Role of Magnetic Resonance Diffusion Weighted Imaging (DWI) in Differentiation between Benign and Malignant Ovarian Masses

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Abstract

Background: Determining whether a clinically diagnosed adnexal mass is benign or malignant is frequently not possible until surgical exploration and histologic examination are performed. Magnetic Resonance (MR) imaging provides useful information for characterization of various ovarian masses. Diffusion-weighted imaging is sensitive to changes in the micro diffusion of water into both intracellular and extracellular spaces and its use may improve MR characterization of ovarian lesions.

Aim of Study: To reveal added value of Diffusion Weighted Images (DWI) in differentiation between benign and malignant ovarian masses.

Patients and Methods: The study included 26 female patients referred from Gynecology to Radiology Department with indeterminate complex and solid ovarian masses based on preliminary abdominopelvic ultrasound; pelvic MRI and Diffusion Weighted Imaging (DWI) were conducted.

Results: Both conventional MRI and DWI had shown 100% sensitivity while the specificity was higher for DWI 70% compared to conventional MRI sequences 50%, as well as the accuracy which was 80.8% for conventional MRI while that of DWI was 88.5%. Addition of DWI to the conventional MRI increased the specificity and the accuracy of examination to 90 and 96.6% respectively.

The mean ADC values for malignant lesions was \((0.9 \times 10^{-3} \pm 0.1 SD mm^2/s)\), while that for benign lesions was \((1.5 \times 10^{-3} \pm 0.4SD mm^2/s)\). The lower ADC values associated with the malignant group were found to be statistically significant \((p\text{-value} < 0.05)\) with \(0.9 \times 10^{-3} mm^2/s\) may be an optimal cutoff value for differentiating benign and malignant ovarian tumors with sensitivity 81.25%, specificity 100%.

Conclusion: Combined evaluation of conventional MRI sequences as well as DWI (both qualitative and quantitative analysis) can confirm or exclude potential malignancy in suspicious ovarian masses taking into consideration possible sequence pitfalls.

Key Words: DWI – MR imaging – Ovarian tumors – ADC value.

Introduction

OVARIAN cancer is a leading cause of death among women. It is the second most common gynecological cancer and the fifth most common cancer in women; unfortunately most women are diagnosed with late stage disease, which has a poor survival rate [1].

Proper management depends on proper preoperative assessment, with the help of clinical examination, laboratory tests and different imaging modalities [2]. Ultrasonography (US) is the first-line technique for detecting and characterizing adnexal masses but it is less accurate for complex or indeterminate masses, even when combined with color Doppler imaging [3]. Because of its inferior soft tissue contrast compared to MRI, Computed Tomography (CT) is not the imaging modality of choice for further characterization of adnexal lesions detected at sonography. In contrast, for staging of suspected ovarian cancer CT remains the primary imaging modality [4]. Pelvic MRI may identify the location of the mass and determine if it is a cystic, solid, or complex. MRI has a high accuracy in differentiating benign from malignant masses. Teratomas, endometriomas, simple and hemorrhagic cysts and fibromas can be diagnosed with high confidence [5].

DWI is one of the promising new functional imaging techniques that have shown to be effective in the differentiation of benign from malignant adnexal masses and improve the detection and delineation of peritoneal implants at both initial staging and follow-up [6]. Other advantages of DWI include its cost-effectiveness and brevity of execution, its complete noninvasiveness, its lack of ionizing radiation, and the fact that no injection of contrast material is required, thus enabling its
use in patients with renal dysfunction [7]. (DW-MRI) is sensitive to molecular diffusion which is due to random microscopic translational motion of water molecules (known as Brownian motion). DW-MRI permits a quantitative evaluation by assessing Apparent Diffusion Coefficient (ADC) values which measures the random motion rate of water molecules and decreases with increased tumor cellularity [8].

**Aim of work:** The purpose of this study was to reveal added value of Diffusion Weighted Images (DWI) in differentiation between benign and malignant ovarian masses, comparing the results with histopathological studies.

