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MRI verification of adnexal mass

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Ovarian cancer accounts for 3.5% of all cancers among women worldwide, with 5% of women dying from cancer due to poor survival rates and delays in diagnosis and difficulty in care of cancer patients.
The objective: **to evaluate of the effectiveness of magnetic resonance imaging (MRI) in the diagnosis of ultrasonography indeterminate formations of the uterine appendages and of the detection of their malignancy.**
***Materials and methods*. During one year – from May 2021 to May 2022, a cross-sectional study was conducted with the participation of 100 patients in whom, according to ultrasound examination of the pelvic organs, the origin of mass formations of the uterine appendages was not determined. All patients underwent MRI of the pelvic organs. The results of MRI were analyzed, the type of formations of the uterine appendages and their malignancy were determined.**
The sensitivity and specificity of MRI diagnostics were statistically calculated. The final diagnosis was established according to the results of histological examination and clinical observation.
***Results*. The results showed that the sensitivity of the MRI method in the diagnosis of malignant neoplasms of the adnexa, the type of which was not determined by ultrasound examination, was 60%, its specificity was 74%, the overall accuracy was 73%, the positive predictive value was 15.78%, and the negative predictive value - 95.91%.**
***Conclusions*. As it is known that ultrasound examination has a limited ability to determine the origin and nature of some adnexal masses, which could have different origins – cystic, hemorrhagic or malignant formations, etc., MRI turned out to be more accurate in their diagnosis and establishing the type of tumor and the nature of the content tissue damage. This is very helpful in avoiding unnecessary surgery and complications that may arise from surgery.**
Keywords: *adnexal masses, diagnosis, MRI, sensitivity, specificity, accuracy.*

МРТ-діагностика об'ємних утворень придатків матки

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Захворюваність на рак яєчників становить 3,5% від усіх випадків раку серед жінок у всьому світі, причому 5% жінок помирають від раку через низький рівень виживаності та затримку діагностики і труднощі у спостереженні за хворими на рак.
Мета дослідження: оцінювання ефективності магнітно-резонансної томографії (МРТ) у діагностиці ультрасонографічно невизначених утворень придатків матки та у виявленні їх злоякісності.
Матеріали та методи. Протягом одного року – з травня 2021 р. до травня 2022 р. було проведено перехресне дослідження за участю 100 пацієнток, у яких, за даними ультразвукового дослідження органів малого таза, походження об'ємних утворень придатків матки не визначене. Усім пацієнткам проведено МРТ органів малого таза. Проаналізовано результати МРТ, визначено тип утворень придатків матки та їхню злоякісність.
Статистично обраховували чутливість, специфічність діагностики МРТ. Остаточний діагноз був встановлений відповідно до результатів гістологічного дослідження та клінічного спостереження.
Результати. Результати продемонстрували, що чутливість методу МРТ стосовно діагностики злоякісних новоутворень придатків матки, тип яких при ультразвуковому дослідженні не було визначено, становила 60%, його специфічність – 74%, загалом точність становила 73%, позитивне прогностичне значення – 15,78%, а негативне прогностичне значення – 95,91%.
Висновки. Оскільки відомо, що ультразвукове обстеження має обмежену здатність визначати походження та природу деяких об'ємних утворень придатків матки, які могли мати різне походження – кістозні, геморагічні або злоякісні та ін., МРТ виявилась більш точною у їхній діагностиці та встановленні типу пухлини і характеру вмісту тканини ураження. Це є дуже корисним для уникнення непотрібного хірургічного втручання та ускладнень, які можуть виникнути внаслідок операції.
Ключові слова: *об'ємні утворення придатків матки, діагностика, МРТ, чутливість, специфічність, точність.*

As the adnexal mass or lesions appear to be the most common gynaecological problem in women of all age groups and the benign or normal physiological lesions are the most common, especially in women of reproductive age groups. Ultrasound appears to have limited ability to precisely detect the nature of that adnexal lesion, in the other hand magnetic resonant imaging (MRI) is always superior to other imaging techniques in showing the origin, nature and tissue characteristics of that adnexal lesion, especially in the condition of malignant masses.

