ORIGINAL ARTICLE

Potential Advantages of Diffusion Study Over Conventional MRI in Diagnosing Ovarian Lesions

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Abstract

Background: ***One promising new functional imaging technique that has shown promise in identifying benign or malignant ovarian lesions is diffusion-weighted imaging (DWI).***
Aim of the study: ***To assess the incremental benefit of the DWI over conventional MRI in the characterization of ovarian masses already identified by ultrasonography or conventional CT.***
Patients and methods: ***This retrospective study involved fifty females with adnexal masses identified during ultrasonography or computed tomography examinations. All patients provided their informed consent prior to being included in the current research, which was carried out at the departments of radiology and gynecology between September 2022 and August 2024. In every patient, a pelvic MRI with DWI was conducted. All patients subjected to surgery and the pathological results were contrasted with the radiological DWI and MRI findings.***
Results: ***Based on histopathological findings, 80% (40 cases) were benign, while 20% (10 cases) were malignant. There has been an increase in the sensitivity, the specificity, the positive predictive value (PPV), the negative predictive value (NPV) NPV, and the accuracy from 82%, 77%, 46%, 96%, and 78% for conventional of MR Imaging to 100%, 92%, 73%, 100%, and 94% for the DWI.***
Conclusions: ***Our retrospective analysis concluded that the addition of DWI to conventional MRI constitutes an effective and noninvasive approach in evaluating ovarian masses. DWI improves MRI's sensitivity and specificity, which boosts radiologists' confidence in interpreting the images and eventually influences the patient's prognosis.***

Keywords: MRI; Diffusion; Ovarian masses

1. Introduction

After cervical cancer, ovarian cancer ranks as the second most prevalent gynecological malignant tumor. Cancer of the Ovary is the fifth most prevalent cause of cancer-related death. [1] Regretfully, the late-stage illness has a low rate of survival and affects most women.[2] To prevent needless surgery for benign ovarian lesions and to educate patients about potential surgical options, preoperative identification of complex adnexal tumors is essential. [3]

The main imaging method for adnexal lesions is ultrasound. When it comes to describing adnexal masses, MRI has proven to be more precise and specific than Doppler and US assessments. Furthermore, it is the most effective technique for defining local spread to the pelvic organs. [4]

Conventional MR sequences give information about the adnexal lesion's anatomy and morphology, including wall and septal thickness, nodularity, and papillary projection. [5]

One of the functional MRI sequences, DWI, can also provide a great tissue contrast by using Brownian motion, or the random microscopic motion of molecules of water. [6] The ADC (Apparent Diffusion Coefficient) map is made using at least two different b values, which helps differentiate between benign and cancerous tissues. [7]

Our research aimed to assess the utility of DWI in ovarian lesion characterization in comparison to conventional MRI.

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2. Patients and methods

Case Selection:

50 female patients with adnexal masses based on ultrasound studies participated in this retrospective investigation. Between September 2022 and August 2024, the gynecological department directed patients to the diagnostic radiology department.

The patients were between the ages of 25 and 60. Every instance had a pelvic MRI with DWI, and every malignant lesion had a pathological correlation. The trial was authorized by the Ethics Committee, and prior to enrollment, each patient provided written informed consent.

Exclusion criteria include the presence of MRI-incompatible equipment, such as cardiac pacemakers, which prevent an MRI from being performed, and those with simple ovarian cysts, which are a common benign magnetic resonance feature.

MR Imaging Technique:

A 1.5-Tesla MRI machine (Philips Achieva/Netherlands) was used to image each individual while they were supine, head first, utilizing a pelvic phased-array 4-channel coil.

