Original Article

Magnetic Resonance Imaging Findings in Patients with Benign and Malignant Ovarian Masses Versus Pathologic Outcomes

Fariba Behnamfar, Zahra Tashakor, Atoosa Adibi[1]

Departments of Obstetrics and Gynecology and [1]Radiology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran

Abstract

Background: The results of the former study confirmed the accuracy of magnetic resonance imaging (MRI) in determining the origin and content of ovarian masses. The present study aimed to evaluate the diagnostic value of MRI in differentiating benign and malignant ovarian masses in women. **Materials and Methods:** This was a cross-sectional study. All candidates for surgery to remove ovarian masses were selected to participate in this study. They underwent MRI with gadolinium before the surgery. MRI images were reviewed by an experienced radiologist who was aware of the ovarian mass found in pelvic ultrasonography (US). A thick-enhancing wall, mural nodules, septations, and internal enhancement within the mass were reviewed by the radiologist. Mass specimens were examined in the laboratory by an experienced pathologist to determine malignancy or benignancy of the masses. Pathological findings were compared with MRI results. **Results:** there was no significant difference between MRI findings and pathology denoted by benign and malignant (P = 0.06), but results showed a significant difference between US and pathology (P = 0.002). In MRI findings related to a thick-enhancing wall (P = 0.18), internal enhancement (P = 0.18), and pelvic fluid (P = 1.00), no significant difference was seen in benign or malignant masses. However, in findings related to septation, all cases had malignant reports (P = 0.006), and in mural nodule, 80% had malignant reports (P = 0.006). CA-125 blood level in patients with benign masses (1.72 ± 0.97) was significantly less than patients with malignant masses (3.20 ± 0.83) (P < 0.001). **Conclusion:** We showed that MRI has better results in diagnosing adnexal masses and their characteristics compared to simple ultrasound imaging based on pathological studies.

Keywords: *Magnetic resonance imaging, ovarian masses, ultrasonography*

Introduction

Ovarian cancer is one of the leading causes of cancer-related death among women. In 2009, 21,550 new cases of ovarian cancer were diagnosed, and 14,600 women died of ovarian cancer.[1] The mortality rate of invasive ovarian cancers is 1 in 95. The average 5-year survival rate for women with invasive breast cancer is 90% if diagnosed early. However, most patients (65%–70%) are diagnosed at advanced stages of the disease, and their 5-year survival rate is 30%–73%.[2] Ovarian tumor is an indication for surgery in women.[3] Some cases of adnexal masses were also detected incidentally. In the United States, 5%–10% of women underwent surgery following the incidental detection of adnexal masses.[4,5] Random findings are challenging for the physician due to the overlap of the benign and malignant characteristics of adnexal masses in many cases. Diagnostic modalities can be used for screening the patients with ovarian cancer since early diagnosis can improve prognosis.[6-8]

Ultrasound is the imaging modality of choice for pelvic masses in females. Pelvic ultrasonography (US) is convenient, low-cost, and highly sensitive in detecting adnexal masses.[9] However, this technique has a low specificity in the differentiation of benign and malignant masses. Its specificity varied from 60% to 95% in various studies.[10] The origin of large masses cannot be determined with ultrasound. Ultrasound cannot differentiate between malignant and benign masses. Studies have shown surgical elimination of 50%–67% of benign ovarian masses since ultrasound did not distinguish between benign and malignant masses. Various studies have examined the specificity and accuracy of

How to cite this article: Behnamfar F, Tashakor Z, Adibi A. Magnetic resonance imaging findings in patients with benign and malignant ovarian masses versus pathologic outcomes. Adv Biomed Res 2020;9:64.

