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Role of Diffusion Weighted MRI in Differentiation of Malignant from Benign Ovarian Tumors

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ABSTRACT

Background and Aims: Ovarian masses are common and due to the risk of dissemination, biopsy is not recommended before surgery; thus, imaging techniques can play a crucial role in differentiating benign from malignant lesions. Diffusion weighted magnetic resonance imaging (DW-MRI) is now considered a part of the standard evaluation of pelvis. The aim of this study was to investigate the role of DW-MRI in distinguishing between benign and malignant ovarian tumors and its comparison with pathology results.

Materials and Methods: In this diagnostic study, 85 non-pregnant women of childbearing age with an ovarian mass who were referred to Imam Hossein hospital in 2018 were evaluated. All patients underwent MRI before surgery and apparent diffusion coefficient (ADC) value was calculated for each. In addition, demographic data and postoperative pathology results were recorded. The acquired data were then entered into the SPSS software for statistical analysis.

Results: The mean age of the participants was 39.01 ± 6.98 years. Mean ADC value was calculated as 1.14 ± 0.67 × 10-3 mm2/s. Mean ADC value was significantly lower in malignant lesions compared to borderline and benign ones (P<0.001). Mean ADC value was the highest in cysts and the lowest in metastatic lesions (with the exception of serous cystadenocarcinoma (P=0.267) compared to other types of lesions (P<0.05). The optimal cutoff point for ADC to differentiate between benign and malignant ovarian lesions was 1.16 × 10-3 mm2/s with 95% sensitivity, 100% specificity, 100% positive predictive value (PPV), 98% negative predictive value (NPV), and 99% accuracy.

Conclusion: ADC value in DW-MRI is highly sensitive and specific in differentiation between benign and malignant ovarian tumors.

INTRODUCTION

Ovarian masses are a common clinical finding and may be symptomatic or asymptomatic with incidental detection. In addition, ovarian cancer, as one of the most common types of cancer, is found in 3.6% of women worldwide [1]. Therapeutic procedures differ when ovarian lesions are benign or malignant and this is challenging since many lesions are only found to be malignant during or after surgery based on pathology and not preoperatively. On the other hand, due to the risk of dissemination, biopsy is not recommended before surgery; therefore, imaging techniques can play a significant role in differentiating benign from malignant lesions preoperatively [2]. Many diagnostic imaging techniques have been used to determine the characteristics of malignant ovarian masses, namely ultrasonography (US), computed tomography (CT), and magnetic resonance imaging (MRI) [3]. CT is now considered to be the preferred method due to its efficacy in the assessment of the benignity or malignancy of ovarian masses; however, it involves radiation exposure [4, 5].

MRI can be used to locate the origin of a pelvic lesion and determine the characteristics of an adnexal mass, especially when the lesion is undetermined with regard to malignancy [6, 7]. One of the major advantages of MRI is lack of expo-

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sure to radiation, which is of great importance in women of childbearing age [2]. Furthermore, MRI is 76 % sensitive, and 97 % specific in the diagnosis of ovarian cancer, especially when indeterminate ovarian masses on US are concerned [8]. DWI is also thought to be a helpful technique in the evaluation of ovarian masses. This method basically evaluates the extent of water diffusion in tissues and it can quantitatively measure the random motion of water molecules by ADC values [9, 10]. DW-MRI and ADC have been shown to be effective in differentiating benign from malignant ovarian tumors in multiple studies [11-13]; however, the efficacy of DW-MRI remains controversial, whereas some other studies have found this technique ineffectual in distinguishing between malignant and benign lesions of ovary [14, 15]. Further studies are required to determine the true value of DW-MRI and ADC in this regard; therefore, in this study we have investigated the role of DW-MRI in differentiation of benign from malignant ovarian tumors and appointed a cutoff point for ADC, while calculating its sensitivity and specificity.

MATERIALS and METHODS

Participants

This diagnostic study was conducted in Imam Hossein Hospital, Tehran, in 2018. The study sample consisted of 85 non-pregnant women of childbearing age (15-45 years) in whom an ovarian mass was diagnosed using US or other diagnostic methods. The exclusion criteria were pregnancy and unavailability of postoperative pathology results.

Study Design

This study was performed according to the Declaration of Helsinki issued by the World Medical Association. After obtaining written informed consent and recording demographic data, before surgery, participants underwent conventional MRI using a 1.5 tesla MRI scanner (Avanto, manufactured by Siemens) and DWI sequence was used to calculate ADC. During surgery, a specimen was collectd from the lesion and the pathology finding regarding type and malignancy of the lesion was reported postoperatively. The study was approved by the ethics committee of Shahid Beheshti University of Medical Sciences (IR.SBMU. MSP. REC.1397.27).