The identical protocol comprises:

T2 sagittal: TR (Repetition Time) 3700 ms, TE (Time to Echo) 110 ms, Matrix 210X210, FOV (Field of view) 290X290 mm and slice thickness 3

T2 Axial: TR 3700 ms, TE 110 ms, Matrix 290X200, FOV 288X350 mm and slice thickness 3

T1 Axial: TR 500 ms, TE 10 ms, Matrix 290X200, FOV 260X216 mm and slice thickness 3

T1 Axial fat sat: TR 530 ms, TE 7 ms, Matrix 270X200, FOV 300X300 mm and slice thickness 3

T2 Coronal: TR 4800 ms, TE 10 ms, Matrix 270X200, FOV 240X250 mm and slice thickness 3

DWI (B0, 500 & 1000): TR 5200 ms, TE 80 ms, Matrix 125X125, FOV 240X250 mm and slice thickness 4.

Post IV contrast T1, axial, coronal, and sagittal: TR 500 ms, TE 10 ms, Matrix 290X200, FOV 260X216 mm and slice thickness 3

A comparison was made between the radiological and histopathological results.

3. Results

In this study, 50 females had adnexal masses. The patients' average age was 40 +/-15 SD, with a range of 25 to 60 years.

This study contained ten malignant masses (20%) and forty benign lesions (80%) based on the histological diagnosis. Table (1) lists the different benign and malignant tumors that are the subject of the current inquiry.

Table 1. Case distribution based on histopathological findings

	PATHOLOGICAL TYPE	NUMBER OF CASES	PERCENTAGE %
BENIGN	Serous cystadenoma	10	20
	Mature cystic teratoma	7	14
	Mucinous cystadenoma	7	14
	Hemorrhagic cyst	6	12
	Endometrioma	5	10
	Tubo-ovarian abscess	3	6
	Pedunculated subserous fibroid	2	4
MALIGNANT	Moderately differentiated adenocarcinoma	4	8
	Mucinous cystadenocarcinoma	2	4
	Granulosa cell tumor	2	4
	Ovarian sarcoma	2	4
	TOTAL	50	100

A high diffusion signal was found inside the solid component in all cases of malignant ovarian lesions.

A high diffusion signal was found inside the solid component of benign mature cystic teratoma.

A high diffusion signal was found inside the cystic component of the ovarian abscess.

A high diffusion signal was found inside the cystic component of endometrioma.

A low diffusion signal was found inside other benign cystic ovarian lesions.

The solid component's mean ADC value for benign tumors was around 1.4 ± 0.8 × 10-3 mm2/s ($P < 0.001$).

The solid component's mean ADC value for malignant tumors was around 0.7 ± 0.3 × 10-3 mm2/s. ($P < 0.001$).

The cystic component's mean ADC value for benign and malignant lesions showed no appreciable difference. (P is equal to 0.2).

According to conventional MRI, 18 tumors were diagnosed as malignant; 10 of them were true malignant (True positive), while 8 were benign (False positive) as compared to pathological diagnosis. On the other hand, 32 lesions were diagnosed as benign; 30 of them were true benign (True negative) while 2 cases were malignant (False negative).

On Diffusion-weighted Image (DWI), 14 tumors were diagnosed as malignant, 10 of them were true malignant (True positive), while 4 were benign (False positive) as compared to pathological diagnosis. On the other hand, 36 lesions were diagnosed as benign; all of them were true benign (True negative) and there were no false negative cases.

The total sensitivity, specificity, PPV, NPV and accuracy of conventional MRI were 82%, 77%, 46%, 96%, and 78%. Adding DWI (using ADC maps) improves conventional MRI's overall sensitivity, specificity, PPV, NPV, and accuracy to 100%, 92%, 73%, 100%, and 94%, respectively.