Address for correspondence:
Dr. Zahra Tashakor, Department of Obstetrics and Gynecology, Alzahra University Hospital, Isfahan University of Medical Sciences, Sofe Blvd., Isfahan, Iran.
E-mail: tashakorz@gmail.com

Received: 04 December 2019
Revised: 09 March 2020
Accepted: 20 June 2020
Published: 30 October 2020

Access this article online

Website: www.advbiores.net

DOI: 10.4103/abr.abr_253_19

Quick Response Code:

magnetic resonance imaging (MRI) in differentiating benign and malignant pelvic masses.[11-13] In a study, the patients underwent MRI following the detection of adnexal masses in pelvic sonography. The results of the former study confirmed the accuracy of MRI in determining the origin and content of these masses. The authors of the former study recommended MRI in case that the masses found in pelvic US were suspicious for malignancy.[14] Meta-analysis studies suggested that MRI with intravenous contrast is the best modality for the detection of ovarian cancers, especially in comparison with computed tomography, Doppler ultrasound, or MRI without contrast.[15] Few studies have assessed the diagnostic value of modalities, and each study had some limitations (e.g., small sample size). Therefore, the present study aimed to evaluate the diagnostic value of MRI in differentiating benign and malignant ovarian masses in women visiting Al-Zahra Hospital.

Materials and Methods

This was a cross-sectional study performed in 2018–2019 in Isfahan. The participants included patients diagnosed with an ovarian mass in pelvic US, who visited the Radiology Department of Al-Zahra Hospital in Isfahan University of Medical Sciences in 2018–2019. The sample size was thirty. Inclusion criteria were indications for ovarian mass surgery (detection of ovarian mass in pelvic US that has an indication for surgery based on patient's condition or suspected for malignancy according to ultrasound report), consent to participate in the study, and lack of determination of benign or malignant masses in pelvic US. Exclusion criteria included previous history of malignancy and gadolinium sensitivity. Convenient sampling was used in this study. The patients visiting the clinic of Al-Zahra Hospital and candidates for ovarian mass surgery were selected to participate in this study. Eligible patients entered the study according to the inclusion criteria.

All candidates for surgery to remove ovarian masses were selected to participate in this study. The project was explained to the participants. Informed consent forms were collected from the patients. They underwent MRI with gadolinium before the surgery. The procedure was performed in the MRI Department of Al-Zahra Hospital. Later, the patients underwent surgery to remove the ovarian mass. Collected specimens from the ovarian mass were transferred to the laboratory of Al-Zahra Hospital for pathological examination. MRI images were reviewed by an experienced radiologist who was aware of the ovarian mass found in pelvic US, but the radiologist was unaware of ultrasound findings. A thick-enhancing wall, mural nodules, septations, internal enhancement within the mass, an abnormal amount of pelvic fluid, lymph node enlargement, and peritoneal metastases were reviewed by the radiologist. The radiologist used an integer between 1 and 4 to describe the mass. The integer 1 represented a benign mass (2 = probably benign, 3 = probably malignant), and the integer 4 showed a malignant mass. CA-125 levels were also measured for patients using blood samples of patients before surgeries.

Mass specimens were examined in the laboratory by an experienced pathologist to determine malignancy or benignancy of the masses. Pathological findings were compared with MRI results. Collected data were entered into SPSS v. 23 (SPSS Inc., Chicago, United States) and were analyzed.

Results

According to Table 1, results showed that there was no significant difference between MRI findings and pathology denoted by benign and malignant (P = 0.06), but results showed a significant difference between US and pathology (P = 0.002).

A number of gravidities did not show a significant difference in benign and malignant ovarian masses (P = 0.25). On the other hand, gravidity does not affect mass type. Menopausal status did not have any effect on mass types too (P = 0.06) [Table 2].

According to Table 3, in MRI findings related to a thick enhancing wall (P = 0.18), internal enhancement (P = 0.18), and an abnormal amount of pelvic fluid (P = 1.00), no significant difference was seen in benign or malignant masses. However, in findings related to septation, all cases had a malignant report (P = 0.006), and in the mural nodule, 80% had a malignant report (P = 0.006).

About US, findings are shown in Table 4; solid (P = 0.31), solid cystic (P = 0.11), thick wall (P = 0.87), and an abnormal amount of pelvic fluid (P = 0.16) did not have a significant difference in the assessment of benign and malignant masses. The most observation in benign cases was the cystic feature of masses (P = 0.04). However, the

Table 1: Magnetic resonance imaging and ultrasonography versus pathology in the benign and malignant groups

Parameter	Pathology		*P*
	Benign, *n* (%)	Malignant, *n* (%)	
MRI			
Benign	19 (63.3)	2 (6.7)	0.06*
Probably benign	2 (6.7)	0	
Malignant	2 (6.7)	3 (10.0)	
Probably malignant	2 (6.7)	0	
US			
Benign	13 (43.3)	0	0.002*
Probably benign	9 (30.0)	1 (3.3)	
Malignant	0	2 (6.7)	
Probably malignant	3 (10.0)	2 (6.7)	
Yes	2 (6.7)	2 (6.7)	

*At 5% level of Fisher's exact test. MRI: Magnetic resonance imaging, US: Ultrasonography

most observations in malignant cases were related to mural nodule (P = 0.02), internal vascularity (P = 0.009), and peritoneal implants (P = 0.02).

