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Original Research Article

Assessing ability of dynamic contrast-enhanced MRI (DCE–MRI), and Diffusion-weighted image (DWI) to describe uncertain ovarian masses

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Abstract

Aim: The aim of the present study was to assess the ability of dynamic contrast-enhanced MRI (DCE–MRI), and Diffusion-weighted image (DWI) to describe uncertain ovarian masses.

Methods: The present study was conducted in department of radiology and we did transabdominal ultrasound and transvaginal ultrasound for all cases. We investigated 50 patients with 50 adnexal lesions.

Results: The patient's age ranged from 20 to 78 years old (mean 43.56 years). The main complaint was abdominal pain and/or abdominal distension; other cases came with different symptoms as subfertility or irregular vaginal bleeding. The histopathology of the assessed masses were 21 benign, 4 borderline, and 25 malignant. The age range for patients with benign tumors was 20 - 65 years (mean 39 ± 13 years) while those with malignant tumors, their age range was 21- 78 years (mean 46 ± 16.953 years). Benign masses included seven serous cystadenoma, six mucinous cysadenoma, three mature cystic teratoma, two ovarian fibroma, and fibrothecoma, and one tubo-ovarian abscess. There were four Borderline tumors (two serous and two mucinous). There were 25 invasive malignant masses (Nine Serous cyst-adenocarcinoma, six Mucinous cyst-adenocarcinoma, three Metastatic krukenburg, three Immature teratoma, two fibrosarcoma, and two clear cell carcinoma).

Conclusion: DCE-MRI and DWI have accepted ability to distinguish between benign and malignant ovarian mass.

Keywords: Ovarian, contrast, diffusion, MRI

Introduction

Ovarian tumors are a group of neoplastic lesions showing a wide and varied spectrum of features according to the specific tumor entity. They can be categorized as benign, low-malignant potential/borderline and malignant subtypes [1-3]. The World Health Organization (WHO) provided classification of the ovarian masses based on their histogenetic principles, hence categorizing them with regard to their derivation from coelomic surface epithelial cells (75% of all ovarian neoplasms), germ cells (15–20%), and mesenchyme (the stroma and the sex cord; 5–10%). Metastatic lesions usually arising from breast, colon, endometrium, gastric and cervical cancers, constitute 5% of ovarian neoplasms [4].

Ovarian masses become a diagnostic challenge, when proper categorization into benign or malignant masses can't be reached by imaging [5]. Accurate characterization is greatly valuable for appropriate patient's management, especially young women for whom conservation of fertility is mandatory and can be achieved via conservative surgical approaches [6]. Ultrasonography (US) shows limitations in characterization and staging despite being the first-line imaging modality for suspected adnexal masses [7]. Magnetic resonance (MR) imaging has shown great accuracy in the detection and discrimination of adnexal masses. In particular, contrast- enhanced MR can depict the lesion's intrinsic architecture with great detail [8]. Dynamic enhanced imaging (DCE-MRI) has added to the

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diagnostic accuracy of these masses, due to its capacity to characterize tumor microcirculation and angiogenesis in malignant tumors [9, 10]. It depends on contrast medium leakage from capillaries into the extravascular extracellular space, therefore enabling quantitative analysis with information on the blood flow as well as vascular permeability [11]. It allows proper characterization of internal architecture, delineation of necrotic areas, solid components, papillary projections, septations, and peritoneal implants [12]. It is likely to play a major role in the evaluation of ovarian malignancy, by acting as a predictive and prognostic tool [13]. Earlier reports on the ability of DWI to recognize malignant ovarian tumour have found that DWI is not useful [14, 15]. Later reports found that DWI is useful in discrimination between benign and malignant ovarian mass [7, 16, 17]. A more recent study found a sensitivity of 84%, and a specificity of 89% [18].

The aim of the present study was to assess the ability of dynamic contrast-enhanced MRI (DCE–MRI), and Diffusion-weighted image (DWI) to describe uncertain ovarian masses.

Materials and Methods

The present study was conducted in department of radiology and we did transabdominal ultrasound and transvaginal ultrasound for all cases. We investigated 50 patients with 50 adnexal lesions.