Early detection of the malignant lesion is very important in improving the survival rate and good outcome of management of those type of masses due to MRI provide better and additional information on soft tissue composition of adnexal masses based on certain tissue relaxation times and let multiplanar imaging at large field of view to find the origin and extent of pelvic pathology.

For pregnant and premenopausal women who complain of vague appearance and complicated adnexal masses whose ultrasound does not clearly explain and show the nature of those lesions but whose cancer antigen 125 tumour marker levels are not elevated MRI appear to be very beneficial in those women, as the overlap in imaging appearance among different cell type malignancies appear to be difficult to predict the exact histology of it in other imaging technique. Benign or malignant different adnexal

masses such as (cystic teratoma, endometriomas, simple haemorrhagic cyst or fibroma) and even fallopian tube abnormalities can be diagnosed by the use of MRI [1].

Ultrasound (US), computed tomography (CT) and MRI are the only imaging methods used to evaluate the adnexal lesions, and sometimes those lesions appear to be challenging to determine whether those lesions are benign or malignant [2]. Still, the MRI appears to be the best one of other imaging techniques for determining the nature and the key signal characteristics of the mass [3].

The importance of discovering whether the indeterminate adnexal mass is benign or malignant is enormous as women diagnosed with ovarian cancer require radical surgery which is best to be done by a specialist surgeon in the gynaecological oncology unit, but on the other hand, benign adnexal masses only need either managed conservatively or simple resection by a general gynaecologist [4].

The usual strategy used for the management of women with ultrasound indeterminate adnexal masses is to wait and see by repeating the examination after 2 or more menstrual cycles to let the blood component of hemorrhagic cysts which look like malignant masses fade, but with the use of MRI which is more specifically detect the malignant mass, so don't need to wait for 2–3 months to precisely diagnose the mass and as the time, early detection and proper treatment of malignant mass, which is very important as it decreases the mortality rate by early detection of malignant mass, and on the other hand lower the cost for unnecessary investigation and inappropriate surgery [5]. MRI had a vital role in assessment that led to a problem-solving, tailored approach based on signal characteristics and morphology [6].

Define the nature of a sonographically indeterminate adnexal mass has very important clinical benefit, as the benign mass may only need conservative follow-up of the women and sometimes need simple resection of the mass according to the patient's symptom, on the other hand, malignant mass needs more aggressive and radical surgical operation done by a gynaecological oncologist and from the first attempt and to do staging of the mass and determine if need further adjuvant chemotherapy or not. It is for these reasons, that MRI has a vital role in the investigation of the indeterminate adnexal mass, and there is a strong evidence base to support its use [7–10].

The suspicious adnexal mass which was not confirmed its diagnosis by the US constituted 18–31% of all adnexal masses. In the condition of suspicious adnexal mass inappropriate and unnecessary surgical intervention could affect on future fertility of the patient with comorbidity and percutaneous biopsy is not preferred because of the risk of wrong upstaging a confined early-stage ovarian cancer or because of the risk of error in the sampling, resulting in a missed cancer diagnosis, although the low rate of malignant adnexal masses found at US which was from 8%-20% [11–14].

Preoperative characterization and risk stratification of indeterminate adnexal masses are pivotal and clinically important as women with malignant masses could undergo primary, limited and non-oncological or insufficient cytoreductive surgery which is a bad outcome. So the need for a sensitive validating scoring system appears for standardized imaging reports to triage the patient to find whether they need surgery or not and the extent of those surgery which in the end decrease the unnecessary and aggressive surgical intervention [15].

The objective: is to highlight the remarkable ability of MRI (Magnetic Resonance Imaging) to identify the nature of sonographically indeterminate adnexal masses.