**Patients and Methods**

**Patients:** The study was conducted in the Department of Diagnostic Radiology of Assuit University Hospital. Twenty six female patients with their ages ranged from 13-76 years old “mean age was 41.69 years” were recruited from the Department of Obstetrics and Gynecology and were examined by routine pelvic MRI protocol in addition to DWI in the period between March 2015 and March 2016. The main complaint of the cases was abdominal pain (13 patients), and/or abdominal distension (5 patients), other cases came with different complaints such as: Infertility (3 patients), irregular uterine bleeding (4 patients) or follow-up for previously operated ovarian mass (4 patients).

**Inclusion criteria of suspicion were as follows:**
1. Complex cystic or solid ovarian masses,
2. Solid masses,
3. Papillary projections and/or septations in cystic masses
4. Heterogeneous cystic masses.

- We excluded masses with typical benign MR features including pure cystic ovarian masses, endometriomas and mature cystic teratoma.
- Approval of Ethical Committee at Faculty of Medicine, Assuit University was obtained.

**Methods:** All patients underwent preliminary abdominopelvic ultrasound examination. It was done on ultrasound machine GE logic 7, trans-abdominal ultrasound approach was done using a 3-5MHz probe.

MR imaging was performed using a 1.5-T magnet. All the patients were imaged in the supine position with the aid of pelvic phased-array coil.

The following sequences were obtained:
- Axial T2W fast spin echo MR imaging from the renal hilum to the symphysis pubis (TR range/TE range, 3500/90-110; echotrain length, 13-15; slice thickness, 5-7mm; gap, 1-2mm; field of view, 24-38cm; excitations (NSA), 3; and matrix, 304 X 512).
- Sagittal T2W fast spin echo MR imaging from one femoral head to the other (TR range/effective TE range, 3500/90-110; echotrain length, 8; slice thickness, 4-6mm; gap, 1-2mm; field of view, 24-38cm; excitations (NSA), 3; and matrix, 304 X 512).
- Coronal T2W fast spin echo MR imaging of the pelvis from the aortic bifurcation to the symphysis pubis (TR range/effective TE range, 3500/90-110; echotrain length, 8; slice thickness, 4-5mm; gap, 1mm; field of view, 24-38cm; excitations (NSA), 3; and matrix, 304 X 512).
- Axial T1 W spin echo MR imaging from the renal hilum to the symphysis pubis (TR range/TE range, 400-640/10-14; slice thickness, 5-8mm; gap, 1mm; field of view, 24-38cm; excitations (NSA), 1-2; matrix, 256 X 256; and respiratory compensation).
- Axial T1 Spectral Pre-saturation with Inversion Recovery (SPIR) sequence (TR range/TE range, 435/10; slice thickness, 4-5mm; gap, 1mm; field of view, 24-38cm; excitations (NSA), 1-2; and matrix, 256 X 256; and respiratory compensation).
- Axial DWI using spin-echo-type single-shot echo planar imaging with the following parameters: b-value=0, 50, 400, 800 and 1000sec/mm², TR/TE=1259/67ms, a 4-5mm slice thickness; gap, 1mm; a 24-to 45-cm FOV, and a 128 X 192 matrix. Motion-probing gradient pulses were placed in the three orthogonal planes. Isotropic DW imaging was generated using the three orthogonal axis images.

**MR imaging analysis:**
- Conventional images were analyzed as regards involvement of one or both ovaries, maximal diameter of tumors, their MR appearance; tumors were classified as predominantly cystic (if less than half of the mass was solid) or predominantly solid (if more half of the mass was solid), the term “solid component” includes all structures composed of solid tissue (i.e. solid portion, papillary projections and thickened irregular septa). Signal intensity of solid components was evaluated on T2-weighted MR images relative to outer myometrium, and classified as “low” when lower in signal, “intermediate” when the signal was equal to the outer myometrium and “hyperintense” when the signal was greater than outer myometri-
um. The presence of ascites, peritoneal implants, pathologically enlarged pelvic or para-aortic lymph nodes and soft tissue infiltration of other pelvic organs was recorded.

