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MRI Accuracy in Diagnosing Sonographically Indeterminate Masses Taking Histopathology as Standard

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ABSTRACT

Introduction: Approximately 25% of ultrasound-detected adnexal masses pose clinical challenges, being indeterminately categorized as benign or malignant. Characterizing them is pivotal for deciding surgery or pelvic MRI.
Aims and Objectives: To validate the accuracy of MRI for diagnosing sonographically indeterminate masses using biopsy as the gold standard.
Place and Duration of study: A validation cross-sectional study was performed at the Department of Radiology, Mayo Hospital, Lahore, for a period of six months i.e. from December 2019 to June 2020.
Material and Methods: Non-probability consecutive sampling was employed to select 289 patients (12-60 years) with sonographically indeterminate adnexal masses. All those patients who were unwilling to participate or had MRI contraindications like metallic inserts, pacemakers, and claustrophobia were excluded from the study. Data was collected using the proforma as approved by IRB. All patients underwent MR imaging on a 1.5-T GE unit, and MRI accuracy was calculated. The analysis of data was performed using SPSS 25.0 version software, p-value ≤ 0.05 was taken as significant.
Results: MRI sensitivity, specificity, PPV, NPV, FP, FN, and diagnostic accuracy in sonographically inconclusive adnexal lesions were 94.25%, 85.22%, 90.61%, 90.74%, 3.46%, 5.88% and 90.66%, respectively, referencing histopathology.
Conclusion: The study concludes MRI as a noninvasive, accurate modality for distinguishing benign and malignant adnexal masses. While IOTA Simple Rules can't categorize all masses, around 20% with inconclusive results may need alternative evaluation, like skilled ultrasound examination& MRI. It significantly enhances preoperative differentiation, aiding surgeons in making informed decisions regarding treatment approaches.

Key Words: Adnexal masses, Magnetic resonance imaging, Sonographically indeterminate.

INTRODUCTION

Adnexal lesion includes masses which arise from the ovaries, fallopian tubes and adjacent structures. It is observed in females across all age demographics. They may result from functional or physiological changes and inflammatory processes[1].Adnexal masses are infrequent amongst adolescents, with an incidence rate of 2.6 per 100,000 girls per annum. However, they are prevalent in adult women of reproductive age. Determining the accurate incidence in the overall population is challenging due to many cases being asymptomatic and consequently underdiagnosed[2,3]. Diagnosing an adnexal mass can be challenging.

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because it can either be benign or cancerous, with the risk of cancer driving the need for timely & accurate diagnosis. The mean risk of death from ovarian malignancy before 75 years age is twice as high in developed countries rather than developing countries, with deaths from the ovarian malignancy ranking as the fifth most common across women in developed countries[4].

Ultrasound is the primary, cost-effective, noninvasive imaging for ovarian disease evaluation. Transvaginal ultrasound is preferred, but limitations in field of view may require transabdominal ultrasound[5].

In response to concerns about identification of ovarian pathology before surgical intervention, the International Ovarian Tumor Analysis (IOTA) group developed ultrasound-based models. The Simple Rules model categorize suspicious pelvic lesions as indeterminate, benign or potentially cancerous. Simple Rules categorize ovarian tumors: B-features (Uni-locular cyst in any size, solid components either not present or less than 7 mm in diameter, presence of posterior acoustic shadowing, smooth outlined multi-locular lesion with maximum diameter < 10 cm & no abnormal blood flow) for

benign, M-features (Irregular shape solid tumor, at-least 4 papillary projections, irregular outlined multi-locular solid mass with maximum diameter > 10 cm, ascites & very strong vascularity) for malignant. Uncertain if both or none. Sensitivity: 91–96%, specificity: 68–93% by inexperienced sonographers[6,7,8].

The Ovarian-Adnexal Reporting and Data System (O-RADS) tool, based on IOTA rules, aims to improve sonographic interpretation, reduce ambiguity in findings of ultrasonography & offer guidelines for management of ovarian masses based on O-RAD Scategories[6].

ADNEX model utilizes 9 different parameters, 3 clinical parameters serum CA-125 level, age & the type of health facility (cancer care or other hospitals) and 6 ultrasound parameters ascites, maximum size of the lesion, the solid tissue component, number of papillary growths, posterior acoustic shadowing and greater than 10 cystic cavities[9.]