MATERIALS AND METHODS

A cross-sectional study was conducted in Samarkand's private radiological clinic in Mosul city. The screening period was from May 2021 to May 2022. A random sample size of 100 patients present with a history of previous US reports shows indeterminate adnexal abnormalities or masses. All the patients included in the study were in the reproductive age group (from 17 years till 48 years old) after excluding pregnancy and any contraindication to do an MRI and also patients refused to do an MRI or did not give informed written consent.

MRI characteristics of adnexal mass: On MRI, the uterus looks like an oval structure with intermediate signal intensity, with recognized myometrium & endometri-

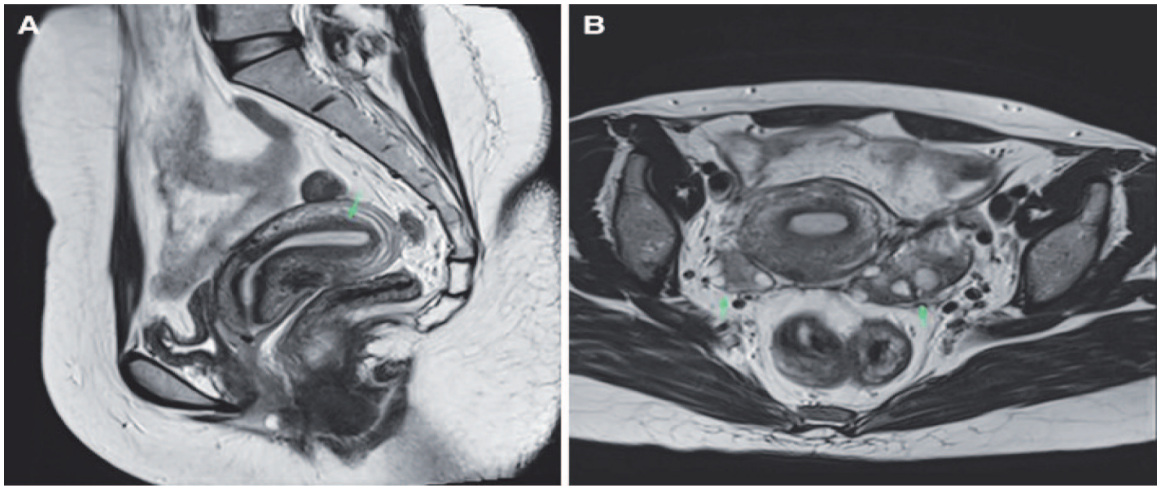

Figure 1. Normal anatomy: (A) Sag T2W showing normal uterine myometrium and normal hyperintense endometrium. The hypointense region in between represents the junctional zone (arrow). (B) Axial T2W shows the same above-mentioned structures with hyperintense follicles bilaterally representing ovaries [15]

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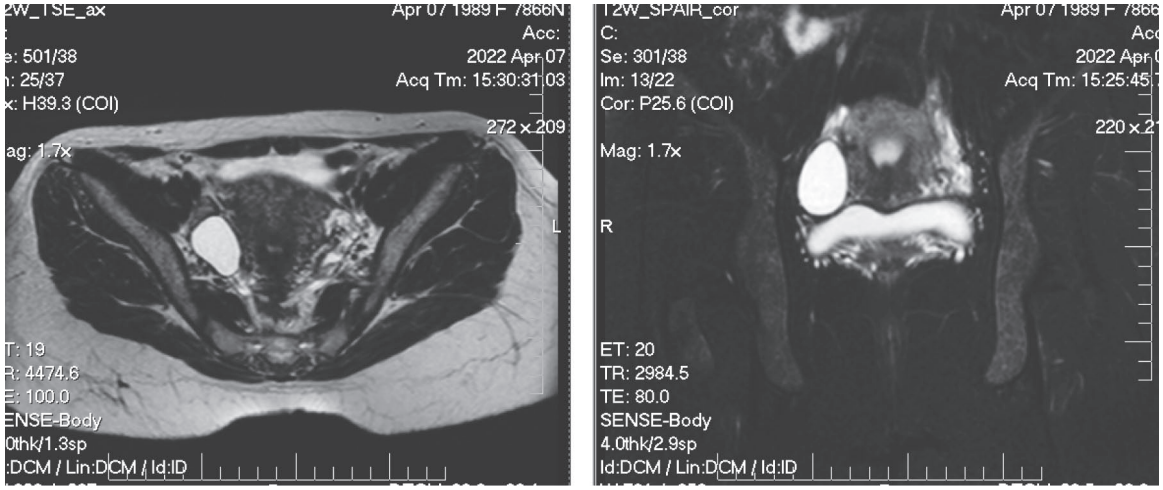