**Interpretation of DWI:**

1- **Qualitative analysis:**

Regarding the signal intensity:

Our data analysis focused upon T2WI as base reference for mass detection.

DW images were inspected for the presence of persistent high SI (restricted diffusion) in correlation to the solid components of the included masses on different b-values (0, 50, 400, 800 and 1000).

DW images with a b-value of 0, 50 and 400 seconds/mm$^2$ were not included in our analysis due to the less diffusion effect and larger T2 shine-through effect yet they are needed to provide a post-processing ADC map with a good resolution and consequently develop an accurate measurement of the ADC value.

Matched ADC maps were applicable using a Phillips Advantage windows workstation with functional tool software; presence of bright SI on the ADC map stands for benign tissue, intermediate to low SI for malignant tissue.

2- **Quantitative analysis:**

Manually plotted Region of Interest (ROI) was drawn on the solid component that showed restricted diffusion (previously interpreted in DWI), following Zhang P, 2012 [9], we used the largest possible Regions of Interest (ROIs), which varied from 15 to 150mm$^2$.

The suggested pathology of the ovarian tumours based on conventional MR imaging and DWI whether benign or malignant was correlated with surgical pathology specimen being the gold standard of reference.

**Statistical analysis:**

Computer software package SPSS 20 was used in the analysis. For quantitative variables, mean and standard deviation were presented. Frequency and percentages were presented for qualitative variables, sensitivity, specificity; PPV, NPV and accuracy all were calculated for the conventional MRI and for the DWI. $t$-test was used to estimate differences in quantitative variables. $p$-Value <0.05 is considered to be significant.

**Results**

**Histopathological findings:**

Twenty six patients were included in the study, 10 patients with benign ovarian tumors, 2 patients with borderline ovarian tumors and 14 patients with invasive malignant ovarian tumors.

Benign masses included two papillary serous cystadenoma, three mucinous cystadenoma, two ovarian fibroma, one fibrothecoma, one serous cystadenofibroma and one sclerosing stromal tumor.

Malignant masses included two borderline tumors of low potential malignancy (borderline papillary serous cystadenoma and borderline mucinous cystadenoma) and 14 invasive malignant masses; including five serous cystadenocarcinoma, four granulosa cell tumor, two mucinous cystadenocarcinoma, two immature teratoma and one endodermal sinus tumor).

For the sake of statistical evaluation, the borderline tumor with low potential malignancy was categorized in our study with the malignant tumors.

**Conventional MR findings:**

There was no significant statistical difference between maximal diameter of benign and malignant ovarian masses ($p=0.56$).

Most of the masses elicited high signal intensity in T2 (46.2%), while the rest elicited heterogeneous signal intensity (23.1%), low signal intensity (23.1%) and intermediate signal intensity (7.7%).

Masses of hyperintense signal on T2WI comprised 46.2% (n=12/26), seen more frequently in malignant masses (n=10/12) than benign ones (n=2/12). Low signal intensity was displayed on T2WI by 23.1% (n=6/26) of the included masses, all of them were benign (n=6/6).

Ascites was less frequently associated with benign masses ($p=0.005$). None of the benign masses was associated with peritoneal implants.

Thickened irregular septa were found in 5/26, two of them were borderline masses while the other 3 were invasive malignant masses.

Conventional MRI suggested malignant pathology in 21 tumors. Fourteen of them were true malignant and 2 of them were borderline tumor (TP), while 5 were benign and diagnosed as being malignant (FP). Conventional MRI suggested benign pathology in 5 cases; all of them were true benign (TN).
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DWI findings:
In the current work, we considered DWI with b-value: 1000, such value provided accepted image resolution with minimal artifacts. High b1000 signal intensity was observed in 73.08% (n=19/26) of the considered masses; among the malignant tumors, all of them elicited high b1,000 signal intensity of their solid component while some masses showed restricted diffusion and were diagnosed malignant despite being of benign pathology. These masses included two ovarian fibroma, one sclerosing stromal tumor.