Various scoring systems, such as the Risk of Malignancy Index (RMI), have been developed to assess adnexal masses. These systems incorporate clinical, biochemical (e.g., CA 125 or HE 4 levels), and ultrasonographic criteria to evaluate the risk of malignancy. Despite the detailed evaluation provided by sonography, additional tools like RMI help in better risk assessment for adnexal masses[10].

The Risk of Malignancy Index (RMI) integrates ultrasound findings, CA125 levels & menopausal status to assess pelvic masses before surgery, it has high accuracy, the RMI upper normal limit of 200 is agreed upon by experts as the best differentiating tool between benign and cancerous pelvic mass. The formula to calculate RMI = Menopause x CA125x Ultrasound Characteristics[11].

Abdominal and pelvic computed tomography (CT) is the preferred staging tool, crucial for assessing disease extension, calcification & fat. It is commonly used to evaluate therapy response, comparing pre and post-treatment scans after six chemotherapy cycles, with a three-cycle interval if needed based on serum markers.PET/CT is typically not part of the initial assessment however an elevated FDG uptake in postmenopausal women should always be viewed as abnormal[6].

Performing percutaneous biopsy on suspicious adnexal masses is discouraged due to risks like upgrading early-stage ovarian cancer or sampling errors, potentially leading to missed diagnoses. Although ultrasonography detects malignant adnexal masses at a relatively low rate (8-20%), many women with inconclusive but benign masses may still encounter unnecessary or excessively invasive surgeries. Most adnexal lesions are non-cancerous and tend to resolve on their own[12].

MRI plays a crucial part in identifying and characterizing pelvic masses, particularly in cases with uncertain lesions. It excels in detecting local invasion due to its high resolution and excellent depiction of soft tissues. Notably, MRI poses no risk of ionizing radiation, making it safe for use in young female patients. T1WIs and T2WIs are essential for providing anatomical details and aiding in characterization. Additionally, fat-sat T1WIs are valuable for identifying hemorrhagic lesions. Overall, MRI is indispensable for accurately assessing pelvic masses and guiding appropriate management decisions[13].

A study reported a sensitivity value as 100% for MRI for determining adnexal masses with specificity of 93.6%[13]. Another study reported sensitivity of 91.1% and specificity of 100.0%[14]. Another study reported sensitivity of 93.9% and specificity of 31.5%[15].

The goal of this study is to assess the precision of MRI in categorizing adnexal indeterminate masses that are inconclusive on sonography, as no authentic data is available locally to assess the diagnosis of indeterminate adnexal masses and discrepancy is also seen in sensitivity and specificity of previously reported studies. Our research will be very helpful in establishing the diagnosis, clinical decision making & avoidance of unnecessary surgeries of indeterminate adnexal masses.

MATERIAL AND METHODS

The study was a cross-sectional study conducted at the Radiology Department of Mayo Hospital in Lahore from December 11, 2019, to June 12, 2020. The sample size was determined to be 289 using a sensitivity and specificity calculator, with a prevalence of 8.8% and a precision of 13%. Non-probability consecutive sampling was employed to select participants.

Female patients aged 12-60 years with sonographically indeterminate adnexal masses were included, while those with diagnosed malignancy, contraindications for MRI investigation (such as metallic implants, cardiac pacemakers, claustrophobia), impaired renal function (serum creatinine > 1.5), or frank ascites were excluded. Data collection involved obtaining written informed consent from all participants and advising them to fast and have a moderately filled bladder before the examination.

MRI was performed using a 1.5-Tesla GE MRI unit, with various sequences including T1WIs, T2WIs,

and contrast-enhanced images. Patients suspected of malignancy underwent surgery, and histopathology was performed for confirmation (Fig-1A). Data was gathered utilizing a pre-established data collection proforma.

Statistical analysis:

The analysis of data was performed using SPSS 25.0 version software, qualitative variables (benign/malignant of adnexal masses on MRI and histopathology) measured using frequency and percentages, and quantitative variables (age) measured using mean and standard deviation. Results were summarized using tables, and data were stratified for age and BMI to account for effect modifiers. Diagnostic accuracy was calculated post-stratification.

Ethical consideration:

Confidentiality and privacy of all the participants was ensured. No information was disclosed to anyone except the researchers involved in the study. No monetary benefit was given to the subjects.

RESULTS

In MRI positive patients, 164 (True Positive) had malignant adnexal masses and 17 (False Positive) had benign adnexal masses on Histopathology. Among 108, MRI negative patients, 10 (False Negative) had malignant adnexal masses on histopathology whereas 98 (True Negative) had benign adnexal masses on histopathology (p=0.0001). In general sensitivity, specificity, PPV, NPV and diagnostic accuracy of MRI in sonographically uncertain adnexal masses were 94.25%, 85.22%, 90.61%, 90.74% and 90.66% separately. Table-1 & Table-2.

