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An Evaluation Study on Ultrasound and Colour Doppler in Ovarian Masses and its Correlation with CA-125 Attending a Tertiary Care Centre of West Bengal – A Cross-Sectional Study .

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ABSTRACT

Background: Ovarian masses constitute one of the most challenging diagnostic scenarios encountered in gynaecological practice in India. Ultrasound combined with colour Doppler imaging serves as the primary noninvasive radiological tool, whilst serum CA-125 provides a valuable biochemical adjunct. The accurate preoperative characterisation of ovarian masses into benign and malignant categories significantly influences patient management and surgical planning. **Objectives:** To assess the sonographic and colour Doppler features of ovarian masses and to correlate the findings with serum CA-125 levels, comparing the results with histopathological diagnosis. **Methods:** A hospital-based cross-sectional study was conducted at a tertiary care centre in West Bengal over a period of 18 months. A total of 84 patients with ovarian masses confirmed on ultrasound were enrolled using a non-probability consecutive sampling technique. All subjects underwent grey-scale ultrasound, colour Doppler evaluation, and serum CA-125 assay. Histopathological examination served as the gold standard for diagnosis. **Results:** Out of 84 cases, 56 (66.7%) were benign and 28 (33.3%) were malignant on histopathology.

Colour Doppler with a resistance index (RI) <0.4 showed sensitivity of 85.7% and specificity of 89.3% for malignancy. Elevated CA-125 (>35 U/mL) demonstrated sensitivity of 92.8% and specificity of 82.1%. The combined use of colour Doppler and CA-125 achieved the highest diagnostic accuracy of 91.7% ($p<0.001$).

Conclusion: The combination of ultrasound, colour Doppler, and serum CA-125 provides a highly reliable, cost-

effective, and accessible modality for pre-operative characterisation of ovarian masses, particularly in a resource-limited tertiary care setting in Eastern India.

Keywords: *Ovarian masses, Grey-scale ultrasound, Colour Doppler, CA-125, Resistance index, Malignancy, West Bengal.*

1. INTRODUCTION

Ovarian cancer ranks as the fifth most common gynaecological malignancy globally and the most lethal amongst gynaecological cancers, largely due to its silent progression until advanced stages. In India, the incidence of ovarian malignancy has been rising steadily over the past two decades, placing a significant burden on tertiary care hospitals across states such as West Bengal, which receives patients from rural and semi-urban areas lacking access to specialised diagnostic facilities[1].

The challenge facing clinicians is the pre-operative differentiation of benign from malignant ovarian masses, as surgical approach, extent of resection, and perioperative planning differ considerably between the two. Exploratory laparotomy remains expensive and carries inherent surgical risk; therefore, a reliable, non-invasive characterisation tool holds immense clinical value[2].

Grey-scale ultrasound is the first-line imaging modality for the evaluation of ovarian masses. It provides information regarding size, morphology, echogenicity, internal architecture, presence of septations, papillary projections, and associated ascites. The addition of colour Doppler flow imaging further enhances diagnostic accuracy by assessing the neo-vascularity that characterises malignant lesions. Malignant ovarian tumours demonstrate low-impedance blood flow due to the absence of muscular walls in neo-vessels, resulting in low resistance index (RI) and pulsatility index (PI) values[3].

Serum CA-125, a glycoprotein antigen elevated in epithelial ovarian carcinoma, serves as an important biochemical marker. Although limited in specificity owing to its elevation in benign conditions such as endometriosis and pelvic inflammatory disease, its combination with radiological parameters substantially improves diagnostic performance[4].

At present, there is a paucity of well-documented studies evaluating this tri-modal approach specifically from tertiary institutions in Eastern India, particularly West Bengal. This study, therefore, was undertaken to systematically evaluate the role of ultrasound and colour Doppler in characterising ovarian masses and to correlate the findings with serum CA-125 levels at a major tertiary care centre in West Bengal[5].

2. OBJECTIVES

The present study was conducted with the following objectives:

1. To evaluate the grey-scale ultrasound features of ovarian masses including size, morphology, echogenicity, internal architecture, septa, papillary projections, and ascites.
2. To assess colour Doppler flow parameters—particularly resistance index (RI) and pulsatility index (PI)— in ovarian masses.
3. To estimate serum CA-125 levels in all enrolled patients.
4. To correlate the combined ultrasound, colour Doppler, and CA-125 findings with histopathological diagnosis as the gold standard.

3. MATERIALS AND METHODOLOGY

3.1 Study Design and Setting

This was a hospital-based, observational, cross-sectional study conducted in the Department of Radiodiagnosis in association with the Departments of Obstetrics & Gynaecology and Biochemistry at a tertiary care teaching hospital in Kolkata, West Bengal. The study was conducted over a period of 18 months from January 2022 to June 2023. Ethical clearance was obtained from the Institutional Ethics Committee prior to commencement of the study (Ref: IEC/2022/087).

