Section: Radio-Diagnosis

Original Research Article

MRI CHARACTERIZATION OF OVARIAN MASSES AND DIFFERENTIAL DIAGNOSIS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Ovarian masses present a significant challenge in gynecology, necessitating accurate differentiation between benign and malignant lesions for effective patient management. This study aims to evaluate the diagnostic efficacy of magnetic resonance imaging (MRI) in distinguishing between benign and malignant ovarian masses.

Material and Methods: A cross-sectional study was conducted at Department of Radiology, Index Medical College Hospital and Research Centre, Indore involving 60 female patients with ovarian masses diagnosed via pelvic ultrasound. Patients underwent MRI, including both plain and contrast sequences, and findings were compared to histopathology results.

Results: The age range of patients was 18 to 80 years, with an average age of 41.4 ± 10.2 years. The most common clinical presentation was lower abdominal pain (88%). The most frequently observed tumor was mucinous cystadenoma (15%). MRI demonstrated a sensitivity of 93.33% and specificity of 68.89% for detecting malignancy, with a positive predictive value (PPV) of 50% and a negative predictive value (NPV) of 96.88%. Significant differences were noted in the presence of solid components (P=0.010) and contrast enhancement (P=0.005) between malignant and benign tumors.

Conclusion: MRI is an effective diagnostic tool for differentiating between benign and malignant ovarian tumors, particularly due to its high sensitivity and strong NPV. The findings support the incorporation of MRI into preoperative decision-making. Future studies should focus on standardizing imaging parameters to further enhance diagnostic accuracy.

Key Words: Ovarian masses, magnetic resonance imaging, benign tumors, malignant tumors, diagnostic efficacy, sensitivity, specificity.

INTRODUCTION

Ovarian masses are one of the most frequently encountered conditions in gynecology, posing a significant challenge due to the complexities of differential diagnosis. Ovarian cancers, in particular, rank among the most lethal gynecological malignancies, with a mortality rate of 1 in 95 women. These cancers are often characterized by late-stage presentation and a poor response to treatment.[1]

Accurate characterization of ovarian lesions and differencing malignant and benign lesions is crucial for planning appropriate therapeutic interventions and can significantly influence patient management. Optimal evaluation of adnexal masses necessitates a multidisciplinary approach that includes physical examination, laboratory tests, and imaging techniques. Primary ovarian tumors are generally classified into three main categories based on their origin: epithelial, germ cell, and sex cord-stromal tumors. Ovarian neoplasms may be benign, borderline, or malignant.[2]

Management strategies differ, with radical surgery indicated for suspected ovarian malignancies, while less invasive options, such as laparoscopy, are appropriate for potentially benign tumors. Ultrasound (US) is the first-line imaging technique for suspected ovarian lesions, playing a vital role in the identification of ovarian tumors.[3]

An adnexal mass is classified as indeterminate on ultrasound when it cannot be confidently categorized as either benign or malignant, despite a comprehensive evaluation that includes Doppler assessment. Additionally, it remains unclear whether the mass originates from the ovary, uterus, or another pelvic structure.[4]

Ultrasonography is the primary and preferred imaging modality for evaluating adnexal lesions, providing a valuable preoperative assessment to characterize simple cysts and noncomplex masses due to its convenience, low cost, and high sensitivity in detecting adnexal masses. However, its specificity in distinguishing between benign and malignant lesions is limited, with reported rates ranging from 60% to 95%.[5] Additionally, ultrasound often fails to identify the origin of large masses and cannot reliably differentiate between benign and malignant tumors. Research indicates that surgical removal has been performed on 50% to 67% of benign ovarian masses because ultrasound was unable to make this distinction.[6]

When ultrasound findings are inconclusive or ambiguous, MRI serves as a valuable problem-solving tool and an adjunctive method for evaluating adnexal lesions. It provides crucial information for surgical planning while avoiding radiation exposure. MRI is particularly effective in offering detailed insights into hemorrhage, fat, and collagen content.[5] It can differentiate between various tissue types within pelvic masses and effectively distinguish benign from malignant ovarian tumors, boasting an overall accuracy of 88% to 93%.[7]

Magnetic resonance imaging reveals structural characteristics and alterations in signal intensity in T1- and T2-weighted images to aid in assessing ovarian masses. Also, magnetic resonance images can readily identify papillary projections, mural nodules, thick septa and solid components, which may not consistently differentiate between malignant and non-malignant tumors.[8]