Facilitated diffusion (bright signal decay) was detected in 7 benign masses, none of malignant masses displayed facilitated diffusion.

ADC measurements:
The mean ADC values for malignant lesions was (0.9 × 10⁻³±0.1SDmm²/s), while that for benign lesions was (1.5 × 10⁻³±0.4SDmm²/s), the lower ADC values associated with the malignant group were found to be statistically significant (p-value <0.05) with 0.9 × 10⁻³mm²/s may be an optimal cutoff value for differentiating benign and malignant ovarian tumors with sensitivity 81.25%, specificity 100%, PPV 100%, NPV 76.9% and accuracy 90.7%.

Diffusion-Weighted (DWI) magnetic resonance suggested malignancy in 19 tumors compared to only 16 stated by the pathology.

Combined evaluation of both conventional MRI and diffusion weighted images suggested malignant pathology in 17 of the included masses. Fourteen of them were true malignant and 2 of them were borderline tumor (TP), while one was benign and diagnosed as being malignant (FP). Combined evaluation suggested benign pathology in 9 cases (TN) compared to 10 masses stated by the pathology Figs. (1-4).

![Fig. (1): A 34-year-old patient with left ovariangranulosa cell tumor (1A and 1B) sagittal T2WI and axial T1WI showed a large complex predominately solid left ovarian mass measuring 9 X 11 X 13cm at its maximum dimensions.](image-url)

(1A) Axial DWI showed persistent high SI of the solid component of the left ovarian carcinoma at b1000 (1C) ADC map showing low signal of solid component with ADC value was 0.8 × 10⁻³mm²/s.
Fig. (2): A 36-year-old patient with recurrent benign papillary serous cystadenoma (2A) Sagittal T2WI, (2B) Axial T2WI (2C) axial T2 fat sat (2D) Axial T1WI showed right ovarian bilocular complex lesion measuring about 10 X 10 X 8cm with cystic component elicited hyperintense signal in T1WI with variable signal intensity on T2WI with no signal drop at fat suppression sequences denoting blood of different age. The lesion showed multiple papillary projections and soft tissue component that elicit hypointense signal in T1 and hyperintense signal in T2WI. (2E) Axial DWI at b1000 showed low signal of solid component with high signal at corresponding ADC map (2F) with ADC value $2 \times 10^{-3} \text{mm}^2/\text{sec}$. 
Fig. (3): A 48-years-old patient with right ovarian high grade serous cystadenocarcinoma. (3A) Sagittal T2WI (3B) Axial T2WI (3C) Axial T1WI showed right complex ovarian lesion with mixed cystic and soft tissue components. The solid component elicits isointense signal in T1 (Fig. 3C white arrow) and intermediate signal in T2 (Fig. 3A & 3B white arrow). Uterus showed multiple interstitial and subserous Fibromyomata (Fig. 3A white curved arrow). The tumor shows persistent high signal on DWI (Fig. 3D white star) with low signal on the corresponding ADC maps (Fig. 3E white star). ADC value of the tumor was $0.9 \times 10^{-3}\text{mm}^2/\text{sec}$.
Fig. (4): A 76-year-old patient with left ovarian cystadenofibroma. (3A, 3B & 3D) sagittal, coronal and axial T2 WI (3C) axial T1 WI showed complex left ovarian mass with mixed cystic and solid components. The solid component elicits hypointense signal in T 1 and heterogeneous signal in T2 (Fig. 4A white arrow), with signal void areas representing calcific foci (Fig. 4B black arrow). Axial T2 image revealed twisted pedicle with swirling appearance suggesting superimposed torsion (Fig. 4D white curved arrow). Lesion shows low signal on DWI (Fig. 4E white star) with intermediate signal on corresponding ADC map (Fig. 4F black star). ADC value was 2.3 X 10\(^{-3}\) mm\(^2\)/sec.

Discussion

DWI is one of the promising new functional imaging techniques that have shown to be effective in the differentiation of benign from malignant adnexal masses [10]. Among the advantages of DWI is that it is a noninvasive technique and it does not require injection of contrast material, thus enabling its use in patients with renal dysfunction [7].

