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Diagnostic Performance of Diffusion-Weighted Magnetic Resonance Imaging for the Differentiation of Benign from Malignant Ovarian Tumors

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ABSTRACT

Objective: Preoperative characterization of malignant and benign ovarian masses is important for informing patients about possible surgical approaches. This study aimed to determine the diagnostic performance of apparent diffusion coefficient values in differentiating between benign and malignant ovarian tumors.

Material and Methods: A total of 142 patients who underwent surgery for ovarian masses were retrospectively analyzed. Eighty-two patients who underwent diffusion-weighted imaging and had a confirmed histopathological diagnosis were included in the study. Ovarian masses were classified as benign or malignant, and epithelial or non-epithelial. The ADC values of the masses and cerebrospinal fluid and the ratio of mass/CSF-ADC were measured and compared between the groups.

Results: There were 94 masses of 82 patients included in the study and 14.6% (n= 12/82) of the patients had bilateral ovarian tumors. The masses were confirmed to be benign in 73 (77.7%) patients and malignant in 21 (22.3%). The average age of the patients with malignant masses was significantly higher compared to the benign group (p= 0.002). No notable distinction was observed between the ADC values of malignant and benign ovarian masses in either the mass-ADC (p= 0.894) or the mass/CSF-ADC values (p= 0.826). However, when the epithelial and non-epithelial ovarian tumors were compared, the epithelial group had higher values than the non-epithelial group in both the mass ADC (p< 0.001) and the mass/CSF-ADC (p< 0.001).

Conclusion: While the ADC values of ovarian masses may not be adequately discriminatory between benign and malignant tumors, they do offer valuable insights for distinguishing between those of epithelial and non-epithelial nature.

Keywords: Apparent diffusion coefficient, magnetic resonance imaging, ovarian tumor

ÖZ

Difüzyon Ağırlıklı MRG'nin Benign-Malign Over Tümörlerini Ayırmadaki Tanısal Performansı

Giriş: Malign ve benign over kitlelerinin preoperatif karakterizasyonu, hastaların olası cerrahi yaklaşımlar hakkında bilgilendirilmesi açısından önemlidir. Bu çalışma, benign ve malign over tümörlerini ayırt etmede görünen difüzyon katsayısı değerlerinin tanısal performansını belirlemeyi amaçlamıştır.

Gereç ve Yöntemler: Over kitlesi nedeniyle ameliyat edilen toplam 142 hasta retrospektif olarak incelendi. Difüzyon ağırlıklı görüntüleme yapılan ve doğrulanmış histopatolojik tanısı olan 82 hasta çalışmaya dahil edildi. Over kitleleri benign-malign ve epitelyal-epitelyal dışı olarak sınıflandırıldı. Kitlelerin ve beyin omurilik sıvısının ADC değerleri ve kitle/BOS-ADC oranı ölçüldü ve gruplar arasında karşılaştırıldı.

Bulgular: Çalışmaya dahil edilen 82 hastanın %14.6'sında (n= 12/82) bilateral over tümörü vardı bu nedenle 94 lezyon değerlendirildi. Kitlelerin 73'ünün (%77.7) benign, 21'inin (%22.3) malign olduğu doğrulandı. Malign kitlesi olan hastaların yaş ortalaması benign gruba göre anlamlı olarak daha yüksekti (p= 0.002). Malign ve benign over kitlelerinin ADC değerleri (p= 0.894) ve kitle/BOS-ADC değerleri (p= 0.826) arasında anlamlı bir fark yoktu. Ancak epitelyal ve epitelyal dışı over tümörleri karşılaştırıldığında, epitelyal grup hem kitle ADC değeri (p< 0.001) hem de kitle/BOS-ADC değerleri (p< 0.001) epitelyal dışı gruba göre daha yüksek değerlere sahipti.

Sonuç: Over kitlelerinin ADC değerleri, benign ve malign tümörleri ayırt etmek için yeterli olmasa da epitelyal ve epitelyal dışı tümörleri ayırt etmede değerli bilgiler sağlar.