Figure 2. Axial T2W showing oval high SI (signal intensity) cystic lesion involving right adnexia. Coronal STIR (short tau inversion recovery) images show simple cystic lesions, no solid component, no septations, and no enhancement post-contrast. Picture denoting simple cyst [16]

um with a low signal junctional zone in between. Ovaries showed a round structure with multiple small round high-signal-intensity follicles on T2W(weighted image) (Figure 1). Fallopian tubes normally cannot be recognized on MRI unless enlarged or show pathology [16].

Ovarian Cysts: Usually cysts show common MRI features, but large ovarian cysts especially more than 7 cm need more attention & further workup. MRI features of ovarian cysts and serous cystadenomas are the same which are regular round or oval lesions with clear fluid content, but if shows a thin wall with multiple septations (multilocular), then it represents mucinous cystadenomas. Paraovarian cysts show the same MRI cysts features but are usually located adjacent to a normal-looking ovary (Figure 2).

Pedunculated or Subserous Uterine fibroids: These are fibroids that originate from the uterus subserosal or from broad ligaments which in some cases can simulate adnexal masses, in such cases, MRI is better than ultrasound for evaluation, MRI can visualize normal ovaries, in addition to detection of pedicle or connection to the nearby uterus (Figure 3) [17,18].

Endometriosis: These lesions presented as small implants in many pelvic sites, showing high T1W SI, which differs from fatty contents of the dermoid cyst by that not suppressed on FAT SAT (fat saturated image) sequences, so MRI is much better than ultrasound in this pathology (Figure 4) [17, 18].

Dermoid: Dermoid cysts usually appear as hyperechoic cysts on ultrasound but in conditions where lesions can simulate hemorrhagic cysts or endometriosis, MRI can confirm diagnosis by detecting their fatty content (Figure 5).

Malignant Surface Epithelial Tumors: Cystadenocarcinomas of the ovary usually show complex solid & cystic components, post-contrast these tumours show heterogeneous enhancement, their characteristics and MRI features differentiate from other benign uterine or ovarian tumors [9, 17]. Of course, MRI is used for better cystadenocarcinoma evaluation; in addition, MRI highly detects their recurrence after resection operations [16].

