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Diagnostic Accuracy of International Ovarian Tumor Analysis (IOTA) Simple Ultrasonography Rules in Differentiation of Benign and Malignant Ovarian Masses with Histopathology as Gold Standard

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ABSTRACT

Objective: To determine the diagnostic accuracy of International ovarian tumor analysis (IOTA) simple USG rules for diagnosis of malignant ovarian masses taking histopathology as gold standard.
Study Design: Cross Sectional Validation study.
Place and Duration of Study: Department of Radiology, Combined Military Hospital, Rawalpindi Pakistan, from Aug 22 to Feb 23.
Methodology: A total of 135 women with ovarian mass were included in the study. Preoperative transvaginal ultrasound examination was performed in all included patients. Histopathologic diagnosis of the surgical specimen was used as the reference standard for definite diagnosis of the adnexal masses. Malignant ovarian masses were noted as per operational definition from Internation ovarian tumor analysis (IOTA) and histopathology.
Results: IOTA diagnosed 39(28.9%) patients while histopathology diagnosed 38(28.1%) patients with malignant ovarian masses. IOTA has shown sensitivity of 86.8%, specificity 93.8% and diagnostic accuracy by 91.9%, PPV 84.6% and NPV was 94.8% in diagnosis of malignant ovarian masses.
Conclusion: International ovarian tumor analysis (IOTA) simple ultrasound rules were highly sensitive and specific in predicting ovarian malignancy preoperatively.

Keywords: Diagnostic Accuracy, Histopathology, IOTA Simple Ultrasound Rules, Ovarian Masses.

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INTRODUCTION

Ovarian cancer is the leading cause of death in women diagnosed with gynecological cancers.1 It is also the fifth most frequent cause of death in women, in general.[1] Most of the cases are diagnosed at an advanced stage, which leads to poor outcomes of this disease.[2]

There are various risk factors associated with ovarian cancer. It mostly affects postmenopausal women, where increasing age is associated with an increased incidence, advanced stage of this disease, and lower reported survival rates.[3] Parity poses a protective role according to a few case-control studies with higher age at childbirth linked to a decreased risk of ovarian cancer.[3] The strongest risk factor of ovarian cancer is a positive family history of breast or ovarian cancer, where a personal history of breast cancer also augments the risk.[4] Several studies have shown an increased risk of smoking, especially the risk of mucinous epithelial tumors.[3] The incidence is highest in non-Hispanic whites (11.6 per 100,000), followed by American Indians and Alaska Natives (10.3 per 100,000), Hispanics (10.1 per 00,000), non-Hispanic blacks, and Asian and Pacific Islanders.[5] Ninety percent of ovarian cancers are epithelial, with the serous subtype being the most common. Age-adjusted rates of new ovarian cancer cases are on a reducing trend based on statistical models of analysis.[5] In patients with a high degree of clinical suspicion, radiological imaging including transvaginal ultrasonography (TVUS, highly sensitive and preferred) and/or abdominal and pelvic ultrasonography is done.[6] It gives a fair idea about the size, location, and complexity of the ovarian mass. For defining tumor extension, further imaging with chest and abdomen pelvis CT scan, pelvic MRI, and/or PET scan can be done.[6] To date, the IOTA study is the largest study in the literature on ultrasound diagnosis of ovarian pathology.[7] In a study by Garg S, *et al.*, has shown that the sensitivity for the detection of malignancy in cases where IOTA simple rules were applicable was 91.66% and the specificity was 84.84%

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and accuracy was 86.66%.[8] In another study by Yoshida A, *et al.*, has shown that prevalence of malignant ovarian masses was 41.6% among suspected ovarian masses.[9] The IOTA models carry important advantages over subjective assessments in terms of objectivity, simplicity, and applicability.10 They provide easy-to-use guidance to non-expert sonographers for making an accurate presurgical diagnosis. But there is paucity of data in this subject in our local population. Results of the study will help to derive new prediction models based on the IOTA Simple Rules in general population.

METHODOLOGY

This Cross Sectional Validation study was conducted in the Department of Radiology, Combined Military Hospital, Rawalpindi Pakistan. 135 sample size was calculated with sensitivity, specificity sample size software by using following assumptions. Sensitivity = 91.66%8 Specificity = 84.84% Prevalence of Ovarian Tumor = 41.6%[9] Confidence level = 95% Precision for sensitivity 8.34%, for specificity =10%. Non-Probability consecutive sampling was done to recruit the participants.

Inclusion Criteria: Women aged 25 to 60 years, both married/unmarried, ovarian mass as per operational definition for >3 months were included.

Exclusion Criteria: history of pelvic surgery, patients taking chemotherapy or hormonal therapy on medical record and pregnant patients were excluded from study.

Ethical permission was taken from ethical review board of Combined Military Hospital, Rawalpindi and granted ethical permission. (Serial No. 671). Informed consent was taken. Basic demographics like age, marital status and duration of complaints was recorded.