Table 1. Frequency of ovarian masses with respect to malignancy and type of lesion

BMI		Number (%)
Malignancy of the tumor	Benign	20 (23.5%)
	Borderline	13 (15.3%)
	Malignant	52 (61.2%)
Types of lesions	Teratoma	15 (17.5%)
	Mucinous cystadenocarcinoma	14 (16.5%)
	Endometrioma	13 (15.3%)
	Cyst	13 (15.3%)
	Adenoma	7 (8.2%)
	Adenocarcinoma	7 (8.2%)
	Germ cell tumor	7 (8.2%)
	Metastatic tumor	4 (4.7%)
	Clear cell carcinoma	3 (3.5%)
	Serous cystadenocarcinoma	2 (2.4%)

Data analysis method

Statistical analysis of data was performed using SPSS software version 25 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to report frequencies, percentages, and mean values. Since age and ADC values were not normally distributed (evaluated by Kolmogorov-Smirnov test), comparison was made using non-parametric tests such as Kruskal-Wallis and Mann-Whitney; however, mean values were used as measures of central tendency in tables. A receiver operating characteristic (ROC) curve was created to calculate sensitivity and specificity.

RESULTS

Sixty-five non-pregnant women of childbearing age with an ovarian mass were evaluated in this study. The mean age of the participants was 39.01±6.98 years. Mean ADC value was calculated as 1.14 ± 0.67 × 10-3mm2/s. Most of the ovarian masses/tumors were malignant (61.2%), followed by benign (23.5%) and borderline (15.3%) lesions. Teratomas were the most common type of ovarian masses (17.6%), followed by mucinous cystadenocarcinomas (16.5%), endometriomas (15.3%), and cysts (15.3%), while serous cystadenocarcinomas were the least common (2.4%) (Table 1). Malignant lesions had the lowest mean ADC (0.70±0.17 × 10-3mm2/s), followed by borderline (1.61±0.54 × 10-3mm2/s), and benign ovarian masses (1.98±0.52 × 10-3mm2/s) (P<0.001). Furthermore, patients with malignant lesion were the oldest (41.25±5.50 years), followed by patients with borderline (37±7.74 years), and benign lesions (34.5±7.65 years) (P<0.001); however, in a two-by-two comparison, the age difference between patients with benign and borderline lesions was not statisti-

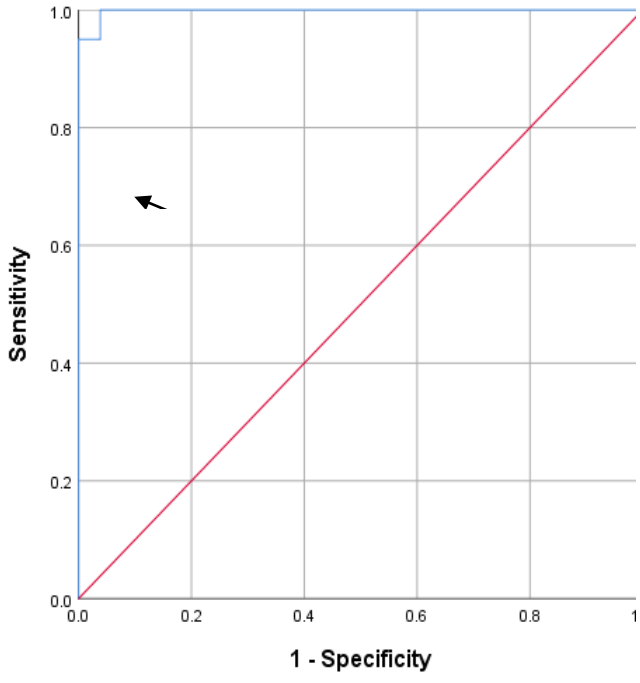

Figure 1. ROC curve of sensitivity and specificity of ADC

Table 2. Comparison of age and ADC values among malignant, borderline, and benign ovarian tumors (SD= Standard deviation)

Malignancy of the tumor	Age (Years) Mean±SD	P-value*	ADC ($\times 10^{-3}$mm^2/s) Mean±SD	P-value*
Benign	34.50±7.65	<0.001	1.98±0.52	<0.001
Borderline	37.00±7.74		1.61±0.54	
Malignant	41.25±5.50		0.70±0.17	

* Analyzed by Kruskal-Wallis test

Table 3. Comparison of ADC values among different types of ovarian masses (SD= Standard deviation)

Types of lesions	ADC ($\times 10^{-3}$ mm^2/s) Mean±SD	P-value*
Cyst	2.25±0.40	<0.001
Endometrioma	1.61±0.54	
Adenoma	1.49±0.31	
Teratoma	0.84±0.81	
Mucinous cystadenocarcinoma	0.71±0.16	
Germ cell tumor	0.68±0.12	
Clear cell carcinoma	0.63±0.15	
Adenocarcinoma	0.61±0.13	
Serous cystadenocarcinoma	0.56±0.08	
Metastatic tumor	0.43±0.06	

* Analyzed by Kruskal-Wallis test

cally significant (P=0.250) (Table 2). Table 3 shows the comparison of mean ADC values among different types of ovarian masses; cysts had the highest, and metastatic tumors the lowest ADC values (P<0.001). Figure 1 shows the ROC curve for the cutoff point of ADC that best differentiates malignant from benign ovarian tumors. The optimal cutoff point for ADC was 1.16 × 10-3mm2/s with 95% sensitivity, 100% specificity, 100% PPV, 98% NPV, and 99% accuracy.