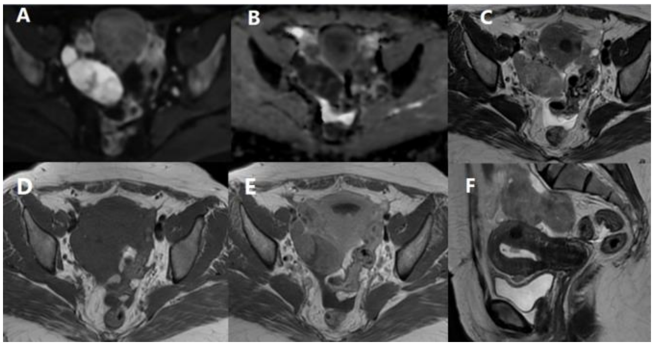

Figure 1. (A) DWI, (B) ADC map, (C) Axial T2, (D) Axial T1 pre-contrast, (E) Axial T1 post-contrast, (F) Sagittal T2 WI show Malignant right ovarian lesion with peritoneal deposits. Right hemi pelvic region large lobulated soft tissue mass lesion, inseparable from the right ovary. Mild right side hydrosalpinx. Minimal free fluid in Douglas pouch. Small endometrial polyp. Posterior uterine wall small interstitial fibroid. It shows a diffusion restriction pattern, a bright DWI signal (A), low ADC map signal (B), intermediate to low signal in T2 WI (C & F), a low signal in T1 (D) with heterogonous post-contrast enhancement (E) The tumor's ADC value is around 0.7x 10^{-3} mm^2/s.

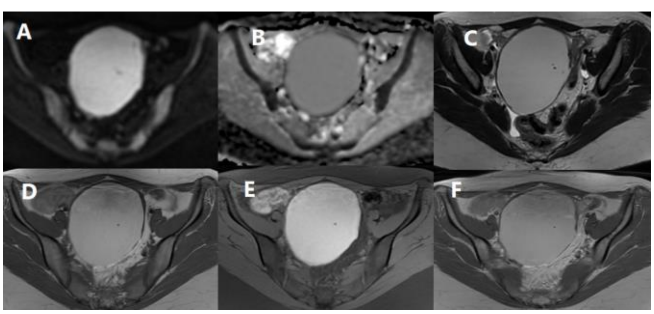

Figure 2. (A) DWI, (B) ADC map, (C) Axial T2, (D) Axial T1 pre-contrast, (E) Axial T1 fat sat, (F) Axial T1 post-contrast show left ovarian large unilocular hemorrhagic cystic lesion (Endometrioma) is seen with fine internal incomplete septations. No solid component. It displays DWI high signal (A), low ADC map signal (B) high T2 signal (C), high signal in T1 (D), high signal in T1 fat sat WIs (E) with no pathological post contrast enhancement (F). The ADC value is around 0.8x 10^{-3} mm^2.

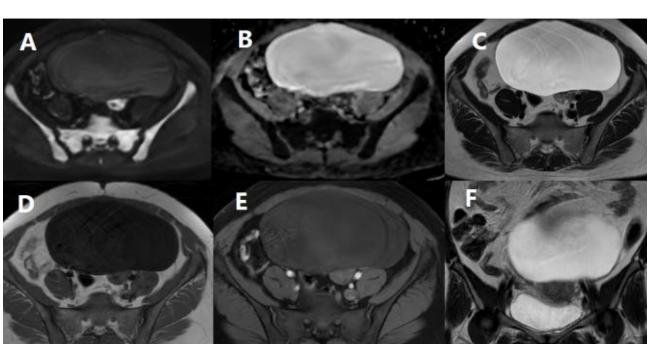

Figure 3. (A) DWI, (B) ADC map, (C) Axial T2, (D) Axial T1 pre-contrast, (E) Axial T1 fat sat post-contrast WIs, (F) coronal T2 WI show left ovarian large Serous cystadenoma. Large left ovarian well-defined unilocular cystic lesion displays DWI low signal (B) ADC map bright signal (B), a bright signal in T2 (C& F), a low signal in T1 (D), and no pathological post-contrast enhancement. The cystic lesion's ADC value is around 1.8 x 10^{-3} mm^2/s.