In this study we had performed analysis for the conventional MR sequences, diffusion weighted images regarding their diagnostic performance in the evaluation of complex ovarian masses. Masses differentiation on the conventional MR was based on the morphological features which is a very important issue that was considered for many years. Blinded evaluation was done for the functional data supplied by diffusion weighted imaging regardless specific signal intensity of the masses included on the conventional series.

In our study, we excluded endometriomas, hemorrhagic cysts and mature cystic teratomas which were easily diagnosed by conventional MRI.

In such masses individual performance of DWI could lead to serious misinterpretations and improper case management. False positive findings could be elicited from compact cellular organization and products of hemoglobin degradation in benign endometrioma. A comparable situation could also be found with keratinoid substances and Rokitansky protuberance in mature cystic teratomas, since all of these masses display features of restricted diffusion [11]. As reported by Nakayama et al., [12] DWI is not helpful to characterize mature cystic
prominent ectatic vascular channels suggesting benign lesions was (1.5 \times 10^{-3} \pm 0.4 \text{SDmm}^2/\text{s}), while that for benign lesions was (1.5 \times 10^{-3} \pm 0.4 \text{SDmm}^2/\text{s}), the lower ADC values associated with the malignant group were found to be statistically significant (p-value <0.05) with 0.9 \times 10^{-3} \text{mm}^2/\text{s} may be an optimal cutoff value for differentiating benign and malignant ovarian tumors with sensitivity 81.25\%, specificity 100\%, PPV 100\%, NPV 76.9\% and accuracy 90.7\%.

Three masses showed restricted diffusion in DWI and were diagnosed as being malignant in spite of being actually of benign pathology, these masses included the following entities: Two ovarian fibromas and one sclerosing stromal tumor.

The two cases of ovarian fibroma showed restricted diffusion which could be explained by their high cellularity with their solid component composed of hyalinized cartilage, collagen and spindle cells responsible for restriction, ADC values of those tumors were 1-1.1 \times 10^{-3} \text{mm}^2/\text{sec}.

As regards sclerosing stromal tumor, it showed soft tissue component with restricted effusion but relatively high ADC value 1.2 \times 10^{-3} \text{mm}^2/\text{sec}. This probably could be explained by pathology data which revealed on microscopic examination nodules separated by edematous areas showing prominent ectatic vascular channels suggesting slow flow; these findings may explain relatively high signal intensity in DWI. Quite similar findings was elicited in a case report documented in literature by Hiroko Wada et al., [13].

Awareness of possible diffusion pitfalls was very important in images interpretation, it helped us in predicting benignity of fibrothecoma case which showed low signal intensity at ADC map with low ADC value 1.1 \times 10^{-3} \text{mm}^2/\text{sec}, however it was not hyperintense at b1000 DWI, may be due to “T2 dark out effect”, correlating with the low T2WI signal intensity at conventional images suggestive of benign lesion.

Our results agreed with a study carried out by Koyama et al., [14] on 35 women to determine the accuracy of DWI imaging in the characterization of ovarian masses in patients undergoing pelvic MRI. The study included 26 benign tumors, 8 malignant tumors and 1 borderline tumor. Malignant lesions only showed definite high signal intensity in DW images. Addition of DWI to conventional MRI has increased the specificity from 81\% to 85\% respectively. In their study the sensitivity of both (conventional MRI and DWI) was 100\% which is comparable to our study. They also excluded the teratomas and hemorrhagic cysts.

Another study carried out by Thomassin-Naggara et al., [3] evaluated the contribution of DWI in conjunction with morphological criteria to characterize 77 complex adnexal masses (30 benign and 47 malignant). Like our study, they concluded that low signal intensity on T2-weighted images and disappearance of restricted diffusion signal in the solid component of the mixed adnexal masses may predict benignity.

They attributed the presence of low mean ADC values elicited by benign fibrous tumors as fibromas, Brenner tumors, and cystadenofibromas are due to dense network of collagen fibers within the extracellular matrix.