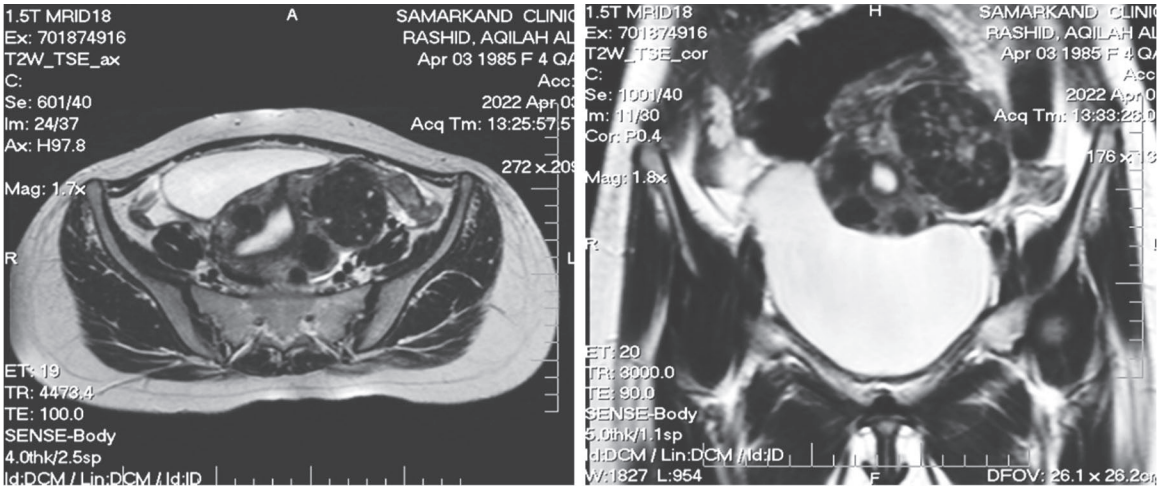

Figure 3. An axial and coronal T2W showing multiple variable size lesions, the largest one is an oval well-defined low-intermediate SI(signal intensity) mass involving the left lateral uterine wall, picture of subserosal fibroid [17]

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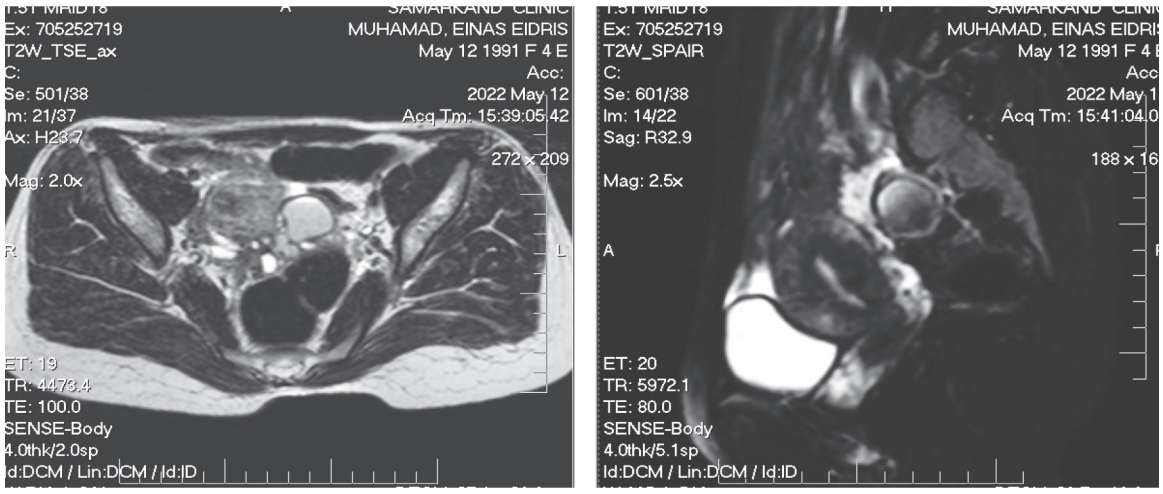

Figure 4. Endometrioma: (A) Axial T2W showing left ovarian high SI cystic lesion with shading features, which is partially suppressed on (B) STIR images [17]