Anahtar Kelimeler: Görünür difüzyon katsayısı, manyetik rezonans görüntüleme, over tümörü

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INTRODUCTION

Although significant improvements and developments have taken place in the field of medicine in the last few decades, there has not been a significant decrease in mortality due to ovarian cancer. At the time of diagnosis, 70% of the cases are in the advanced stage. While five-year survival is 86.9% in stage 1a, it is 11% in stage 4 (1). Ovarian masses constitute the fourth most common gynecological reason among hospital admissions, and 90% of them have benign character (2).

Magnetic resonance imaging (MRI) is a valuable tool in the evaluation of ovarian masses and the benign-malignant characterization of a lesion (3). In the evaluation with conventional MRI, the morphological structure, signal characteristics and enhancement pattern of the lesion may be helpful in distinguishing between benign and malignant tumors. However, radiologists still have difficulty in accurately assessing lesions (4). This leads them to use diffusion-weighted imaging (DWI) and similar advanced MRI techniques (4).

Some studies have shown that the qualitative evaluation of DWI can contribute to the characterization of ovarian lesions (5-7). DWI can also be evaluated quantitatively, usually by calculating apparent diffusion coefficient (ADC) values (8). Since ADC is associated with the molecular translational action of water molecules, increasing tissue cellularity or cell density decreases the ADC value (9). Generally, malignant tumors have more hypercellularity, enlarged nuclei, and nuclear contour angle compared to benign lesions; therefore, ADC values help differentiate benign lesions from malignant lesions (4).

Today, a variety of MRI devices are accessible, employing diverse b values for diffusion assessments, lacking a specific standardized approach. This can create differences in measurements between different devices. By taking the ratio of the ADC value of the more stable cerebrospinal fluid (CSF) to the ADC value of the lesion, such differences can be minimized, thereby providing a more objective method. Hence, the objective of this study was to assess the diagnostic effectiveness of the lesion-ADC and lesion-ADC/CSF-ADC ratios in distinguishing between benign and malignant ovarian lesions, with histopathology serving as the reference standard.

MATERIALS and METHODS

Patient Selection

Local ethics committee approval was obtained for this retrospective, single-center study. Written informed consent was waived (Harran University Faculty of Medicine, Date: 06.05.2013; Session 5; Decision 33).

The data of 142 patients who underwent surgery for ovarian tumors between June 1, 2012, and April 30, 2013, and had a histopathologically confirmed diagnosis were obtained from electronic medical records. Only patients that had undergone pre-operative DWI with the appropriate protocol were included in the study. Sixty patients exhibiting extensive artifacts that could hinder accurate diffusion measurements, as well as cases in which the histopathological diagnosis couldn't be confirmed following surgery performed at an external center, were excluded from the study. The remaining 82 patients were included in the sample. Since the tumor was bilateral in 12 patients, the evaluation was made on a total of 94 lesions.

MRI Protocol

MRI scans were conducted using the 1.5 Tesla Magnetom Symphony A Tim System (Siemens, Erlangen, Germany). Patients were positioned in a supine posture without sedation, and a 16-channel body coil was positioned over the pelvic region. Before DWI, coronal localized and T2-weighted axial (TR= 3.440, TE= 87, NEX= 1) MRI images were obtained, followed by three series of single-shoot, spin echo and echo planar (SS, SE, and EP, respectively) DWI images. With the TR/TE/EX/echo planar (6.000/88/1/144) imaging factor, variables were sensitized in the x, y and z directions and enriched with the b values of 0, 500 and 1.000 sec/mm^2. The following parameters were used: matrix, 512 x 512; field of view, 380 mm; slice thickness, 7 mm; number of slices, 30; interslice gap, 30%; and NEX 4.

