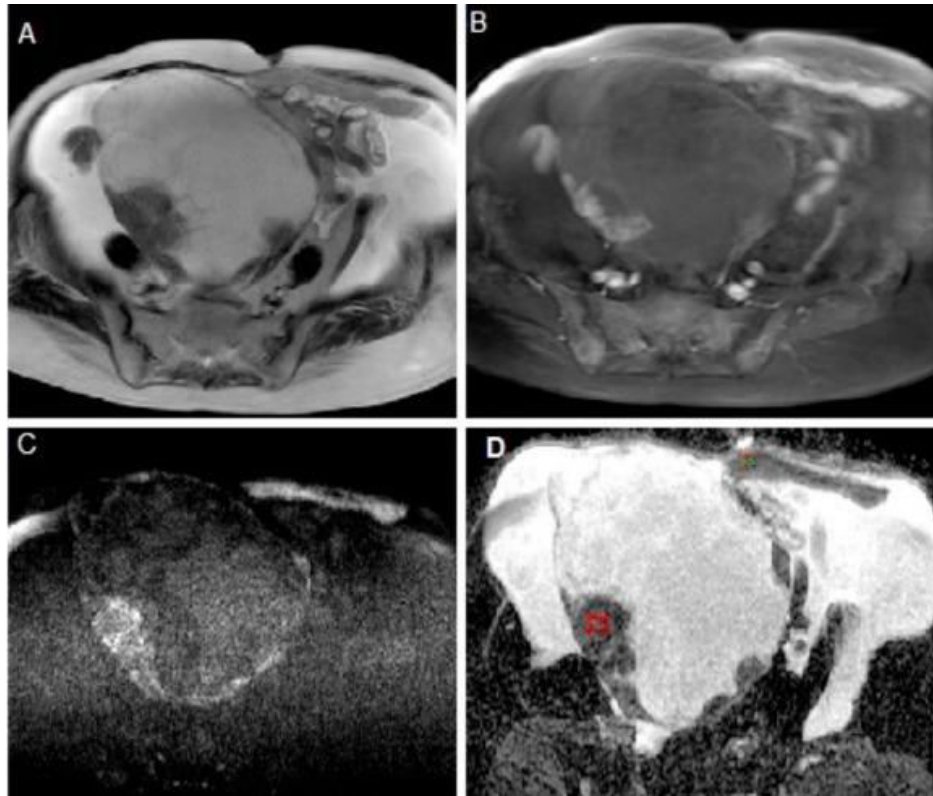


Fig. 4. Right ovarian serous cystadenocarcinoma in 64-year-old woman with peritoneal implant & ascites, presented with abdominal enlargement. (A) An axial T2-weighted image shows complex mass with low signal solid component. (B) Contrast-enhanced T1-weighted image demonstrates the enhancing solid component. (C) & (D) Axial diffusion-weighted imaging (DWI) & ADC map showing restricted pattern of the solid part and also the left iliac peritoneal implant with low ADC values $0.8315 \times 10^{-3} \text{ mm}^2/\text{s}$ & $1.072 \times 10^{-3} \text{ mm}^2/\text{s}$ respectively, while the cystic component show free diffusion pattern and high ADC value $2.214 \times 10^{-3} \text{ mm}^2/\text{s}$ (Tantawy et al., 2018).