CA-125 blood level in patients with benign masses (17.07 ± 10.45) was significantly less than patients with malignant masses (156.64 ± 145.90) (P < 0.001). The mean age of patients with malignant masses was significantly more than patients with benign masses (P = 0.01) [Table 5].

Total abdominal hysterectomy and bilateral salpingo-oophorectomy and staging were done in the malignant group due to the type of tumor. Pathologic findings denoted by benign and malignant tumors are indicated in Table 6.

Discussion

Here, in this study, we indicated that ultrasound imaging of ovarian masses had a significant difference compared to pathological results. On the other hand, MRI had indicated better results for diagnosing benign and malignant masses. Our MRI evaluation reported septation for all of the patients with a malignant ovarian mass. A mural nodule was also reported in 80% of malignant tumors. Based on ultrasound imaging, cystic masses, mural nodule and internal septation, internal vascularity, and peritoneal implant were seen in malignant tumors. Based on our analysis, serum levels of CA-125 were higher among patients with malignant tumors. Functions of MRI and ultrasound imaging have been evaluated in different lines of evidence. In a study by Adusumilli *et al*. in 2006, they evaluated 87 patients with both ultrasound imaging and MRI studies and compared the results with histopathological findings. They declared that MRI is more accurate and specific for adnexal masses and is able to diagnose its tissue content. Furthermore, they reported that septation, mural nodules, and thick enhancing wall are characteristics of malignant masses.[16] They also indicated that sonography had a poor agreement with tissue content. These results are in line with the results of our study. We showed that septation and mural nodules are observed in almost all of the malignant tumors and were reported by MRI.

In another study by Sohaib *et al*. in 2005, they assessed 72 patients with clinically suspected adnexal masses by MRI and ultrasound imaging. In the end, they indicated that MRI has better results in characterizing and diagnosing adnexal masses.[17] They also showed that septation is more common in malignant tumors. Furthermore, evaluation of CA-125 in patients showed higher results among patients with malignant tumors. These results are also in line with our study. We indicated that MRI has a better ability in diagnosing adnexal tumors compared to ultrasound imaging. We also observed a higher CA-125 in patients with malignant tumors.

Grab *et al*. evaluated ovarian masses with MRI and US and also positron-emission tomography (PET) and reported that US is able to indicate characteristics of ovarian masses and can help physicians for correct classification. They also

Table 2: Gravidity and menopausal status in the benign and malignant groups

Parameter	Pathology		*P*
	Benign, *n* (%)	Malignant, *n* (%)	
Gravidity			
0	7 (23.3)	0	0.25*
1	4 (13.3)	0	
2	4 (13.3)	2 (6.7)	
3	7 (23.3)	1 (3.3)	
4	2 (6.7)	2 (6.7)	
5	1 (3.3)	0	
Menopause			
No	23 (76.7)	3 (10.0)	0.06*
Yes	2 (6.7)	2 (6.7)	

*AT 5% level of Fisher's exact test

Table 3: Magnetic resonance imaging findings

Variable	Benign, *n* (%)	Malignant, *n* (%)	*P*
Thick enhancing wall	3 (10.0)	2 (6.7)	0.18*
Internal enhancement	3 (10.0)	2 (6.7)	0.18*
Septation	7 (23.3)	5 (16.7)	0.006**
Mural nodule	3 (10.0)	4 (13.3)	0.006**
Abnormal amount of pelvic fluid	3 (10.0)	1 (3.3)	1.00*