	Diagnostic accuracy of MRI	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Acc (%)
Overall		94.25 %	85.22 %	90.61 %	90.74 %	**90.66 %**
Age	**12-35 years**	92%	96.49 %	97.18 %	90.16 %	**93.94 %**
	36-60 years	95.96 %	74.14 %	86.36 %	91.49 %	**87.90 %**
BMI	**≤30 kg/m2**	91.21 %	89.03 %	86.46 %	85.96 %	**86.27 %**
	>30 kg/m2	97.59 %	92.45 %	95.29 %	96.08 %	**95.59 %**

Table 1: Diagnostic accuracy of MRI according to age & BMI,
***Acc = Acuuracy**

MRI Findings	Histopathology Findings		Total
	Positive	Negative	
Positive	164 (TP=56.70%)	10 (FP=3.46%)	174 (60.21%)
Negative	17 (FN=5.88%)	98 (TN=33.90%)	115 (39.79%)
Total	181 (62.63%)	108 (37.37%)	289

Table 2: Agreement of MRI with final diagnosis

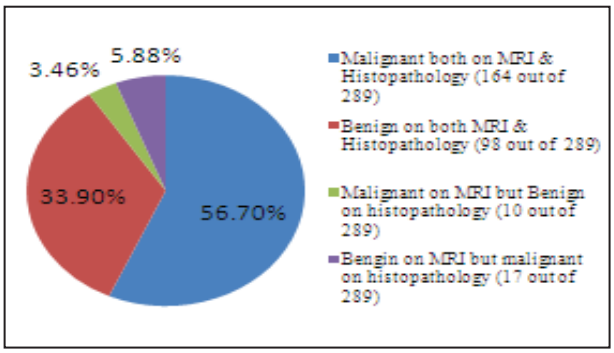

Fig 1A: MRI & Histopathology Findings

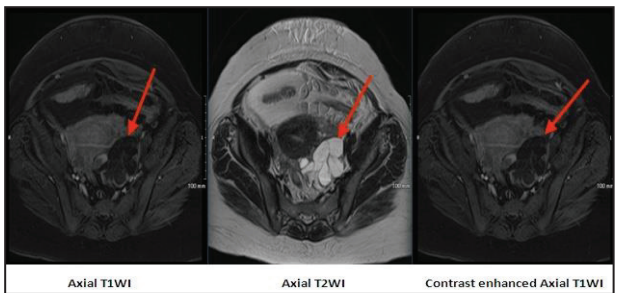

Fig-1: MRI pelvis images showing left sided hydrosalpinx (arrow)

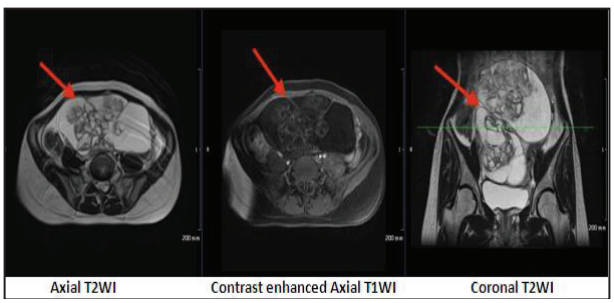

Fig-2: MRI pelvis images showing right adnexal mass (arrow) with malignant features as described

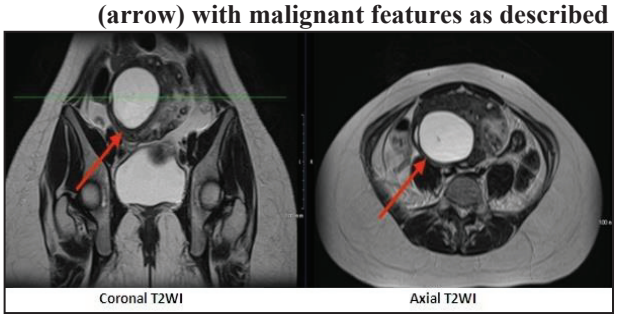

Fig-3: MRI pelvis images showing left ovarian torsion (arrow)

DISCUSSION

MRI is indispensable for identifying the pelvic masses origin, identification of adnexal masses and invasion in surrounding tissue. Its key advantages include noninvasive, high resolution, cost effective and avoidance of ionizing radiation exposure. Despite similar radiological appearances, different pathologies may exhibit distinct MRI features, aiding in accurate diagnosis. In our study uterine pathologies like pedunculated subserosal fibroids which were labeled as adnexal masses on sonography were accurately diagnosed on MRI due to identification of fibroid stalk & normal ovaries, similar results were reported by Adusumilli et al. in 2006[4].Radiologists must be familiar with MRI characteristics specific to ovarian lesions to guide proper differential diagnosis. Overall, MRI aid as a critical diagnostic tool in the evaluation of pelvic masses, providing detailed anatomical information and assisting in clinical decision making[13].