Quantitative Analysis of Images

The patients' DWI images were transferred to the clinical workstation (Leonardo console, Siemens) and evaluated by a radiologist with three years of experience in abdominopelvic imaging, who was blinded to the histopathological diagnoses. The ADC values of both the ovarian mass and CSF were measured in a standard manner. For the quantitative analysis of the ADC value of the ovarian lesion, a circular region of interest (ROI) was placed in an area away from these structures and at least 1 cm away from the lesion wall, avoiding artifacts that might arise from the abdominal wall, fat, and vascular structures. The region of interest (ROI) measurement area was defined to be approximately 1 cm^2. In cases where the lesion exhibited heterogeneity or included both cystic and solid components, measurements were taken from the most hypointense area on the ADC map. Based on these criteria, measurements were performed at b= 1.000 at three separate points from different regions of the lesion. The mean ADC value of the ovarian lesion was calculated by taking the average of the three ADC measurements obtained. A comparable protocol was employed for cerebrospinal fluid (CSF) measure-

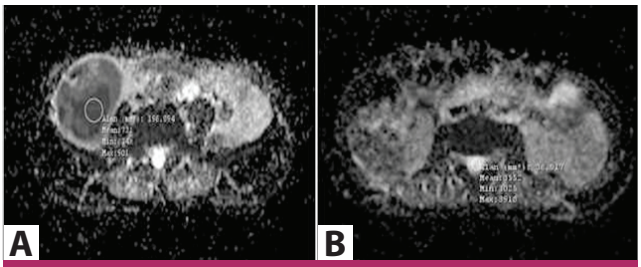

Figure 1. Apparent diffusion coefficient (ADC) map of a 24-year-old female patient with a dermoid cyst. **(A)** Lesion-ADC value (0.73 x 10^{-3} mm^2/s) and **(B)** cerebrospinal fluid-ADC value (3.55 x 10^{-3} mm^2/s).

ments, with the ROI measurement area being maintained at a smaller size of 0.5 cm^2. The mean CSF ADC value was calculated by taking the average of the three ADC measurements obtained. The ROI measurements were made from the most hypointense areas on the ADC map (Figure 1).

Statistical Analysis

All statistical analyses were performed using SPSS for Windows, version 20.0 (SPSS, Chicago, IL, USA). Categorical variables were shown as frequency and percentages, and the data were compared with the Pearson's chi-square or Fisher's exact tests. Continuous variables were given as mean and standard deviation. The Kolmogorov-Smirnov test was used to test the normality of data distribution. Student's t-test was used to compare normally distributed data and the Mann-Whitney U test for data without a normal distribution. A p-value of <0.05 was considered statistically significant.

RESULTS

Of the ovarian masses analyzed in the study, 77.7% (n= 73) were benign and 22.3% (n= 21) were malignant. Table 1 shows the ADC values and lesion-ADC/CSF-ADC values according to the histopathological subtypes of all ovarian lesions. The demographic data of the patients with malignant and benign ovarian masses and the characteristics of these lesions are shown in Table 2. The age of the patients with malignant ovarian tumors was statistically higher than that of the patients with benign tumors (48.11 ± 16.34 vs. 36.91 ± 16.10 years; respectively, p= 0.002), and the lesion size was significantly higher in the malignant tumors (113.15 ± 49.95 vs. 91.39 ± 39.77 mm; p= 0.023, respectively). The lesion-ADC values, CSF-ADC values and lesion-ADC/CSF-ADC ratio were similar in both groups (p= 0.894, p= 0.617, and p= 0.826, respectively) (Table 2).

The ADC value and the lesion-ADC/CSF-ADC ratio of the epithelial ovarian tumors were significantly higher compared to those of the non-epithelial tumors [2.16 ± 0.45 vs. 1.08 ± 0.28 (10^{-3} mm^2/s); p< 0.001 and 0.68 ± 0.14 vs. 0.34 ± 0.09; p< 0.001, respectively) (Table 3).