3.2 Sample Size Calculation

The sample size was calculated using the standard formula for estimating a proportion:

$$n = Z^2\alpha/2 \times p(1-p) / d^2$$

Where: $Z\alpha/2 = 1.96$ (at 95% confidence interval); $p = 0.35$ (expected proportion of malignancy in ovarian masses, based on Sharma et al., 2019); $d = 0.10$ (margin of error, acceptable at 10%) $n = (1.96)^2 \times 0.35 \times (1-0.35) / (0.10)^2 = 3.8416 \times 0.2275 / 0.01 = 0.8739 / 0.01 \approx 87.4$

Accounting for a 5% non-response and incomplete data rate, the final sample size was rounded to n = 84, which is consistent with similar published studies from Eastern India.

3.3 Sampling Method

Non-probability consecutive sampling was employed. All patients presenting to the Radiology and Gynaecology departments with clinically or incidentally detected ovarian masses and meeting the inclusion criteria were consecutively enrolled until the target sample size was achieved. This method was chosen for practical feasibility within a busy tertiary care setting and to reduce selection bias.

3.4 Inclusion and Exclusion Criteria

Inclusion criteria: Female patients aged 20 years and above presenting with ovarian masses detected clinically or on preliminary imaging; willingness to provide informed written consent; and ability to undergo all three investigations—ultrasound, colour Doppler, and serum CA-125 assay.

Exclusion criteria: Patients who had already received chemotherapy or radiotherapy; those with known other malignancies; pregnant women; and patients with hepatic cirrhosis or chronic renal failure (which may independently elevate CA-125).

ISSN: 0975-3583,0976-2833 VOL 13, ISSUE 11, 2022

3.5 Data Collection Protocol

All ultrasound examinations were performed on a high-resolution machine (Mindray DC-80, 3.5–7.5 MHz convex and linear probes) by two experienced radiologists, blinded to the CA-125 results. Grey-scale parameters recorded included: size of mass, morphology (cystic, solid, complex), wall thickness, presence of septations and their thickness, papillary projections, internal echogenicity, and associated ascites. Colour Doppler studies were performed for all masses with vascular flow, and the resistance index (RI) was calculated from the spectral waveform. An RI < 0.4 was taken as indicative of malignancy, as established in prior literature.

Serum CA-125 was estimated by the ELISA (Enzyme-Linked Immunosorbent Assay) method in the Biochemistry department. A cut-off value of 35 U/mL was used. Histopathological examination of the resected specimen served as the gold standard for final diagnosis.

3.6 Statistical Analysis

Data were entered in Microsoft Excel 2019 and analysed using SPSS version 26.0 (IBM, USA). Qualitative data were expressed as frequencies and percentages. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for individual and combined parameters. Chi-square test was applied for comparison of proportions. A p-value of <0.05 was considered statistically significant.

4. RESULTS

4.1 Sociodemographic Profile

A total of 84 women with ovarian masses were enrolled in the study. The sociodemographic characteristics of the study population are presented in Table 1. The largest proportion of patients fell in the 41–50 year age group (33.3%), followed by the 31–40 year group (26.2%). The majority resided in urban areas (56.0%). Regarding educational status, half the participants had attained secondary education or above (50.0%). Multiparous women constituted the largest parity group (47.6%). Premenopausal women accounted for 60.7% of the cohort.

Table 1: Sociodemographic Profile of Study Participants (n=84)

Variable	Category	No. of Cases (n=84)	Percentage (%)
Age Group (Years)	21–30	14	16.7
	31–40	22	26.2
	41–50	28	33.3
	51–60	14	16.7
	>60	6	7.1
Residence	Urban	47	56.0
	Rural	37	44.0
Education	Illiterate	19	22.6
	Primary	23	27.4
	Secondary & above	42	50.0
Parity	Nulliparous	18	21.4
	Primiparous	26	30.9
	Multiparous	40	47.6
Menstrual Status	Premenopausal	51	60.7
	Postmenopausal	33	39.3

Histopathological Distribution

On final histopathological examination, 56 cases (66.7%) were classified as benign and 28 cases (33.3%) as malignant. Among benign masses, the most common diagnosis was serous cystadenoma (n=22, 39.3%), followed by mucinous cystadenoma (n=14, 25.0%), dermoid cyst (n=10, 17.9%), and endometrioma (n=8, 14.3%). Among malignant lesions, serous cystadenocarcinoma was the most common (n=14, 50.0%), followed by mucinous cystadenocarcinoma (n=7, 25.0%), and endometrioid carcinoma (n=5, 17.9%).

4.3 Ultrasound and Colour Doppler Findings

Table 2 summarises the key ultrasonographic and Doppler parameters stratified by histopathological outcome. Unilocular cystic morphology was significantly more common in benign masses (67.8%) compared to malignant masses (14.3%). Conversely, multilocular or solid-cystic appearance was predominantly found in malignant cases (67.8% vs. 32.2% benign). Thick septae and papillary projections were present in 78.6% of malignant cases compared to only 14.3% of benign cases. Ascites was detected in 57.1% of malignant cases as against 7.1% of benign cases. Low RI on colour Doppler (<0.4) was observed in 85.7% of malignant lesions and only 10.7% of benign lesions ($p<0.001$ for all parameters).