We pursue the International Ovarian Tumor Analysis (IOTA) rules to characterize ovarian mass [19]. MR assessment was done at the magnetic resonance unit. We used 1.5 Tesla machine with body coil as a transmitter and a receiver of radio frequency signals. The MR assessment included T1WI, T2WI, post-contrast fat-suppressed T1WI, and DWI. DWI was done at b0, b500, b1000. Descriptive analysis was done. Data from the MR assessment included the mean size of the cyst or mass, the ADC value, and the morphologic criteria suggesting malignancy. We had executed an individual analysis for conventional MRI, DCE-MRI and DWI concerning their diagnostic performance in the characterization of ovarian masses/cysts. Masses are sent for histopathology after operations.

Statistical analysis

All statistical calculations were done using SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15 for Microsoft Windows. Data were statistically described in terms of mean ± standard deviation (± SD) and range, or frequencies (number of cases) and percentages when appropriate. Comparison of numerical variables between the study groups was done using Student t test for independent samples. Chi square (v2) test was performed for comparison of categorical data. Fisher exact test was used instead when the expected frequency was <5. Accuracy was represented using the terms sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy. p values < .05 were considered statistically significant.

Results

Table 1: Patient details

Variables	N%
Complaints	
Abdominal pain	45 (90)
Sub fertility or irregular vaginal bleeding	5 (10)
Histopathology of assessed masses	
Benign	21
Borderline	4
Malignant	25

The patient's age ranged from 20 to 78 years old (mean 43.56 years). The main complaint was abdominal pain and/or abdominal distension; other cases came with different symptoms as subfertility or irregular vaginal bleeding. The histopathology of the assessed masses were 21 benign, 4 borderline, and 25 malignant. The age range for patients with benign tumors was

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20 - 65 years (mean 39 ± 13 years) while those with malignant tumors, their age range was 21- 78 years (mean 46 ± 16.953 years).

Table 2: Different ADC values of the included masses

	N	ADC Values
Benign n=21		1.2 - 2 × 10−3 mm2/sec
Serous cystadenoma	7	1.4 - 2 × 10−3 mm2/sec
Mucinous cysadenoma	6	1.3 - 1.5 × 10−3 mm2/sec
Mature cystic teratoma	3	1.2 - 1.5 × 10−3 mm2/sec
Ovarian fibroma	2	1.6 - 1.8 × 10−3 mm2/sec
Fibrothecoma	2	1.2 × 10−3 mm2/sec
Tubo-ovarian abscess	1	1.3 × 10-3 mm2/sec
Borderline n=4		
Serous	2	1.1 - 1.5 × 10−3 mm2/sec
Mucinous	2	1.2 × 10−3 mm2/sec
Malignant n=25		0.7 - 1.2 × 10−3 mm2/sec
Serous cyst-adenocarcinoma	9	0.7 - 1 × 10−3 mm2/sec
Mucinous cyst-adenocarcinoma	6	0.9 × 10−3 mm2/sec
Metastatic krukenburg	3	1.2 × 10−3 mm2/sec
Immature teratoma	3	0.9 × 10−3 mm2/sec
Fibrosarcoma	2	1.1 × 10−3 mm2/sec
Clear cell carcinoma	2	0.8 - 0.9 × 10−3 mm2/sec

Benign masses included seven serous cystadenoma, six mucinous cysadenoma, three mature cystic teratoma, two ovarian fibroma, and fibrothecoma, and one tubo-ovarian abscess. There were four Borderline tumors (two serous and two mucinous). There were 25 invasive malignant masses (Nine Serous cyst-adenocarcinoma, six Mucinous cyst-adenocarcinoma, three Metastatic krukenburg, three Immature teratoma, two fibrosarcoma, and two clear cell carcinoma). ADC values of malignant tumors showed a minimum of 0.7 × 10−3 mm2/s and a maximum of 1.2 × 10−3 mm2/s. The mean (±SD) was 1.01 × 10−3 mm2/s (±0.34), while ADC values of the benign masses showed a minimum of 1.2 × 10−3 mm2/s and maximum of 2 × 10−3 mm2/s with mean ±SD 1.6 × 10−3 mm2/s (±0.27).

Table 3: Analysis of the ovarian lesions size

Dimension	Benign	Borderline	Malignant
Minimum	4.5 cm	6 cm	7 cm
Maximum	15 cm	22 cm	25 cm
Mean ± SD	9.7 ± 3.3	14 ± 7.3	13.7 ± 5.08

The malignant and borderline ovarian lesions were bigger than the benign lesions.