Due to its superior soft tissue contrast and ability to visualize in multiple planes, MRI excels at delineating and characterizing both normal uterine anatomy and various uterine conditions. It is a non-invasive technique with no radiation risk, does not require anesthesia, and is less dependent on the operator's skill. Features typically indicative of benign tumors include a diameter of less than 4 cm, entirely cystic components, a wall thickness of less than 3 mm, a lack of internal structures, and the absence of ascites, peritoneal disease, or adenopathy.[9]

Many anecdotal studies indicate that MRI with intravenous contrast is the most effective modality for detecting ovarian cancers, particularly when compared to computed tomography, Doppler ultrasound, and non-contrast MRI.[1,6,8,10]

While some studies have explored the diagnostic capabilities of various imaging techniques, they often faced limitations, such as small sample sizes. Consequently, this study aims to evaluate the diagnostic efficacy of MRI in distinguishing and characterisation of between benign and malignant ovarian masses.

MATERIALS AND METHODS

After approval from the institutional ethical committee, the present cross-sectional study was undertaken in the Department of Radiodiagnosis, Index Medical College Hospital and Research Centre, Indore and 60 female patients diagnosed with an ovarian mass in pelvic US and referred from the outpatient department for an MRI and satisfying the inclusion and exclusion criteria were included. A written informed consent was obtained from all patients after explaining the study protocol and enrolment was done.

Inclusion Criteria

- All patients with clinically suspected ovarian masses.
- Patients with incidentally detected ovarian masses on pelvic sonography.
- Patients of all age groups.

Exclusion Criteria

- Patients with bladder carcinoma and rectal carcinoma.
- Patients who have underwent treatment for pelvic mass.
- Patients with metallic implants, cardiac pacemakers, cochlear implants.
- Patients who are claustrophobic.
- Patients who are unwilling for imaging

Methodology

A thorough clinical history was taken followed by physical examination. Patients underwent initial ultrasonography, followed by MRI, including both plain and contrast sequences as necessary. The MRI findings were then compared to those from the ultrasonography and correlated with operative and histopathological results when applicable.

The ultrasonography was performed using multi-frequency linear, curvilinear, and transvaginal transducers on an GE voluson S8 Ultrasound machine.

MRI studies were conducted on a 1.5 Tesla electromagnet (GE Company), employing primary pulse sequences of T1-weighted imaging (T1WI) and T2-weighted imaging (T2WI). Images were captured using a multislice technique, with a slice thickness of 3 mm, an interslice gap of 6 mm, a field of view (FOV) of 220–240 mm, and a matrix size of 512 x 512. Gadolinium contrast at a dosage of 0.1 mmol/kg body weight) was administered when required, and patients were followed up to correlate

imaging findings with clinical outcomes and operative findings. A radiologist analyzed all images and documented the observations within the research checklist. Finally, the preoperative MRI diagnosis was compared with the postoperative histopathology result following the surgical procedure. The histologically reported masses as borderline tumors were included in the group of malignant tumors in the statistical calculations.

Statistical Analysis

Raw data were recorded in Microsoft Excel 10.0 and analyzed using IBM SPSS version 22.0. Continuous parametric data were summarized as means and standard deviations, while non-parametric data were summarized using medians and interquartile ranges. Categorical data were expressed as percentages. The Chi-square test was applied to compare categorical data, with a p-value of less than 0.05 indicating statistical significance. Additionally, sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy of MRI in diagnosing benign and malignant ovarian masses were calculated based on the number of true positives, false positives, and false negatives.

RESULTS

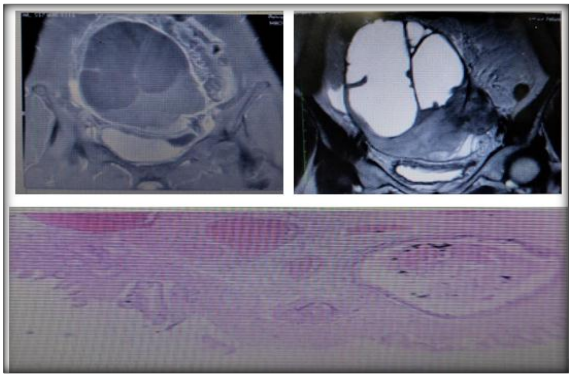


Figure 1: COR T2 showing multilocular cystic lesion with solid intermediate signal intensity component and internal septations. Histopathology showing ovarian cyst wall with mucin