A similar study was carried out by Takeuchi et al., [11] on 49 ovarian tumors (39 malignant/ borderline malignant, and 10 benign), it stated that the solid portions of all the 39 malignant tumors showed homogeneous or heterogeneous high intensity on DWI, whereas only 3 of the 10 benign tumors (3 thecomas) showed high intensity, however the presence of low intensity on T2-weighted images was suggestive for benign fibrous tumor. The mean ADC value in the 39 malignant tumors 1.03 \times 10^{-3} \text{mm}^2/\text{s} and was significantly lower than that of the 10 benign tumors 1.38 \times 10^{-3}, they concluded low DWI and high ADC intensity may suggest benign lesion, however, it may be occasionally difficult to differentiate benign and malignant lesions only on the basis of DWI. Such suggestion agrees with our study that showed that abundant cellular masses such as ovarian fibromas showed restricted diffusion.

Another study was carried out by Li and colleagues [15] on 127 patients with pelvic masses, (46 benign and 85 malignant). The purpose of this study was to evaluate differences in ADC values
for the solid component of benign and malignant ovarian surface epithelial tumors with the goal of differentiating benign versus malignant ovarian tumors preoperatively.

The mean ADC value in their study measured for the solid component was significantly differed between the benign and malignant lesions. Mean ADC value for benign lesions was $1.69 \times 10^{-3} \pm 0.25\text{SDmm}^2/\text{s}$, and for the malignant was $1.03 \times 10^{-3} \pm 0.22\text{SDmm}^2/\text{s}$. The lower ADC values associated with the malignant group were found to be statistically significant. Their results suggest that an ADC value $\geq 1.25 \times 10^{-3}\text{mm}^2/\text{s}$ may be an optimal cutoff value for differentiating benign and malignant ovarian tumors.

Also in their study, the sensitivity, specificity, PPV, NPV and accuracy of conventional MR imaging all have increased 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% after adding DWI to the conventional MRI which was comparable to our study.

Another study was carried out by Zhang P and colleagues [17] on one hundred and 91 patients with 202 ovarian masses. The results of that study showed that DWI appears to be a useful method for differentiating between benign epithelial ovarian tumors with solid components and malignant ovarian tumors, and is associated with high sensitivity and specificity after exclusion of endometriomas, mature cystic teratomas and pure cystic adenomas from the analysis.

Another study was carried out by Zhoa SH and colleagues [18] to investigate Diffusion-Weighted (DW) Magnetic Resonance (MR) imaging for differentiating borderline from malignant epithelial tumors of the ovary, the study included 60 Borderline Epithelial Ovarian Tumor (BEOTs) in 48 patients and 65 Malignant Epithelial Ovarian Tumors (MEOTs) in 54 patients, results of the study showed that majority of MEOTs to be of high signal intensity on DW imaging, whereas most of BEOTs showed low or moderate signal intensity. The mean ADC value of the solid component of BEOTs ($1.562\pm0.346 \times 10^{-3}\text{mm}^2/\text{s}$) was significantly higher than in MEOTs ($0.841 \pm 0.209 \times 10^{-3}\text{mm}^2/\text{s}$).

Our study included only two borderline tumors (borderline papillary serous cystadenoma and borderline mucinous cystadenoma), on DWI the tumor showed persistent high signal intensity, intermediate signal intensity on ADC map and a rather high ADC value ($1.2 \times 10^{-3}\text{mm}^2/\text{s}$).

On the other hand, results of our study disagreed with a study carried out by Fujii and colleagues [16] on 123 ovarian masses that included 42 malignant and 81 benign lesions. In their study, the majority of the malignant tumors, mature cystic teratomas, and almost half of the endometriomas, showed abnormal signal intensity on DWI, whereas most fibromas and other benign lesions did not. The main locations of abnormal signal intensity were solid portions in malignant ovarian tumors, keratinoid substances and Rokitansky protuberance in mature cystic teratomas, and intracystic clots in endometriomas, they finally concluded that DWI of ovarian lesions and the elicited ADC values are not useful for differentiating benign from malignant ovarian lesions. Their results could be explained by inclusion of endometriomas and mature cystic teratomas in their study which can elicit false positive findings on DWI, since all of these masses display features of restricted diffusion whereas they could be easily diagnosed on basis of conventional sequences.