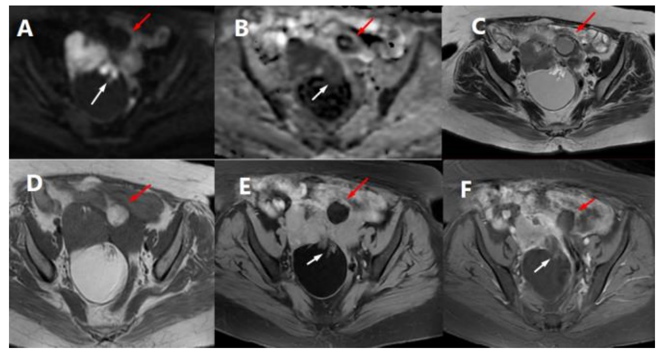

Figure 4. (A) DWI, (B) ADC map, (C) Axial T2, (D) Axial T1 pre-contrast, (E) Axial fat sat T1pre-contrast WIs, (F) Axial fat sat T1 post-contrast show bilateral ovarian mature cystic teratoma. Large right ovarian complex solid/cystic lesion, In DWI, the cystic component displays low signal (A) ADC map low signal (B), heterogenous bright signal in T2 (C), high signal in T1 (D), marked low signal in T1 fat sat (E), no post-contrast enhancement (F). The solid component (White arrow) shows DWI bright signal and ADC map low signal, (Restricted diffusion), T2 bright signal, T1, and T1 fat sat low signal and no post-contrast enhancement. Smaller left ovarian mature cystic teratoma (Red arrow), shows a mainly cystic component displays DWI bright signal and ADC map low signal, (Restricted diffusion), T2 heterogenous bright signal, T1 bright signal, T1 fat sat marked low signal and no post-contrast enhancement. The solid right ovarian lesion component ADC value is around 0.9x 10^{-3} mm^2

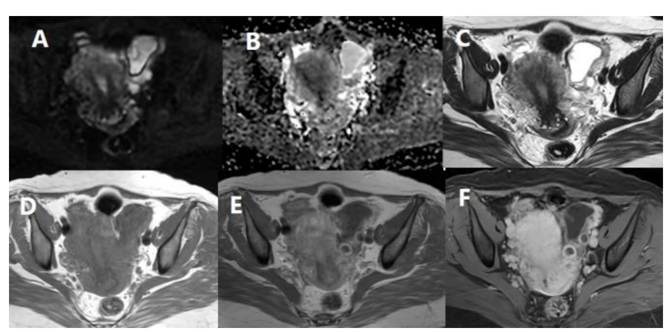

Figure 5. (A) DWI, (B) ADC map, (C) Axial T2, (D) Axil T1 pre-contrast, (E) Axial T1 post-contrast WIs, (F) Axial fat sat T1 post-contrast show left ovarian multi-loculated thickened wall cystic lesion displays DWI high signal in (A) ADC map mild low signal in (B), thickened irregular wall with T2 WI internal bright signal (C) T1WI low signal (D), marginal uniform post-contrast

enhancement with blurred fat planes and engorged pelvic and para uterine vasculature (E&F).
The cystic component ADC value is around 1.1 x 10^{-3} mm^2

4. Discussion

In contrast to ultrasonography, magnetic resonance imaging has demonstrated greater accuracy and precision in characterizing adnexal masses. One intriguing new functional imaging method is DWI, which is also a useful imaging modality for distinguishing benign from malignant adnexal tumors.

Fifty individuals with adnexal lesions were included in the current investigation. Our research set out to assess the additional advantages of DWI over conventional MRI in the characterization of ovarian masses already identified by ultrasonography or conventional CT.

According to histopathology results, 80% were benign and 20% were malignant. This aligns with a related study carried out by El-Wekil et al., which indicated that roughly 73.3% of cases were benign and 26.7% were malignant. [8]

In the current study, the high DWI signal was found inside the solid component of all ovarian malignant lesions, the solid component of benign mature cystic teratoma, the cystic component of ovarian abscess and the cystic component of endometrioma. A low diffusion signal was found inside other benign cystic ovarian lesions. This is consistent with a similar study carried out by Tantawy et al . [9]

In the current study, the solid component's mean ADC value for benign lesions was around 1.4 ± 0.8 × 10-3 mm2/s ($P < 0.001$). The solid component's mean ADC value for malignant tumors was around 0.7 ± 0.3 × 10-3 mm2/s. ($P < 0.001$). The cystic component's mean ADC value for both benign and malignant lesions showed no appreciable difference. (P is equal to 0.2).