Table 4: The performance of the preoperative diagnosis

	Ultrasound	Conventional MRI	DCE-MRI	DWI
TP	20	23	24	26
FN	6	3	2	0
FP	6	5	2	1
TN	12	13	16	17
Sensitivity	76.9%	88.5%	92.3%	100%
Specificity	66.6%	72.2%	88.8%	94.4%
PPV	76.9%	82.1%	85.7%	96.3%
NPV	66.6%	81.2%	88.8%	100%
Accuracy	81.8%	81.8%	90.9%	97.7%

The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy for DWI were 100%, 94.4%, 96.3%, 100%, and 97.7% respectively. The performance of

DWI was higher than the conventional MRI and DCE-MRI.

Discussion

MRI has a pivotal and established role in detection and staging of gynaecological malignancy. The exquisite soft tissue resolution of MRI allows accurate demonstration of tumour size, location, extension and nodal involvement. Despite excellent clinical utilisation to date, conventional T1 and T2 sequences cannot provide information about tumour microenvironment and have limitations in assessing response of tumours to therapy and in particular, differentiating residual or recurrent disease from post-treatment fibrosis due to overlap of morphological appearances [20]. Functional MRI has evolved over recent years with the development of stronger field strengths, receiver coils and pulse sequences and has proven benefit in cerebral, breast and rectal cancers [21].

Conventional MRI assesses morphologic criteria of the lesion, such as wall thickening, intra luminal papilla, mural nodules, thick septae, and signal intensity on T1WI and T2WI. None of these criteria can consistently segregate benign from malignant lesions. Development of novel MRI modalities like DCE MRI and DWI improves the diagnostic performance of MRI [22]. We had executed an individual analysis for conventional MRI, DCE-MRI and DWI concerning their diagnostic performance in the characterization of ovarian masses/cysts. We found that conventional MRI had 88.5% sensitivity and 72.2% specificity. This looks well with a meta-analysis of the value of MRI in characterization of ovarian mass/cyst in women with non-conclusive ultrasound evaluation. They found that the sensitivity and specificity was 76% and 97%, respectively. We found that DCE-MRI had 92.3% sensitivity and 88.8% specificity. This compares favourably to conventional MRI in our study. So, adding DCE to the MRI increased the accuracy of examination. Systematic review showed that DCE-MRI has 81% sensitivity and 98% specificity [23]. However, a more recent study showed 83% sensitivity and 75% specificity [24]. Malignant masses showed more intense enhancement than benign lesions. Difference was clearer in the early phase of the contrast study than the late phase [25, 26].

Our analysis revealed that DWI has 100% sensitivity, 94.4% specificity, 96.3% PPV, 100% NPV, and 97.7% accuracy. The performance of DWI was higher than conventional MRI and DCE-MRI. We found that all malignant lesions and one case of dermoid cyst demonstrated a high signal on DWI. This may be ascribed to keratinized substance in dermoid cyst. These results are consistent with the conclusions in the previous researches. They showed that most of the malignant ovarian masses and some of the dermoid cysts had high intensity on DWI. Most of the benign lesions had low signal intensity on DWI [27].

In our study, the mean ADC values for malignant lesions were $1.01 \times 10{-}3 \pm 0.34$ mm2/s). The mean ADC values for benign lesions were ($1.6 \times 10{-}3 \pm 0.27$ mm2/s). Our cut-off value was $1.2 \times 10{-}3$ mm2/s. This agreed with findings by Takeuchi *et al*. They found the mean ADC value was $1.03 \times 10{-}3$ mm2/sin malignant tumors and $1.38 \times 10{-}3$ mm2/s in benign tumor [26]. A meta-analysis of 16 studies showed that DWI is able to distinguish between benign and malignant ovarian tumor with 91% sensitivity and 91% specificity [28].

Conclusion

DCE-MRI and DWI have accepted ability to distinguish between benign and malignant ovarian mass. The majority of published data has evaluated functional MRI and cervical cancer with promising results to date. Some limited studies have shown added value of functional MRI in recurrent endometrial and ovarian cancers. Given that both DCE-MRI and DWI-MRI are noninvasive, readily accessible and without ionising radiation, there are advantages in being able use these techniques to further individualize and benefit patient care.

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