Table 1. Lesion-ADC and lesion-ADC/CSF-ADC values according to the histopathological subtypes of all ovarian lesions

Lesion type	n (%)	Mean ADC value (10^{-3} mm^2/s)	Mean lesion-ADC/CSF-ADC
Serous cystadenoma	28 (29.79%)	2.52 ± 0.22	0.8 ± 0.1
Mucinous cystadenoma	7 (7.45%)	2.77 ± 0.25	0.86 ± 0.1
Krukenberg tumor	5 (5.32%)	2.03 ± 0.42	0.67 ± 0.2
Serous cystadenocarcinoma	6 (6.38%)	2.63 ± 0.38	0.82 ± 0.1
Endometriosis	9 (9.57%)	2.32 ± 0.57	0.73 ± 0.2
Dermoid cyst	26 (27.66%)	0.77 ± 0.34	0.23 ± 0.1
Other	13 (13.82%)	2.09 ± 0.38	0.36 ± 0.3
Total	94 (100%)	1.63 ± 0.14	0.52 ± 0.3

ADC: Apparent diffusion coefficient, CSF: Cerebrospinal fluid.

Table 2. Comparison of all benign and malignant ovarian lesions

	All lesions (n= 94)	Benign lesions (n= 73)	Malignant lesions (n= 21)	p
Age (years)	39.19 ± 16.15	36.91 ± 16.10	48.11 ± 16.34	0.002*
Lesion size (mm)	95.77 ± 41.86	91.39 ± 39.77	113.15 ± 49.95	0.023*
Lesion-ADC (10^{-3} mm^2/s)	1.64 ± 0.94	1.62 ± 0.97	1.72 ± 0.85	0.894
CSF-ADC (10^{-3} mm^2/s)	3.16 ± 0.14	3.18 ± 0.14	3.10 ± 0.15	0.617
Lesion-ADC/CSF-ADC	0.52 ± 0.30	0.51 ± 0.31	0.55 ± 0.27	0.826

ADC: Apparent diffusion coefficient, CSF: Cerebrospinal fluid.

*p< 0.05.

Table 3. Comparison of all epithelial and non-epithelial ovarian lesions

	Epithelial lesions (n= 56)	Non-epithelial lesions (n= 38)	p
Lesion-ADC (10^{-3} mm^2/s)	2.16 ± 0.45	1.08 ± 0.28	<0.001*
CSF-ADC (10^{-3} mm^2/s)	3.15 ± 0.15	3.18 ± 0.14	0.510
Lesion-ADC/CSF-ADC	0.68 ± 0.14	0.34 ± 0.09	<0.001*

ADC: Apparent diffusion coefficient, CSF: Cerebrospinal fluid.

*p< 0.05.

Table 4. Comparison of all benign and malignant cystic ovarian lesions

	All cystic lesions (n= 86)	Benign cystic lesions (n= 68)	Malignant cystic lesions (n= 18)	p
Age (years)	39.51 ± 16.37	37.32 ± 16.44	48 ± 13.42	0.01*
Lesion size (mm)	95.56 ± 43.07	89.32 ± 39.57	114.87 ± 51.01	0.035*
Lesion-ADC (10^{-3} mm^2/s)	1.83 ± 1	1.74 ± 1.03	2.16 ± 0.79	0.450
CSF-ADC (10^{-3} mm^2/s)	3.17 ± 0.15	3.18 ± 0.14	3.11 ± 0.18	0.117
Lesion-ADC/CSF-ADC	0.58 ± 0.32	0.55 ± 0.33	0.69 ± 0.25	0.443

ADC: Apparent diffusion coefficient, CSF: Cerebrospinal fluid.

*p< 0.05.

Table 5. Comparison of all epithelial and non-epithelial cystic ovarian lesions

	Epithelial cystic lesions* (n= 52)	Non-epithelial cystic lesions* (n= 34)	p
Age (years)	43.38 (14-82)	33.64 (10-74)	0.006*
Lesion size (mm)	99.93 (46-242)	86.41 (25-224)	0.122
Lesion-ADC (10^{-3} mm^2/s)	2.3 (0.49-2.99)	1.15 (0.08-2.91)	<0.001*
CSF-ADC (10^{-3} mm^2/s)	3.15 (2.67-3.48)	3.19 (2.9-3.55)	0.234
Lesion-ADC/CSF-ADC	0.72 (0.16-0.97)	0.36 (0.03-0.91)	<0.001*

ADC: Apparent diffusion coefficient, CSF: Cerebrospinal fluid.