Our findings indicated that, with a sensitivity of 87% and a specificity of 82%, the ideal cutoff ADC value for distinguishing between benign and malignant lesions was around 1.01 × 10-3 mm2.

Consistent with our results, El-Wekil et al. discovered that the solid component mean ADC value might significantly vary between benign and malignant ovarian lesions ($P < 0.001$), with benign tumors ADC mean value being 1.176 ± 0.15 × 10-3 mm2/s and malignant tumors ADC mean value being 0.747 ± 0.12 × 10-3 mm2/s. [8]

As per Li et al., DWI aids in distinguishing between the benign & malignant ovarian masses with regard to solid components.[10] The solid component's mean ADC value for benign lesions was around 1.4 ± 0.8 × 10-3 mm2/s ($P < 0.001$). The solid component's mean ADC value for malignant tumors was around 0.7 ± 0.3 × 10-3 mm2/s. ($P < 0.001$).

Tantawy et al. found, however, that the solid component's ADC mean value for both benign and malignant tumors showed no appreciable difference. [9]

Tantawy et al. noted comparable results. The chemical nature of the component lesions, mostly serous or mucinous, and sometimes hemorrhagic, can account for the low intensity of free diffusion observed on DWI in the cystic portions of ovarian malignant tumors in our analysis. [9]

The study's three tubo-ovarian abscesses displayed a variable degree of mild diffusion restriction with a uniform high DWI signal and a mild ADC map low signal. Similar to our findings, Chou et al. discovered that the ADC mean value of tubo-ovarian abscesses was substantially lower than that of cystic ovarian malignancies. [11]

As per Li et al., the cystic component's ADC mean value for both benign and malignant tumors showed no appreciable difference ($P = 0.198$). [10]

Some endometrioma, mature cystic teratoma, and tubo-ovarian abscess cases had restricted DWI appearances, with DWI high signal and ADC map low signal that resembled a malignant tumor.

However, the fat-suppressed sequences in a typical MRI make it easy to diagnose the majority of teratomas. Additionally, endometrioma and abscess show distinctive MRI appearances. [12,13]

According to earlier research, certain benign ovarian lesions, including endometriomas, abscesses, and mature cystic teratomas, exhibited restricted diffusion, which was consistent with our findings. These findings may be explained by the presence of keratinized substances in mature cystic teratomas, hyperviscosity in abscesses, and intra-cystic blood clots in endometriomas. [14,15]

For DWI, the sensitivity, specificity, PPV, NPV, and accuracy were 100%, 92%, 73%, 100%, and 94%, respectively, compared to 82%, 77%, 46%, 96%, and 78% for conventional MRI.

This was in line with the results of the Li et al., which found that adding DWI to conventional MRI improved its sensitivity, specificity, PPV, NPV, and accuracy from 91.8%, 78.3%, 88.6%, 83.7%, and 87.0%, respectively, to 96.5%, 89.1%, 94.3%, 93.2%, and 93.1%.[10]

This was also in line with the results of the El-Wekil et al., which found that adding DWI to conventional MRI improved its sensitivity, specificity, PPV, NPV, and accuracy from 87.5%, 86.4%, 70%, 95%, and 86.7% respectively, to 100%, 93.3%, 88.9%, 100%, and 95%. [8]

The current study's weakness is the limited study population, which could have an impact on the findings. In order to further assess the diffusion MRI diagnostic utility of in distinguishing benign from malignant ovarian tumors, future research including a larger population is advised.

4. Conclusion

An efficient noninvasive method for evaluating the adnexal masses is the combination of DWI and traditional MRI. It increases MRI's sensitivity and specificity, which boosts radiologists' confidence in interpreting the images and ultimately impacts the patient's outcome and prognosis.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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