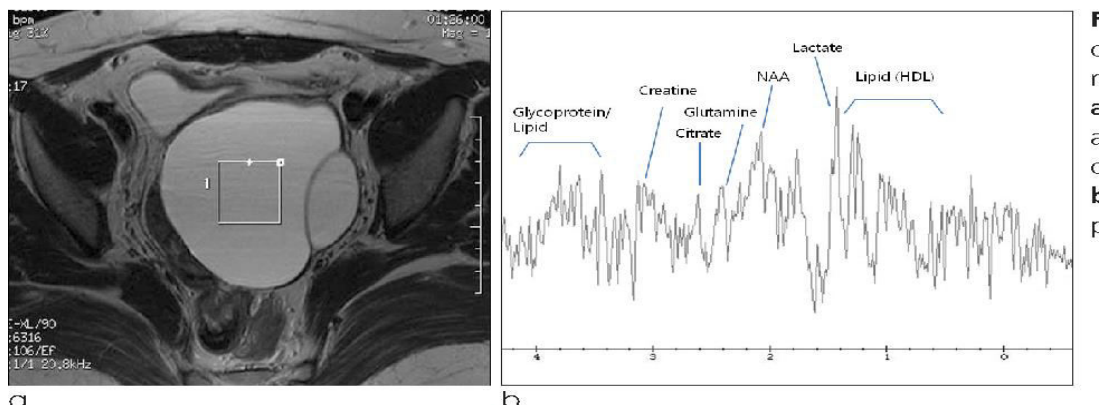


Fig. 5. 53-year-old women with serous cystadenoma (TR=3157 m sec, TE=35m sec). a. Axial T2-weighted MR image shows lesion of homogeneous hyperintense cystic mass without solid component. b. On MRS, there is no detectable peak (Kang et al., 2013).

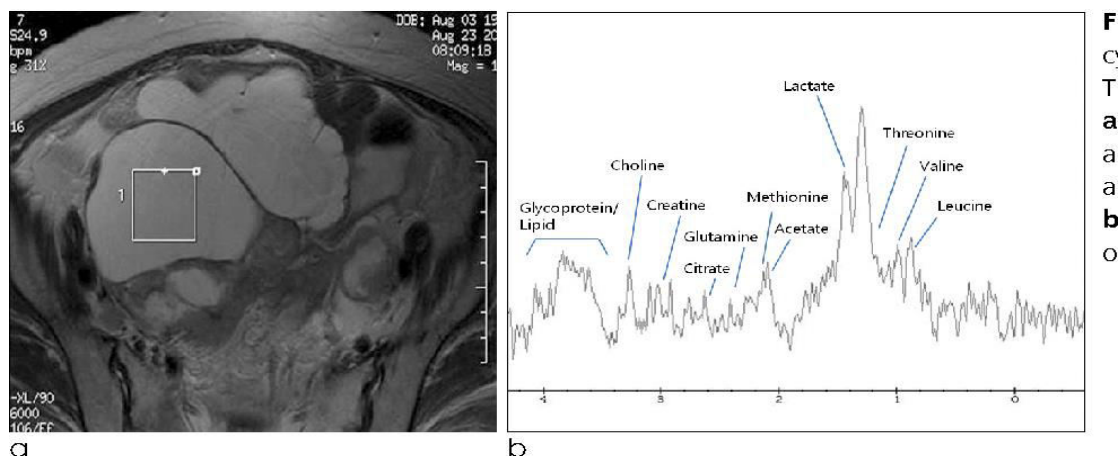


Fig. 6. 69-year-old women with serous cystadenocarcinoma (TR = 3157 m sec, TE=35 m sec). a. Axial T2-weighted MR image shows septated cystic mass with thick septa and solid lesion. b. On MRS, double peaks (asterisk) are observed around 1.3 ppm (Kang et al., 2013).

Conclusion

Ovarian masses have different appearance; cystic, complex (cystic and solid) and solid masses. Cystic masses consider benign while complex or solid masses considered malignant in the presence of malignant features (thick septations > 3 mm, inner wall vegetations > 3 mm, enhanced solid components, ascites, peritoneal implants, visceral metastasis,) by imaging modalities. Even small soft tissue component in the malignant ovarian mass can behave in aggressive malignant behavior hence the challenge in early tumor detection is essential. Conventional MRI is solving tool in this challenge, addition of other functional imaging sequences like DWI, ADC and MRI spectroscopy increase MRI sensitivity and specificity in detection of malignant ovarian masses.

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