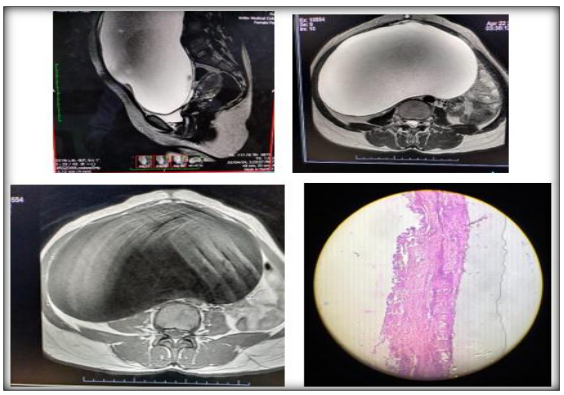


Figure 2: Sagittal and axial T2 weighted images and axial T1 images showing unilocular cystic lesion, on histopathology it is showing smooth epithelial lining, no papillary excrescences

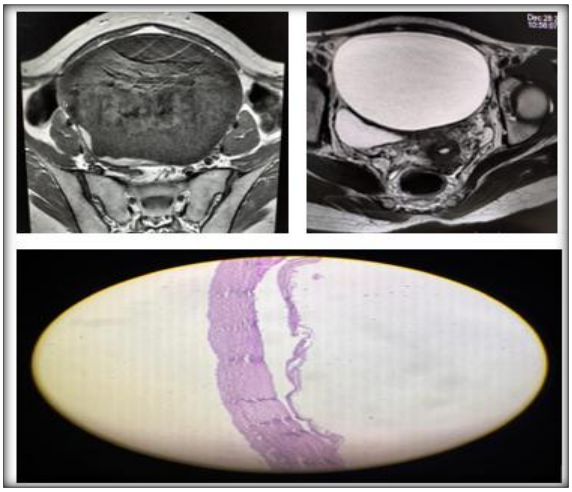


Figure 3: AXIAL T2 showing large pelvic cavity hyperintense paraovarian cystic lesion with T1 hypointensity. HPE showing layers of cuboidal to columnar epithelium without proliferation

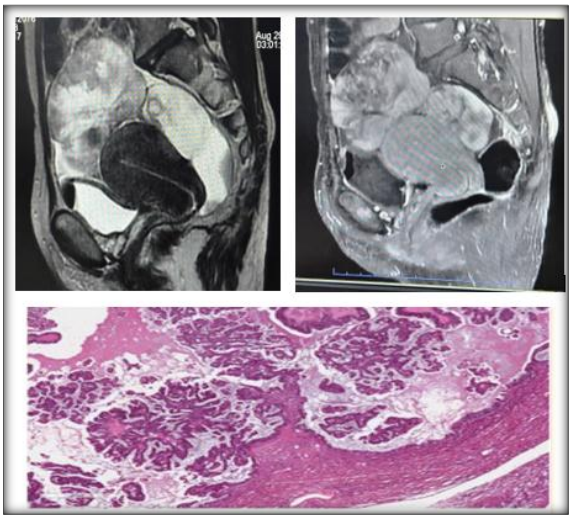
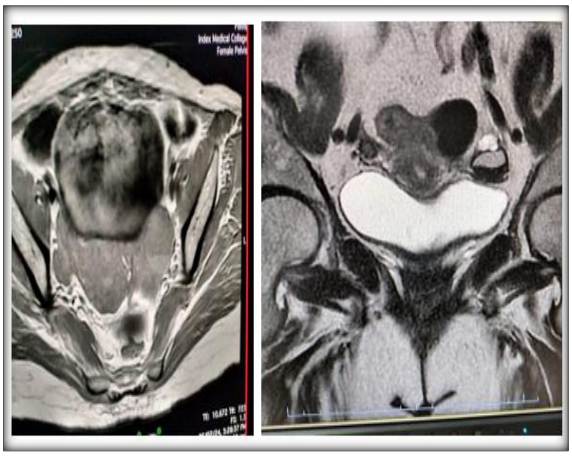


Figure 4: SAGITTALT2-weighted images show a multiloculated cystic ovarian tumour with intermediate to high signal intensity of the loculi and solid parietal component. SAGITTAL contrast-enhanced T1-weighted image demonstrates enhancement of the wall and of the solid component. HPE shows neoplastic glands lined by columnar cells of intestinal-type with mucinous secretion