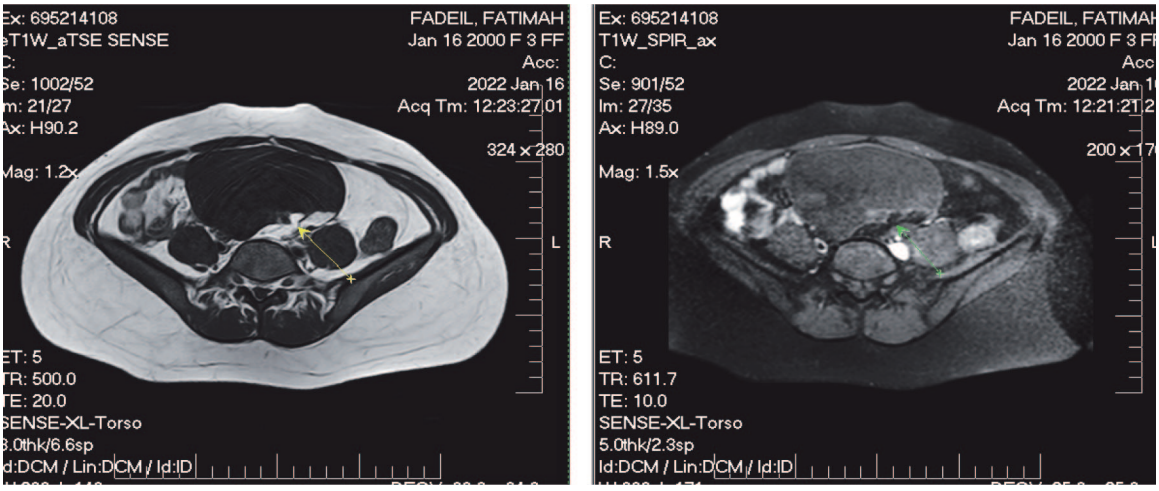

Figure 5. (A) Axial T1W image shows a right ovarian cystic lesion with cystic and high signal components. (B) Lesion showing cystic lesion with suppressed components noted peripherally on STIR images denoting fat, picture suggesting cystic teratoma (dermoid cyst)

Pelvic Inflammatory Disease: This disease can be appear as pelvic abscesses which shown on MRI as cystic lesions with thick enhancing walls, or can be chronic inflammation changes represented as free fluid detected in POD, or tubal and ovarian lesions.

MRI protocol: Examination of our cases is done using an MRI machine of 1.5 Tesla using Philips Achieva with 16 channel array, we use abdomen & pelvis coils, applying special parameters and field measurements used to image the pelvic region & organs. Many sequences were used as T1W, T2W & FAT SAT & in multiple planes, so axial, sagittal & coronal images were acquired. In addition, some cases were examined with added DWI sequences. In many cases, hyoscine butylbromide 20 mg is used to reduce bowel movement artefacts provided that these cases are not contraindicated. Contrast used in all cases in both T1W & fat suppressed sequenced. All cases were inspected & after US findings were analyzed, cases were evaluated depending on MRI findings & histopathological results performed.

Statistical analysis: Sensitivity, specificity, accuracy, positive predictive value and negative predictive values for all reviewers were calculated by using formulas with histopathology as the golden standard [16].

The results of histopathological reports or the imaging of the cases follow them up for at least one year as a standard of reference. The final results of the cases were done according to histopathological report results whether it is (normal ovary, benign, borderline or malignant masses).

Classification of the histopathological results was done and put in tables in numbers and percentages were different statistical equations to describe either as median, interquartile range or mean and standard deviation, according to their distribution. *T*-test and chi-squared or Fisher's test for the data were used to compare MRI features between benign and malignant masses.

RESULTS AND DISCUSSIONS

In our study 100 patients with adnexal mass were enrolled, a percentage of them had a mean age of 45 years

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Table 1

Socio-demographic and clinical characteristics of the study sample

Parameters	No.(n=100)
Age (17–48 years)	%
< 45	71
≥ 45	29
Marital state	
single	36
married	64
Parity	
0	36
1–4	51
≥ 5	13
Abortion	
0	86
1–2	13
> 2	1
Infertility	
present	13
absent	87

Table 2

Classification of clinical presentations among study subjects

Variable	No. (n=100)
Pain	88%
mass	25%
ascites	13%
menorrhagia	19%
Polymenorrhea or oligomenorrhea	2%
amenorrhea	2%

(from 17 till 48 years old), and the majority 71% of patients were less than 45 years old. For socio-demographic and clinical characteristics, the majority (64%) of patients with adnexal mass were married and low parity of less than 5 constituted (51%), with a negative history of infertility (87%) as shown in Table 1.