Preoperative transvaginal ultrasound examination was performed in all included patients under supervision of more than 3 years post fellow ship experienced sonographers. Sonographers were blinded to patients' clinical characteristics and preoperative laboratory results. During ultrasonographic examination, the morphology of the adnexal masses was characterized using 2D real-time and color Doppler ultrasound. The International Ovarian Tumor Analysis (IOTA) Simple Rules were used. The mass was categorized as benign if one or more B-features applied in the absence of an M-feature. Conversely, the mass was categorized as malignant if one or more M-features applied in the absence of a B-feature. Histopathologic diagnosis of the surgical specimen was used as the reference standard for definite diagnosis of the adnexal masses. All adnexal masses were classified into two groups, benign or malignant ovarian tumors.

Data was entered and analyzed through Statistical Package for Social Sciences version 25. Mean±SD was calculated for all quantitative variables like age and duration of complaints. For qualitative variables like marital status, frequency and percentage was calculated. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy for IOTA against histopathology was calculated by using 2X2 model and chi square test was used, $p \leq 0.05$ was considered statistically significant.

RESULTS

This study was carried out on 135 patients, mean age of 44.08±3.87 years and mean duration of complaints was 8.74±3.17 months.

IOTA diagnosed 39(28.9%) patients while histopathology diagnosed 38(28.1%) patients with malignant ovarian masses as shown in Table-I.

Table-I: Comparison of IOTA versus Histopathology for diagnosis of malignant ovarian masses (n=135)

Malignant Ovarian Masses	Malignant	Benign
IOTA	39(28.9%)	96(71.1%)
Histopathology	38(28.1%)	97(71.9%)

IOTA has shown sensitivity of 86.8%, specificity 93.8% and diagnostic accuracy by 91.9%, PPV 84.6% and NPV was 94.8% in diagnosis of malignant ovarian masses. As shown in Table-II.

Table-II: Comparison of IOTA versus Histopathology for diagnosis of malignant ovarian masses (n=135)

IOTA	Histopathology		Total	*p*-value
	Malignant	Benign		
IOTA	TP 33	(FP) 5	38	<0.001
Histopathology	(FN) 91	(TN) 91	97	
Total	39	96	135	

Sensitivity: 86.8%
Specificity: 93.8%
DA= 91.9%
PPV= 84.6%
NPV= 94.8%

IOTA: International Ovarian Tumor Analysis

DISCUSSION

A total of 135 patients with suspected ovarian pathology were evaluated using transvaginal ultrasonography and transabdominal ultrasonography

when transvaginal approach was not feasible. Findings were correlated with histopathological findings. All patients were included in the final analysis who underwent surgery. In our study IOTA diagnosed 39(28.9%) patients while histopathology diagnosed 38(28.1%) patients with malignant ovarian masses. IOTA has shown sensitivity of 86.8%, specificity 93.8% and diagnostic accuracy by 91.9%, PPV 84.6% and NPV was 94.8% in diagnosis of malignant ovarian masses. The specificity of our study was lower as compared to previous studies by Timmerman *et al.,* and Fathallah *et al.*[11,12] The sensitivity and specificity of present study most closely related to study by Hartman CA *et al.,* who reported a sensitivity and specificity of 91% and 87% respectively. This variation may be due to limited number of patients studied in the present study as compared to other studies.[13]

Above studies shows that sensitivity was higher in premenopausal women (100%) than in postmenopausal women (90.9%) while specificity was slightly lower (86.2% and 75% respectively). The increased sensitivity and specificity in premenopausal women compared to the postmenopausal women in present study may be explained by increased number of inconclusive cases in the premenopausal patients in present study where the simple rules could not be applied (10%).[14-16] Applying this strategy in present study the sensitivity of the index test increased from 92% to 93% whereas specificity decreased from 85% to 80% respectively. This result correlated well with the published data and the sensitivity and specificity of present study was close to sensitivity and specificity as per study by Timmerman *et al.*[17] Among 27 studies, including 7,841 adnexal masses, the results of this meta-analysis showed excellent diagnostic performance with a pooled sensitivity of 92% [95% confidence interval (CI), 0.89–0.94] and a pooled specificity of 92% (95% CI, 0.89–0.94). The IOTA-SR was applicable in 85.7% of adnexal masses.[18]

CONCLUSION

This study demonstrates that the International Ovarian Tumor Analysis (IOTA) simple ultrasound rules are highly sensitive and specific for the preoperative prediction of ovarian malignancy, while also being reproducible and easy to learn and apply. Early detection remains the most critical determinant of outcomes in ovarian cancer, with timely diagnosis significantly improving patient survival. Ultrasonography offers inherent advantages, including wide availability, low cost, and absence of radiation exposure; however, it is relatively operator dependent. The IOTA simple rules help mitigate this limitation by providing a standardized approach that maintains high diagnostic accuracy while remaining practical and user-friendly.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

KAK & UN: Data acquisition, data analysis, critical review, approval of the final version to be published.

JA & ALK: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

SA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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