*All values given as median and minimum-maximum, p< 0.05.

There was no significant difference between the ADC value and the lesion-ADC/CSF-ADC value of the benign and malignant cystic tumors (p= 0.450 and p= 0.443, respectively) (Table 4). However, the ADC value and the lesion-ADC/CSF-ADC ratio of the epithelial cystic ovarian tumors were significantly higher compared to the non-epithelial cystic tumors (2.31 vs. 1.15; p< 0.001 and 0.72 vs. 0.36; p< 0.001, respectively) (Table 5).

After the removal of dermoid cysts, there was no significant difference between the benign and malignant non-dermoid cystic lesions in terms of age, lesion size, lesion-ADC value, CSF-ADC value, and lesion-ADC/CSF-ADC value (p= 0.191, p= 0.122, p= 0.335, p= 0.447 and p= 0.364, respectively) (Table 6). Furthermore, there were no significant age, lesion size, lesion-ADC value, CSF-ADC value, or lesion-ADC/CSF-ADC value differences observed between the non-dermoid epithelial cystic tumor group and the non-epithelial cystic tumor group (p= 0.82, p= 782, p= 702, p= 0.206 and p= 0.924, respectively) (Table 6).

The paired comparisons of the cystic ovarian tumors revealed that the ADC value and the lesion-ADC/CSF-ADC value of the serous cystadenomas were significantly higher than those of the dermoid cysts (2.52 ± 0.22 vs. 0.77 ± 0.34; p< 0.001 and 0.8 vs. 0.23; p< 0.001, respectively). The ADC value and the lesion-ADC/CSF-ADC value of the mucinous cystadenomas were significantly higher compared to the dermoid cysts (2.77 ± 0.25 vs. 0.77 ± 0.34; p= 0.006 and 0.86 vs. 0.23; p= 0.005, respectively). The ADC value and the lesion-ADC/CSF-ADC value of the Krukenberg tumors were significantly higher than those of the dermoid cysts (3.0 ± 0.42 vs. 0.77 ± 0.34; p= 0.002 and 0.67 vs. 0.23; p= 0.048, respectively). The ADC value and the lesion-ADC/

Table 6. Comparison of benign-malignant and epithelial-non-epithelial cystic ovarian lesions after excluding dermoid cysts

	Benign cystic lesions* (n= 42)	Malignant cystic lesions* (n= 18)	p
Age (years)	42.1 (14-82)	48 (27-74)	0.191
Lesion size (mm)	94.07 (46-172)	114.87 (26-242)	0.122
Lesion-ADC (10^{-3} mm^2/s)	2.31 (0.49-2.99)	2.16 (0.47-2.86)	0.335
CSF-ADC (10^{-3} mm^2/s)	3.16 (2.86-3.47)	3.11 (2.67-3.48)	0.447
Lesion-ADC/CSF-ADC	0.73 (0.16-0.97)	0.69 (0.03-0.89)	0.364
	Epithelial cystic lesions (n= 52)	**Non-epithelial cystic lesions (n= 8)**	**p**
Age (years)	43.38 (14-82)	46.37 (23-74)	0.820
Lesion size (mm)	112.08 (46-242)	137.4 (26-160)	0.784
Mean lesion-ADC (10^{-3} mm^2/s)	2.47 (0.49-2.99)	2.84 (0.59-2.68)	0.702
CSF-ADC (10^{-3} mm^2/s)	3.20 (2.67-3.48)	3.20 (2.9-3.27)	0.206
Lesion-ADC/CSF-ADC	0.78 (0.16-0.97)	0.91 (0.19-0.89)	0.924

ADC: Apparent diffusion coefficient; CSF: Cerebrospinal fluid.