*At 5% level of Fisher's exact test, **At 5% level of Chi-square test

Table 4: Ultrasonography findings

Finding	Benign, *n* (%)	Malignant, *n* (%)	*P*
Cystic	22 (73.3)	2 (6.7)	0.04*
Solid	1 (3.3)	1 (3.3)	0.31*
Solid cystic	2 (6.7)	2 (6.7)	0.11*
Thick wall	11 (36.7)	2 (6.7)	0.87**
Mural nodule	7 (23.3)	4 (13.3)	0.02**
Internal thick septa	4 (13.3)	3 (10.0)	0.04**
Internal vascularity	1 (3.3)	3 (10.0)	0.009*
Peritoneal implant	0	2 (6.7)	0.02*
Abnormal pelvic fluid	0	1 (3.3)	0.16*

*At 5% level of Fisher's exact test, **At 5% level of Chi-square test

Table 5: Mean age and CA-125 in benign and malignant groups

Pathology	Mean	SD	Test value	*P*
Age				
Benign	35.00	9.72	2.63	0.01*
Malignant	48.60	14.51		
CA-125				
Benign	17.07	10.45	0.001	<0.001**
Malignant	156.64	145.90		

*AT 5% level of independent samples test, **At 5% level of Mann–Whitney U-test. SD: Standard deviation

Table 6: Pathologic findings denoted by benign and malignant

Pathology type	Pathology		Test	Test value	*P*
	Benign	Malignant			
Dermoid	9 (30.0)	0	Fisher's exact test	30.00	<0.001
Serous cystadenofibroma	1 (3.3)	0			
Myoma	4 (13.3)	0			
Serous cystadenoma	9 (30.0)	0			
Serous carcinoma	0	2 (6.7)			
Mucinous cystadenocarcinoma	0	1 (3.3)			
Serous borderline	0	2 (6.7)			
Mucinous cystadenoma	2 (6.7)	0			
Total	25 (83.3)	5 (16.7)			

suggested that a combination of ultrasound imaging and MRI along with PET can improve the accuracy of differentiation of benign and malignant masses.[18] In a recent study by Emil *et al*. in 2018, 18 patients with ovarian masses were studied by MRI. They showed that MRI has a higher ability than other imaging techniques in differentiating functional from neoplastic pediatric ovarian masses.[19] Sofic *et al*. performed a study on 74 patients with pelvic pain and suspected to ovarian masses. They evaluated patients with transvaginal US (TVU) and MRI. They concluded that patients with pelvic pain and patients with suspicion to ovarian masses should be evaluated by TVU at the first line, and when the results were confusing or unspecific, MRI is the next imaging choice.[20] These studies emphasize the important role of MRI in differentiating and diagnosing the adnexal tumors, especially when ultrasound imaging is not able to clarify the disease. These results are also in line with our study. Here, we indicated that MRI reports of ovarian tumors have better coordination with histopathological evaluations. Shimada *et al*. reported that the ultrasound-based logistic regression model (LR2) had a similar sensitivity to MRI for differentiating benign and malignant tumors and is a better choice compared to the normal US.[21] This issue might cast doubt on our findings but the difference is that in the present study, we utilized simple ultrasound imaging.

Conclusion

In the present study, we showed that MRI has better results in diagnosing adnexal masses and their characteristics compared to simple ultrasound imaging based on pathological studies. Based on the present study and the previous data, we can suggest that MRI should be performed in patients, suspicion of adnexal masses, especially when the US reports confusing or unspecific findings.

Financial support and sponsorship

This study was granted by the Isfahan University of Medical Sciences.

Conflicts of interest

There are no conflicts of interest.