Regarding clinical presentations among the study subjects, the majority 88% of them presented with pain (Table 2).

In consideration of MRI findings, cystic mass was more frequently 69% detected than solid mass 38% (Table 3).

Some patients enrolled on the recent study with a case of adnexal mass diagnosed as endometriosis or tubal lesion by MRI were found to be 11 and 13% respectively as shown in Table 4.

For the whole study sample, follow-up was done, some 32% of them needed medical treatment, while 68% of them needed surgical intervention. Benign histopathological findings were recorded in 76.47% (Table 5 and 6).

In the current study, the sensitivity of MRI was found to be 60%, specificity 74% and accuracy 73%, while the positive predictive value (PPV) was 15.78% and the negative predictive value (NPV) of 95.91%, which was calculated by specific equation. These results were obtained from the data shown in Table 7.

Table 3

Distribution of MRI findings of adnexal mass among study subjects

Variable	Non. (n=100)	
Solid mass (n=38)	38	38%
benign	29	76.32%*
malignant	9	23.68%*
multiple mass	14	36.84%*
single mass	12	31.58%*
complicated	12	31.58%*
Cystic mass (n=69)	69	69%
benign	57	82.61%**
malignant	10	14.49%**
borderline	2	2.9%**
ectopic pregnancy	3	4.35%**
simple	21	30.43**
complicated	45	65.22%**

Notes: * – the incidence from 38% (which include all solid masses), ** – the incidence from 69% (which include all cystic masses).

Table 4

MRI results and distribution of endometriosis and tubal lesion

Variable	No. (n=100)	
Endometriosis (n=11)	11	11%
Tubal	1	9.09*
Ovarian	5	45.45*
Adenomyosis	4	36.36*
Pelvic wall	1	9.09*
Tubal lesion (n=13)	13	13%
Pyosalpinx (unilateral)	1	7.69**
Pyosalpinx (bilateral)	1	7.69**
Hydrosalpinx (unilateral)	6	46.15**
Hydrosalpinx (bilateral)	5	38.46**

Notes: * – the incidence from 11% (which are all cases of endometriosis), ** – the incidence from 13% (which are all cases of tubal lesions).

Table 5

Mode of treatment (medical or surgical) of the studied objects according to MRI results

Variable	No. (n=100)	%	Chi² value
medical	32	32.00	12.95**
surgical resection	68	68.00	

Note. ** – Refer to the high significant difference between the mode of treatment (Medical and surgical) of the patients at 0.01.

Table 6

Histopathological results (benign or malignant) of resected mass among the study subjects

Variable	No. (n=68)	%	Chi² value
benign	52	76.47	19.06**
malignant	16	23.53	

Note. **– Refer to the high significant difference between the resected mass (benign and malignant) at 0.01.

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Table 7

Histopathological findings (benign or malignant) of the adnexal mass among the study subjects (sensitivity and specificity of MRI)

MRI results	Histopathological results				Total	Chi² value
	Negative		Positive			
	No.	%	No.	%		
Benign	47	69.12	2	2.94	49 (72.06%)	45.16**
Malignant	3	4.41	16	23.53	19 (27.94%)	
Total	50	73.54	18	26.47		

Note. ** – Refer to the high significant difference between groups at 0.01.

In the study, 100 patients done to them US and MRI and found they had adnexal abnormalities. Analysis of the report results of MRI done to discover who much it is accurate and sensitive in the detection of any malignant abnormalities of those results and compare the MRI findings with the results of histopathology which is the main purpose of this study.

In a study done in 2019 by S. Shanmuga Jayanthan et al, they found the most common (the mean) age of patients present with adnexal mass in general was 35 years which is between 21 and 60 years, but the mean age for development malignant adnexal mass was 49 years, while for development of benign adnexal mass was 30 years, which was very is nearly corresponded to the results of the present study [19].