*All values given as median and minimum-maximum.

CSF-ADC value of the serous cystadenocarcinomas were significantly higher compared to the dermoid cysts (2.63 ± 0.38 vs. 0.77 ± 0.34; p= 0.004 and 0.82 vs. 0.23; p= 0.008, respectively). The ADC values and lesion-ADC/CSF-ADC value of the endometrioses were significantly higher than those of the dermoid cysts (2.32 ± 0.57 vs. 0.77 ± 0.34; p= 0.002 and 0.73 vs. 0.23; p= 0.001, respectively). The ADC value and the lesion-ADC/CSF-ADC value of the serous cystadenomas were significantly higher than those of the endometrioses (2.52 ± 0.22 vs. 2.32 ± 0.57; p= 0.007 and 0.8 vs. 0.73; p= 0.009, respectively). The ADC value and the lesion-ADC/CSF-ADC value of the serous cystadenocarcinomas were significantly higher compared to the endometrioses (2.63 ± 0.38 vs. 2.32 ± 0.57; p= 0.002 and 0.82 vs. 0.73; p= 0.045, respectively).

DISCUSSION

MRI is a useful modality in the evaluation of ovarian tumors, and DWI can provide additional information in determining the characterization of ovarian masses (3,5-7). To date, some studies have indicated a difference between the ADC values of benign and malignant ovarian tumors and showed that the latter has a lower ADC value (7,10,11). Hence, researchers have suggested that the ADC can be utilized to differentiate between malignant and benign masses. Nonetheless, certain studies have indicated that ADC alone might not be adequate for this differentiation (5,6,8,12-15). In our study, no significant difference was observed in the CSF-ADC value between the benign and malignant groups, as well as between the epithelial and non-epithelial groups. This finding implies that the CSF-ADC value remains consistent and stable across these groups.

In this study, when all the ovarian tumors were evaluated together, there was no difference between the benign and malignant groups in terms of the ADC, CSF-ADC and lesion-ADC/CSF-ADC values (p= 0.89, p= 0.62, and p= 0.83, respectively). This result supports previous publications stating that ADC is not sufficient in this differentiation. There could be numerous factors contributing to the differences observed between these two groups. One possibility is that dermoid cysts and endometriomas, akin to malignant lesions, exhibit low ADC values, which might account for these differences. In addition, in malignant lesions, the ADC value may increase due to areas of intra-mass necrosis, desmoplastic reactions in the stroma, and interstitial edema (4-6,8,12-14).

Li et al. reported that the ADC value of epithelial ovarian tumors was higher than that of non-epithelial ovarian tumors (10). Similarly, in our study, the ADC value and the lesion-ADC/CSF-ADC value of the epithelial tumors were higher compared to the non-epithelial tumors (p< 0.001 and p< 0.001, respectively). Li et al. also noted that the patients with malignant ovarian tumors were older than those with benign tumors (10). This is supported by our findings, indicating that the mean age of the malignant group was higher than that of the benign group (p= 0.002). Moteki et al. reported that malignant ovarian tumors were larger than benign tumors (16). Similarly, in our study, the malignant ovarian tumors were larger than the benign tumors (p= 0.023). This indicates that factors such as advanced age and increased tumor size are associated with the development of malignancy.

When all the cystic ovarian tumors were included in the analysis, we detected no significant difference between the ADC, CSF-ADC and lesion-ADC/CSF-ADC values of the cystic benign and malignant tumors (p= 0.63, p= 0.63, and p= 0.56, respectively). This result supports previous research indicating that ADC is not sufficient in the differentiation of benign and malignant lesions (4,8,15). However, in the current study, the ADC and lesion-ADC/CSF-ADC values were significantly higher among the cystic epithelial tumors compared to the non-epithelial cystic tumors (p< 0.001 and p< 0.001, respectively).