DISCUSSION

Much effort has been made to find a suitable and harmless diagnostic tool to evaluate ovarian masses regarding benignity or malignancy, because this can guide therapeutic procedures and patients' management. DW-MRI has been used in multiple studies for the differentiation of malignant from benign ovarian lesions; however, results have been controversial. Furthermore, different ADC cutoff point have been suggested. The differential value of ADC to distinguish between benign and malignant lesions has also been investigated in various organs and it has been shown to be beneficial to differentiate between benign and malignant lesions in several organs such as liver, uterus, and breast while ineffective in other organs such as thyroid, pancreas, and salivary glands [16]. The results of our study showed that the optimal cutoff point for ADC was 1.16 × 10-3mm2/s which was 95% sensitive and 100% specific for the diagnosis of malignant ovarian masses, in addition to 100% PPV, 98% NPV, and 99% accuracy.

US is usually the first diagnostic imaging tool when an ovarian lesion is suspected, mostly due to its availability [17]. Sensitivity and specificity of Doppler US has been reported as 84% and 82%, respectively for the diagnosis of ovarian cancer [8].

CT after contrast administration is mostly beneficial when spread of malignancy and response to therapy are concerned; however, its value is limited in the primary diagnosis of ovarian masses. Furthermore, its limitation regarding exposure to radiation and use of contrast media in patients with renal dysfunction should be taken into consideration. In case of undetermined adnexal masses, CT has shown 81% sensitivity and 87% specificity in the diagnosis of ovarian malignancy [8]. In a case-control study by Fan et al. the sensitivity, specificity, PPV, NPV, and accuracy of CT for diagnosis of ovarian cancer were 84.48%, 76.67%, 87.50%, 71.88%, and 81.82% respectively, while those in DW-MRI were 93.10%, 83.33$, 91.53%, 86.21%, and 89.77%, respectively; thus DW-MRI was superior to CT regarding sensitivity, specificity, and accuracy [18]. In addition, the combined sensitivity and specificity of DW-MRI in the diagnosis of malignant versus benign ovarian tumors in 10 studies has been reported as 93% and 88%, respectively [9, 10, 19-26]. However, in some studies DWI was not proven effective in distinguishing between malignant and benign ovarian masses [14, 15, 27].

The results of our study showed significantly lower ADC values in malignant ovarian lesions compared to benign or borderline lesions. Contrarily, in a meta-analysis conducted by Kim et al., ADC values measured in DWI were not significantly different between malignant and benign ovarian lesions [28]. The difference between studies may be due to different stages of malignant tumors, the accuracy of the MRI device, and the sample size. On the other hand, consistent with the findings of our study, Kovac et al. found that lower ADC values were highly suggestive of endometroid adenocarcinomas compared to other malignant ovarian lesions [29]. Additionally, Li et al. showed that the mean ADC value of benign ovarian lesions was significantly higher than malignant masses. In the same study, an ADC cutoff of 1.25× 10-3mm2/s was associated with sensitivity of 90.1% and specificity of 89.9% for differentiation between malignant and benign ovarian surface epithelial tumors [9]. Since the lower ADC cutoff in our study has higher sensitivity and specificity, ours appears to be more appropriate in this regard. In another study which was performed by Oh et al., an ADC value of 1.09× 10-3mm2/s was 94.4% sensitive and 85.7% specific for distinguishing between grade I and grade II or III ovarian cancer [30]. The cutoff point suggested by this study is slightly lower than ours and it has similar sensitivity; however, its specificity is much lower than ours. Although the application of the ADC cutoff point in this study is quite different compared to ours, the ADC cutoff in our study seems to be superior regarding specificity.

Besides, Davarpanah et al. found that ovarian lesions with

ADC values of higher than 1.55 × 10-3mm2/s have a more than 99.9% chance of being benign [31]. Obviously, the 1.16 × 10-3mm2/s ADC cutoff in our study for benign lesions covers the cutoff suggested in this study.

In comparison with other studies, the ADC cutoff suggested by our study appears to be the most sensitive, specific, and accurate to distinguish between malignant and benign ovarian tumors, while maintaining the highest PPV and NPV.

CONCLUSION

Our results showed that DW-MRI together with ADC measurements are beneficial in the diagnosis of malignant ovarian lesions and their differentiation from benign masses. Moreover, ADC values of lower than 1.16 × 10-3mm2/s are highly suggestive of malignancy. DW-MRI and ADC measurements should be included in the assessment protocol of ovarian lesions preoperatively.

CONFLICT OF INTERESTS

None declared.

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