Regarding the detection ability for the origin of adnexal masses US was able to detect in only 44% of cases, including 5.6% uterine origin, 36% ovarian and 2% was other than uterine or ovarian which shows that more than 55% of cases cannot detect their origin, on the other hand, the MRI was able to detect the origin of adnexal masses in all of the cases, that is why MRI was superior an excellent imaging technique in compare to other [19].

Different factors can affect the detection ability of US (as if the mass was large, the obesity of the patient, faeces and the fluid-filled bowel loops), but all these factors cannot affect on MRI ability for detection of the origin of adnexal mass. For accurate tissue characterization, the US was able to characterize 48% only of adnexal mass (14.4% solid, 33.3% cystic and 1.1% mixed), whereas MRI was able to characterize the component of all adnexal mass which was (21.1% solid, 66.7% cystic and 12.2% mixed). It was not necessarily the solid component of the cystic adnexal mass that indicated malignancy for example in cases with cystic teratoma where the solid component of the cystic mass was simply fat, this problem was solved by the use of unenhanced T1 and T2 – weighted MR imaging which was very important for specific tissue characterization and the lipid or blood component can simply detect and differentiated on T1-weighted MR imaging with and without fat suppression.

In our study, we followed up with 90 patients with adnexal mass their MRI reports showed that 66 patient (73%) was benign, and 24 of them 26 were detected as malignant lesions, histopathology examination was done for all of these cases and their results showed out of those 24 malignant cases only 21 was true malignant and the other 3 was benign masses [20].

Regarding the MRI results 66 of the cases were shown to be benign, while histopathological results revealed 63 were truly benign and the other 3 cases were identified as malignant cases, which means that the accuracy of MRI was 93% in detection and identifying benign from malignant lesions. These results were very similar to results shown by a study conducted by Komatsu T et al which evaluated the accuracy of MRI in detecting adnexal masses (benign/ malignant) and correlating with histopathology results [21].

A study was done by Scoutt LM et al which showed results similar to our study about age and benign or malignant lesions correlation, which showed the age groups between 20–40 years are mostly complaint from benign lesions, and malignant lesions are most common among 40–60 years age patients [22].

A study done by Saroja Adusumilli et al recorded that there was a strong correlation between the mass size and malignancy possibility as the study results show the adnexal mass of more than 5 cm had a high suspicion of malignancy [9].

On the other hand, in a study done by Ruby Lin et al, the study included 338 women with adnexal mass and did MRI for evaluation of their masses. The study shows that the sensitivity of MRI to detect malignancy in adnexal mass was 16.7%, while had 96.2% specificity and the MRI (PPV) 28.5% on the other hand (NPV) was 92.7% [23].

Among other many studies done on the accuracy of MRI in detecting and differentiating benign from malignant adnexal abnormalities six studies in a U.S. community-based practice stated that the difference in accuracy results between study and other in some sort depends on reviewer bias [24]. So important of need the MRI report to be reviewed by more than one expert reader to identify cancer in a tertiary care setting to decrease the incidence of bias in results [8, 9, 25–27].

CONCLUSION

The many plans and soft tissue contrast of the MRI make it the most sensitive imaging technique for evaluation of any adnexal mass or abnormalities and it is the superior one in detecting the origin of this abnormality and their tissue character where it was (solid, haemorrhagic, fatty, and fibrous). As a result of the high specificity of MRI, the patient can avoid unnecessary or aggressive surgical intervention.

MRI can give a clear plan of what to do for the patient who complains of malignant mass for staging and the best surgical outcome and eventually good prognosis of the condition. The present study ascertained that MRI was highly specific (74%), sensitive (60%) and accurate (73%) in diagnosing benign and malignant masses which will aim to be beneficial in the future to help both patients and gynaecological oncologists in proper management of the malignant conditions.

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