Evaluating all the ovarian lesions and ovarian cysts, we consider that the reason for the low ADC value in the non-epithelial tumor group may be the presence of dermoid cysts. In a study by Nakayama et al. (7), the ADC value of dermoid cysts was lower than those of the other tumor groups. Similarly, in our study, the paired comparisons showed that the dermoid tumors had a lower ADC value than the serous, mucinous, Krukenberg and serous cystadenocarcinoma groups (p< 0.001, p= 0.006, p= 0.002, and p= 0.004, respectively). In addition, the lesion-ADC/CSF-ADC value of the dermoid tumors was lower than those of the serous, mucinous, Krukenberg and serous cystadenocarcinoma groups (p< 0.001, p= 0.005, p= 0.048, and p= 0.008, respectively). The lower ADC value of the dermoid cysts is attributed to their keratinoid content (7).

In our study, there was no difference between the ADC and lesion-ADC/CSF-ADC values of the benign and malignant tumors when the dermoid tumors were not excluded from the evaluation. When we excluded the patients with dermoid cysts, again there was no difference in the ADC or lesion-ADC/CSF-ADC values of the benign and malignant ovarian tumors (p= 0.335 and p= 0.364, respectively).

Nakayama et al. (7) reported that when patients with dermoid cysts were included in the analysis, a significant difference emerged in the ADC values of benign and malignant cystic tumors. In contrast, when they excluded patients with dermoid cysts from the evaluation, the difference between benign and malignant cystic tumors disappeared. Similarly, in our study, there was a significant difference in the ADC and lesion-ADC/CSF-ADC values between the epithelial and non-epithelial groups before we excluded the dermoid cysts while there was no statistical difference after excluding these cysts (p= 0.702 and p= 0.924, respectively). Our results show that the ADC measurement cannot distinguish between cystic ovarian tumors.

Moteki et al. found that the rate of endometrial cysts was lower in all groups except malignant cystic ovarian tumors (16). Katayama et al. noted that individuals with endometriosis exhibited lower ADC values compared to those with serous cystadenomas (6). Consistently, our study revealed that patients diagnosed with endometriosis displayed lower ADC values compared to those diagnosed with serous tumors and serous cystadenocarcinoma (p= 0.007 and p= 0.002, respectively). The lesion-ADC/CSF-ADC value of the endometrioses was also lower than those of the serous tumors and serous cystadenocarcinomas (p= 0.009 and p= 0.045, respectively). The diminished ADC values and lesion-ADC/CSF-ADC ratios observed in endometriosis are hypothesized to stem from their hemorrhagic content and the presence of hemosiderin (6,16). Our analysis indicated that the lesion-ADC/CSF-ADC ratio did not yield supplementary information beyond the outcomes obtained from other mass ADC measurements.

Limitations of the Study

Our study had certain limitations: The sloshing effect that may occur in large ovarian cysts is one of the reasons for the high ADC values. In addition, the study was conducted in a single center with a relatively limited number of solid and malignant lesions.

CONCLUSION

Initially, diffusion MRI held promise for the assessment of ovarian tumors. Nevertheless, our study underscores that it may not be adequate to effectively differentiate between benign and malignant ovarian tumors. We believe that the supplementary lesion-ADC/CSF-ADC value we derived from our study could enhance the objectivity of other measurements. Dermoid cysts can be easily distinguished from other lesions based on their lower ADC values. While a routine diffusion examination added to conventional pelvic MRI methods might not be entirely effective in distinguishing between benign and malignant lesions, it can still play a role in aiding the differentiation between epithelial and non-epithelial lesions.

Ethics Committee Approval: This study was approved by Harran University Faculty of Medicine Ethics Committee (Decision Number: 13/05/33, Date: 06.05.2013).

Author Contributions: Concept/Design: NK, EK, FD, ÖK, HC, AC, MEG; Analysis/Interpretation: NK, EK; Data Acquisition: NK, FD, ÖK, EK, HC, AC, MEG; Writing: NK, MT, MEG, EK; Critical Revision: NK, MT, MEG, EK; Final Approval: NK.

Conflict of Interest: All authors declare that they have no conflict of interest.

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