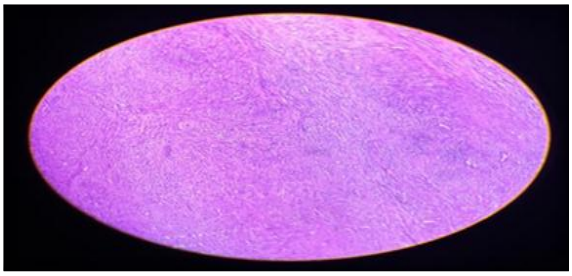


Figure 5: Axial T1 & COR T2 showing hyperintense cyst with fluid-fluid levels in left ovary. HPE showing convoluted layer of mainly granulosa lutein cells surrounding a fibrous to haemorrhagic centre

Out of 60 patients with ovarian masses, the age range varied from 18 to 80 years, with an average age of 41.4 + 10.2 years. The most affected age group was 21 to 40 years, accounting for 54% of the cases. The most common clinical presentation was lower abdominal pain, reported by 88% (53 out of 60) of the patients, followed by a lower abdominal lump in 32% (19 patients). Additionally, 10% of the patients reported irregular cycles, while primary amenorrhea, primary infertility, and bloody vaginal discharge were each observed in 4% of the cases. [Table 1]

The diagnostic performance of MRI, compared to histopathology results, is detailed in Table 2. The study findings show that MRI had a sensitivity of 93.33% and a specificity of 68.89% in detecting malignancy. The positive predictive value (PPV) was 50%, the negative predictive value (NPV) was 96.88%, and the overall diagnostic accuracy was 75%. These results suggest that MRI is highly effective in ruling out malignancy due to its strong NPV, though its ability to confirm malignancy (PPV) is relatively moderate. [Table 2]

The study evaluated various MRI parameters to distinguish between malignant and benign ovarian masses before surgery. A statistically significant difference was observed in the presence of solid components, which were more frequent in malignant tumors compared to benign ones (P=0.010). Additionally, malignant tumors showed a significantly higher frequency of contrast enhancement than benign masses (P=0.005). However, other parameters such as internal septa, lymphadenopathy, ascites, and diffusion restriction did not show significant differences between malignant and benign ovarian masses (P>0.05). These findings highlight the importance of solid components and contrast enhancement as key MRI indicators for diagnosing malignancy in ovarian tumors. [Table 3]

Table 1: Shows the frequency distribution of different types of ovarian masses according to the histopathology results. Mucinous cystadenoma has the highest occurrence rate (15%)

Table 1: Different types of ovarian masses according to the histopathology results

Types of ovarian masses	Number (%)
Benign	
• Mucinous cystadenoma	9 (15%)
• Serous cystadenoma	7 (11.8%)
• Mature teratoma	5 (8.3%)
• Fibrotecoma	4 (6.7%)
• Inclusion cyst	3 (5%)
• Corpus luteum cyst	3 (5%)
• Seromucinous cystadenoma	3 (5%)
• Sertoli leydig cell tumour	2 (3.3%)
• Mucinous borderline	2 (3.3%)
• Serous borderline	2 (3.3%)
• Dermoid cyst	2 (3.3%)
• Struma ovary	2 (3.3%)
• Papillary cystadenoma	1 (1.7%)
Malignant	
• Granulosa cell tumor	5 (8.3%)
• Seromucinous adenocarcinoma	2 (3.3%)
• Papillary serous carcinoma	2 (3.3%)
• Immature teratoma	2 (3.3%)
• Low grade serous carcinoma	1 (1.7%)
• Mixed clear cell and ondometrioid carcinoma	1 (1.7%)
• Disgerminoma tumor	1 (1.7%)
• Metastatic lobular carcinoma	1 (1.7%)

Table 2: Sensitivity, specificity, Positive and negative predictive values and overall accuracy of MRI compared to histopathological result

Histopathology report		Malignant Frequency (%)	Benign Frequency (%)	Total
MRI findings	**Malignant**	14 (93.3%)	14 (31.1%)	28 (46.7%)
	Benign	1 (6.7%)	31 (68.9%)	32 (53.3%)
	Total	15 (100)	45 (100%)	62 (100%)
Sensitivity	93.33%			
Specificity	68.89%			
Positive Predictive value (PPV)	50%			

Negative predictive value (NPV)	96.88%
Accuracy	75%

Table 3: Summary of results obtained in the present study in terms of morphologic and functional parameters