In diagnostic radiology, segregation between benign and cancerous lesions is crucial for accurate diagnosis and suitable treatment planning. MRI ability to detect fat (high signals on T1WIs & T2WIs) and blood contents (low signal intensity on T2WIs), which can aid in tissue characterization, helping to differentiate between benign and malignant masses. Traditionally, the criteria used for this differentiation were primarily based on surgical and pathological findings, although advancements in imaging technology and understanding of disease processes have elaborated the criteria to include imaging features[16]. Magnetic resonance imaging (MRI) is especially useful when CA-125 levels, a tumor marker associated with ovarian cancer, are either normal or only slightly elevated. This indicates that MRI plays a crucial role in detecting and evaluating tumors in cases where blood tests might not provide enough information to confirm or rule out cancer. Therefore, MRI serves as a valuable diagnostic tool in such situations, providing detailed imaging of tissues and aiding in accurate diagnosis and treatment planning[17].

MRI is superior in detecting extra-ovarian cystic lesions and its ability to reveal morphological features like the tortuous folded appearance of a hydrosalpinx (Fig-1) which were indeterminate sonographically[18].

In 2007, Sohaib et al. demonstrated through MR imaging analysis that certain features are highly indicative of malignancy. These include the presence of abdominal/pelvic ascites, tumor size exceeding 6 cm, the presence of solid element/septation within a cyst and the presence of calcification/liquefaction within a solid lesion (Fig-2). These characteristics serve as strong predictors for identifying malignant adnexal lesions and our study confirmed these parameters[19].

In a 2011 study done by Valentini et al. put forward criteria to aid in the classification of adnexal lesions as either benign or indeterminate for malignancy. They highlighted that features indicative of malignancy include the presence of solid or solid/cystic showing post contrast enhancement of masses. These characteristics observed through MRI, indicate a higher likelihood of the lesion being malignant rather than benign as compared to trans-abdominal or trans-vaginal ultrasound. This distinction is crucial for guiding appropriate clinical management decisions, such as determining the need for further diagnostic tests or initiating treatment. Therefore, our findings are similar to Valentini et al. and provide valuable insights for clinicians and radiologists in accurately diagnosing and managing adnexal lesions[20].

MRI characteristics of ovarian torsion shows bulky edematous ovary with peripherally arranged follicles, unusual enhancement of torsed ovary, ovarian hemorrhage and displacement of the uterus to torsed ovary (Fig-3). These imaging features will enable the radiologist to diagnose ovarian torsion and differentiate it confidently from other benign or malignant ovarian lesions even if the clinical and ultrasound signs are inconclusive[21].

So, an adnexal lesion that looks abnormal at ultrasound may be exactly diagnosed as benign at MRI, preventing unnecessary radical surgery. In our study, the key imaging features for diagnosing adnexal masses on MRI are, hypointense signals on T2WIs indicate fibrotic component, for identifying specific tumors like the Brenner tumor, cystadenofibroma, or fibroma. To differentiate teratomas from endometrial cysts or hemorrhagic lesions Fat-SAT T1WIs are crucial. These insights guide accurate diagnosis and management of adnexal masses, enhancing patient care[13]. Accurately identifying an adnexal mass as benign carries several benefits. It can prevent unnecessary or excessive surgery, offering the possibility of less invasive or fertility-preserving procedures. Additionally, it improves patient understanding of the risks associated with surgery, particularly regarding ovarian reserve changes. MRI plays a crucial role in this process due to its high specificity, which enables reliable diagnosis of many adnexal lesions that are actually benign.

CONCLUSION

The study concludes that MRI is preferred non-invasive method for accurate identification of benign and cancerous adnexal lesions. It significantly enhances preoperative differentiation, aiding surgeons in making informed decisions regarding treatment approaches. As a result, the study recommends routine MRI for suspected cases of adnexal masses to ensure accurate differentiation and proper surgical planning.

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