References

1. Torre LA, Trabert B, DeSantis CE, Miller KD, Samimi G, Runowicz CD, *et al*. Ovarian cancer statistics, 2018. CA Cancer J Clin 2018;68:284-96.
2. Reid BM, Permuth JB, Sellers TA. Epidemiology of ovarian cancer: A review. Cancer Biol Med 2017;14:9-32.
3. Matulonis UA, Sood AK, Fallowfield L, Howitt BE, Sehouli J, Karlan BY. Ovarian cancer. Nat Rev Dis Primers 2016;2:16061.
4. Kuchenbaecker KB, Hopper JL, Barnes DR, Phillips KA, Mooij TM, Roos-Blom MJ, *et al*. Risks of breast, ovarian, and contralateral breast cancer for BRCA1 and BRCA2 mutation carriers. JAMA 2017;317:2402-16.
5. Cordeiro Vidal G, Babin G, Querleu D, Guyon F. Primary debulking surgery of the upper abdomen and the diaphragm, with a plasma device surgery system, for advanced ovarian cancer. Gynecol Oncol 2017;144:223-4.
6. Leibman AJ, Kruse B, McSweeney MB. Transvaginal sonography: comparison with transabdominal sonography in the diagnosis of pelvic masses. AJR Am J Roentgenol 1988;151:89-92.
7. Jacobs I, Oram D, Fairbanks J, Turner J, Frost C, Grudzinskas JG. A risk of malignancy index incorporating CA 125, ultrasound and menopausal status for the accurate preoperative diagnosis of ovarian cancer. Br J Obstet Gynaecol 1990;97:922-9.
8. Tingulstad S, Hagen B, Skjeldestad FE, Onsrud M, Kiserud T, Halvorsen T, *et al*. Evaluation of a risk of malignancy index based on serum CA125, ultrasound findings and menopausal status in the pre-operative diagnosis of pelvic masses. BJOG 1996;103:826-31.
9. Tingulstad S, Hagen B, Skjeldestad FE, Halvorsen T, Nustad K, Onsrud M. The risk-of-malignancy index to evaluate potential ovarian cancers in local hospitals. Obstet Gynecol 1999;93:448-52.
10. Bäumler M, Gallant D, Druckmann R, Kuhn W. Ultrasound screening of ovarian cancer. Hormone Molecular Biology and Clinical Investigation. 2019 Sep 17;1.
11. Tailor A, Jurkovic D, Bourne TH, Collins WP, Campbell S. Sonographic prediction of malignancy in adnexal masses using multivariate logistic regression analysis. Ultrasound Obstet Gynecol 1997;10:41-7.
12. Alcázar JL, Jurado M. Using a logistic model to predict malignancy of adnexal masses based on menopausal status, ultrasound morphology, and color Doppler findings. Gynecol Oncol 1998;69:146-50.
13. Timmerman D, Bourne TH, Tailor A, Collins WP, Verrelst H, Vandenberghe K, *et al*. A comparison of methods for preoperative discrimination between malignant and benign adnexal masses:

The development of a new logistic regression model. Am J Obstet Gynecol 1999;181:57-65.

14. DePriest PD, Varner E, Powell J, Fried A, Puls L, Higgins R, *et al*. The efficacy of a sonographic morphology index in identifying ovarian cancer: A multi-institutional investigation. Gynecol Oncol 1994;55:174-8.
15. Tailor A, Jurkovic D, Bourne TH, Collins WP, Campbell S. Sonographic prediction of malignancy in adnexal masses using an artificial neural network. Br J Obstet Gynaecol 1999;106:21-30.
16. Adusumilli S, Hussain HK, Caoili EM, Weadock WJ, Murray JP, Johnson TD, *et al*. MRI of sonographically indeterminate adnexal masses. AJR Am J Roentgenol 2006;187:732-40.
17. Sohaib SA, Mills TD, Sahdev A, Webb JA, Vantrappen PO, Jacobs IJ, *et al*. The role of magnetic resonance imaging and ultrasound in patients with adnexal masses. Clin Radiol 2005;60:340-8.
18. Grab D, Flock F, Stöhr I, Nüssle K, Rieber A, Fenchel S, *et al*. Classification of asymptomatic adnexal masses by ultrasound, magnetic resonance imaging, and positron emission tomography. Gynecol Oncol 2000;77:454-9.
19. Emil S, Youssef F, Arbash G, Baird R, Laberge JM, Puligandla P, *et al*. The utility of magnetic resonance imaging in the diagnosis and management of pediatric benign ovarian lesions. J Pediatr Surg 2018;53:2013-8.
20. Sofic A, Husic-Selimovic A, Katica V, Jahic E, Delic U, Sehic A, *et al*. Magnetic resonance imaging (MRI) and transvaginal ultrasonography (TVU) at ovarian pain caused by Benign Ovarian Lesions. Acta Inform Med 2018;26:15-8.
21. Shimada K, Matsumoto K, Mimura T, Ishikawa T, Munechika J, Ohgiya Y, *et al*. Ultrasound-based logistic regression model LR2 versus magnetic resonance imaging for discriminating between benign and malignant adnexal masses: A prospective study. Int J Clin Oncol 2018;23:514-21.