Histopathology report		Malignant Frequency (%)	Benign Frequency (%)	P-value
Solid component	Yes	12 (80%)	24 (53.3%)	**0.010* Sig**
	No	3 (20%)	21 (46.7%)	
Internal septa	Yes	5 (33.3%)	26 (57.8%)	0.071 (NS)
	No	10 (66.7%)	19 (42.2%)	
Contrast Enhancement	Yes	13 (86.7%)	23 (51.1%)	**0.005* Sig**
	No	2 (12.3%)	22 (48.9%)	
Restriction on DWI	Yes	1 (6.7%)	3 (6.7%)	0.124 (NS)
	No	14 (93.3%)	42 (93.3%)	
Lymphadenopathy	Yes	0 (0)	1 (2.2%)	0.645 (NS)
	No	15 (100%)	44 (97.8%)	
Ascites	Yes	1 (6.7%)	1 (2.2%)	0.562 (NS)
	No	14 (93.3%)	44 (97.8%)	

DISCUSSION

Ovarian cancer is the second most common type of cancer among women and is often diagnosed in its later stages, frequently showing widespread peritoneal metastases. The survival rate drops to 10% for patients with FIGO stage IV and varies between 20% and 40% for those at FIGO stage IIIC.[11] Staging of cancer is a crucial process, essential for predicting patient outcomes and formulating the most effective treatment plans.[12]

A universally accepted criterion exists for preoperative diagnosis, but differentiating between benign and malignant ovarian tumors remains difficult, particularly when they contain both solid and cystic elements. Several key indicators are assessed using MRI data to help predict ovarian malignancy, including wall and septal thickness greater than 3 mm, and the presence of internal features such as papillary projections, nodules, solid components, necrosis, hemorrhage, or areas with strong contrast enhancement. However, these imaging characteristics often overlap between benign and malignant ovarian lesions, making accurate diagnosis challenging.[8]

As noted by Naggara et al., the aforementioned parameters may not always be the most accurate predictors of ovarian malignancies.[13] For instance, a recent study involving 168 ovarian masses found that papillary projections or nodules appeared in 37.5% of benign epithelial ovarian tumors. Subsequent histological analysis showed these projections were present in 20-26% of benign tumors, 62-78% of borderline tumors, and 59-92% of ovarian cancers.[14] Therefore, relying solely on papillary ridge characteristics for diagnosis demonstrated limited sensitivity and specificity.

Wenhua Li et al,[15] found that ovarian surface epithelial cystadenocarcinoma is linked to lower mean apparent diffusion coefficient (ADC) values, highlighting the potential of incorporating diffusion-weighted MRI (DW-MRI) into standard pelvic MRI protocols for better differentiation between benign and malignant ovarian conditions. ADC values reflect water molecule diffusion, which slows in tissues with higher cellularity, such as tumors. Therefore, low ADC values can indicate malignancy or tissue hypercellularity. DW-MRI and ADC assessments offer a valuable method for evaluating tissue diffusion and capillary perfusion in ovarian pathology.[15]

This study was performed to determine the diagnostic value of MRI in distinguishing between benign and malignant ovarian masses in a group of 60 patients during the study period who were referred to the MRI department by gynecologists or oncologists. The primary objective was to compare the MRI diagnosis with histopathological results to determine the relative diagnostic value of MRI. Based on the outcomes, 15 malignant and 45 benign tumors were reported; the sensitivity of MRI in discerning ovarian masses compared to histopathology results was 93.3%, while its specificity reached 68.89%, PPV was 50%, NPV was 96.88% and overall diagnostic accuracy was 75%. In line with the findings of our study, Jalili A et al,[8] reported that MRI had a specificity of 100% and 76.2% for subjects under the age of 40, and 91.7% and 61.9% for those aged 40 years or older. Additionally, the positive and negative predictive values of MRI were 72.2% and 100%, respectively.

Magnetic resonance imaging revealed a significant difference in the frequency of solid components between malignant cases and those with benign histopathology results (p=0.010). These findings are consistent with results from similar studies conducted by Jalili A et al,[8] Li W et al,[15] Rahma Farghaly A et al,[16] and Mansour S et al.[17] Furthermore, the rate of contrast enhancement associated with the solid component was significantly higher in patients with malignant histopathology compared to those with benign histopathology (P<0.005), which aligns with the study conducted by Jalili A et al.[8]

The present study found no significant difference in the extent of diffusion restriction within the solid component between benign and malignant masses (P>0.05). In contrast, a study conducted by Li W,[15] reported that using high b values (1000 s/mm²) in diffusion-weighted images demonstrated a significant sensitivity of 90.1% and specificity of 89.9%, allowing for effective differentiation

between benign and malignant ovarian tumors. These discrepancies may be attributed to variations in the ADC values used as standards across different studies, underscoring the need for further research and the establishment of a uniform standard to ensure more accurate comparisons.