Focusing on the quantitative and not the qualitative analysis of DWI was the purpose of a Turkish study which evaluated 59 ovarian masses [17]. The study group declared that the ADC values of benign and malignant ovarian lesions overlap and DWI cannot be used for discrimination. They included hemorrhagic cysts and dermoid cysts, which in spite of being cystic yet they present with low ADC values and so can overlap with those of malignant masses. Inclusion of those masses could explain inconsistent findings with our study.

**Conclusion:**

Combined evaluation of conventional MRI sequences as well as DWI (both qualitative and quantitative analysis) can confirm or exclude potential malignancy in suspicious ovarian masses taking into consideration possible sequence pitfalls.

**Conflict of interest:**

We have no conflict of interest to declare.

**References**


دور الرنين المغناطيسي باستخدام خاصية الإنتشار في التعرفة بين أورام البيض الحميدة والخبيثة

بعد سرطان البيض من الأسباب الرئيسية لوفاة بين النساء، ولأسف يتم تشخيص معظم الحالات في مرحلة متأخرة من المرض، حينئذ يكون معدل البقاء على قيد الحياة ضعيف، لذا التشخيص السليم للسرطان يمكن أن يساعد في إيجاد خيارات العلاج المتاحة أكثر، وهذا بدوره يتيح توقع نتائج أفضل للعلاج.

تعد الموجات فوق الصوتية طريقة الفحص الأولى في كثير من الأحيان، وخصوصاً لتمييز التليف الكبيسي من الكتلة الحميدة أو الخبيثة، أما بالنسبة للأشعة متعددة المقاطع فهي مفيدة لتحقيق مرحلة الأورام الخبيثة.

وقد أظهر التصوير بالرنين المغناطيسي أنه أكثر تحديداً ودقة من الفحص بالموجات فوق الصوتية والدوبير في توصيف أورام البيض، مع تطور التقنيات الحديثة في التشخيص، تم إحداث تقدمات جديدة للتصوير الوظيفي، منها الرنين المغناطيسي بالانتشار الجزيئي الذي أصبح يستخدم الآن في فحوصات البطن والحوض بعد أن أظهر كفاءة مفيدة للتشخيص في فحوصات الجهاز العصبي لمدة سنوات.

تعتمد فكرة الرنين المغناطيسي بالانتشار الجزيئي على أن جزيئات الماء تنتشر بحرية في البيانات مذكورة قبلها. في حين أن البيانات ذات الخلايا المرتبطة تتدفق إلى إنتاجها (تقميحها) في ظاهرة تسمى (الحركة البرونينية)، ونتيجة لذلك تظهر الأورام الخبيثة تقليد لجزيئات الماء وذلك لارتفاع كليتها على العكس من الأورام الحميدة. وهذه التقنية لا تعتمد على حقن الوسيط المعتم وبالتالي يمكن استخدامها خاصة في الحالات التي يتطلب فيها إدخال الوسيط المعتم كما هو الحال في حالة الحمل.

ولقد أظهرت الدراسة التي أجريت على ستة وعشرون كتلة أن إضافة الرنين المغناطيسي بخاصة الإنتشار الجزيئي إلى التصوير التقليدي أدى إلى:

• زيادة دقة التشخيص وجعله أكثر اخصائيه لتحديد نوع الورم.
• التصور بخاصة الإنتشار الجزيئي فقط ليست طريقة عملية للترقية بين الكتلة الحميدة والخبيثة.
• يجب أخذ نتائج الرنين المغناطيسي التقليدي بعيد الاعتبار وتحليلها جنبًا إلى جنب مع نتائج التصوير بخاصة الإنتشار الجزيئي الكيفية والكمية (حساب معامل الإنتشار).