CONCLUSION

In conclusion, magnetic resonance imaging (MRI) proves to be an effective diagnostic modality for differentiating between benign and malignant ovarian tumors. The high sensitivity and strong negative predictive value of MRI make it a critical tool in the evaluation of suspicious ovarian masses. Despite some discrepancies in findings across studies, the overall evidence supports the integration of MRI into preoperative decision-making processes. Future research should focus on standardizing ADC values and refining imaging techniques to enhance diagnostic accuracy further, ultimately improving patient outcomes in the management of ovarian tumors.

REFERENCES

1. Arun Prasad R, Rajeev Anand, Anu Sarah Easo, Reshma Francis. Role of MRI in differentiating benign versus malignant ovarian lesions. International Journal of Contemporary Medical Research 2018;5(4): D4-D7
2. Foti PV, Attinà G, Spadola S, Caltabiano R, Farina R, Palmucci S, Zarbo G, Zarbo R, D'Arrigo M, Milone P, Ettorre GC. MR imaging of ovarian masses: classification and differential diagnosis. Insights Imaging. 2016 Feb;7(1):21-41.
3. Pierce N, Narayanan P, Sahdev A, Reznek R, Rockall A. ovarian lesions pose diagnostic dilemmas. Diagnostic Imaging Europe. 2008;24(3).
4. Spencer JA, Forstner R, Cunha TM, Kinkel K, ESUR Female Imaging Sub-Committee. ESUR guidelines for MR imaging of the sonographically indeterminate adnexal mass: an algorithmic approach. European radiology. 2010; 20:25-35.
5. Bäumler M, Gallant D, Druckmann R, Kuhn W. Ultrasound screening of ovarian cancer. Hormone Molecular Biology and Clinical Investigation. 2019 Sep; 17:1.
6. 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 Oct 30; 9:64.
7. Bazot M, Daraï E, Nassar-Slaba J, Lafont C, ThomassinNaggara I. Value of magnetic resonance imaging for the diagnosis of ovarian tumors: a review. Journal of computer assisted tomography. 2008; 32:712-23.
8. Jalili A, Afzali N. Diagnostic Value of MRI Compared to Histopathological Results in Differentiating Benign from Malignant Ovarian Masses. Maedica (Bucur). 2024 Mar;19(1):4-8.
9. Valentini A, Gui B, Miccò M, Mingote M, De Gaetano A, Ninivaggi V et al. Benign and Suspicious Ovarian Masses—MR Imaging Criteria for Characterization: Pictorial Review. Journal of Oncology. 2012; 2012:1-9.
10. Rahma Farghaly A, Nassef HH, Ibrahim AM, et al. The Role of Diffusion Weighted Imaging in suspected cases of ovarian cancer. The Egyptian Journal of Radiology and Nuclear Medicine 2020; 51:1-11.
11. Ferlay J, Parkin DM, Steliarova-Foucher E. Estimates of cancer incidence and mortality in Europe in 2008. Eur J Cancer 2010; 46:765-781.
12. Prat J. FIGO's staging classification for cancer of the ovary, fallopian tube, and peritoneum: abridged republication. J Gynecol Oncol 2015; 26:87-89.
13. Thomassin-Naggara I, Daraï E, Cuenod CA, et al. Contribution of diffusion-weighted MR imaging for predicting benignity of complex adnexal masses. Eur Radiol 2009; 19:1544-1552.
14. Bazot M, Nassar-Slaba J, Thomassin-Naggara I, et al. MR imaging compared with intraoperative frozensection examination for the diagnosis of adnexal tumors; correlation with final histology. Eur Radiol 2006; 16:2687-2699.
15. Li W, Chu C, Cui Y, et al. Diffusion-weighted MRI: a useful technique to discriminate benign versus malignant ovarian surface epithelial tumors with solid and cystic components. Abdom Radiol 2012; 37:897-903
16. Rahma Farghaly A, Nassef HH, Ibrahim AM, et al. The Role of Diffusion Weighted Imaging in suspected cases of ovarian cancer. The Egyptian Journal of Radiology and Nuclear Medicine 2020; 51:1-11.
17. Mansour S, Wessam R, Raafat M. Diffusion-weighted magnetic resonance imaging in the assessment of ovarian masses with suspicious features: strengths and challenges. The Egyptian Journal of Radiology and Nuclear Medicine 2015; 46:1279-1289.