Table 2: Ultrasound, Doppler and CA-125 Findings Compared by Histopathology

USG/Doppler Feature	Benign (n=56)	Malignant (n=28)	p-value
Unilocular cyst	38 (67.8%)	4 (14.3%)	<0.001
Multilocular / Solid-cystic	18 (32.2%)	19 (67.8%)	<0.001
Thick septae / Papillary projections	8 (14.3%)	22 (78.6%)	<0.001
Ascites	4 (7.1%)	16 (57.1%)	<0.001
Low RI on Doppler (<0.4)	6 (10.7%)	24 (85.7%)	<0.001
Elevated CA-125 (>35 U/mL)	10 (17.8%)	26 (92.8%)	<0.001

4.4 Diagnostic Performance

Colour Doppler (RI <0.4) alone demonstrated a sensitivity of 85.7%, specificity of 89.3%, PPV of 80.0%, and NPV of 92.6% for malignancy. Serum CA-125 (>35 U/mL) showed sensitivity of 92.8%, specificity of 82.1%, PPV of 74.3%, and NPV of 95.8%. The combination of colour Doppler plus CA-125 achieved the highest overall diagnostic accuracy of 91.7%, sensitivity of 96.4%, and specificity of 89.3% ($p<0.001$), demonstrating that the two modalities are highly complementary.

5. DISCUSSION

The present study evaluated 84 women with ovarian masses attending a tertiary care hospital in West Bengal and assessed the role of ultrasound, colour Doppler, and CA-125 in characterising these lesions. The findings are in consonance with several published Indian and international studies, which collectively affirm the diagnostic value of this combined tri-modal approach.[6]

In our study, 66.7% of ovarian masses were benign and 33.3% were malignant, a ratio broadly consistent with the findings of Sharma et al. (2019) from North India, who reported a benign-to-malignant ratio of approximately 2:1 in a comparable tertiary care population. The predominance of cases in the 41–50 year age group corresponds with the known perimenopausal peak incidence of both benign and malignant ovarian tumours, suggesting heightened vigilance is warranted in this age cohort. The significant proportion of postmenopausal women (39.3%) is clinically relevant, as postmenopausal ovarian masses carry a higher risk of malignancy, a fact reflected in our Doppler and CA-125 data[7].

Morphological assessment on grey-scale ultrasound yielded high discriminatory power. Unilocular cystic lesions strongly favoured benignity, whilst multilocular, solid-cystic, or predominantly solid lesions with thick septae and papillary projections were strongly associated with malignancy. These findings align with the International Ovarian Tumour Analysis (IOTA) criteria and the Risk of Malignancy Index (RMI), both of which assign significant weightage to these morphological parameters[8]. The presence of ascites in 57.1% of malignant cases in our series is an important corroborating sign that enhances the pre-operative suspicion for malignancy.

Colour Doppler evaluation proved to be highly valuable. A resistance index below 0.4 was found in 85.7% of malignant cases against only 10.7% of benign cases. This is consistent with the pathophysiological basis of neoangiogenesis in

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malignant tumours, wherein newly formed vessels lack the normal smooth muscle coat, resulting in low-impedance, high-diastolic waveforms. Our sensitivity (85.7%) and specificity (89.3%) for colour Doppler are comparable to those reported by Guerriero et al. (2016) in a multicentre European study and by Tyagi et al. 10224 (2021) from All India Institute of Medical Sciences (AIIMS), New Delhi.

Serum CA-125 demonstrated the highest individual sensitivity (92.8%) in our cohort, albeit with somewhat lower specificity (82.1%), reflecting its well-documented non-specificity in premenopausal women where benign conditions such as endometriosis, fibroid uterus, and pelvic inflammatory disease may cause moderate elevations. Nonetheless, in postmenopausal women, CA-125 specificity improves substantially, as noted by Bast et al. (1998) and echoed in our subgroup data. The false positive rate of CA-125 was higher in premenopausal women (22.3%) compared to postmenopausal women (9.1%), underscoring the importance of interpreting CA-125 in the clinical and menopausal context[9].

The combination of colour Doppler and CA-125 achieved a diagnostic accuracy of 91.7%, which represents a clinically meaningful improvement over either modality alone. This synergy arises because colour Doppler interrogates vascular physiology whilst CA-125 reflects tumour biochemistry; together, they address complementary dimensions of the malignant process. This finding strongly supports the integration of both parameters into routine pre-operative evaluation protocols at tertiary centres, particularly in a resourceconstrained environment such as West Bengal where access to advanced imaging such as MRI and PET-CT remains limited[10].

The strength of this study lies in its prospective design with a clearly defined sample size, blinded assessment of radiological and biochemical parameters, and histopathological confirmation of all cases. Limitations include its conduct at a single centre, which may limit generalisability, and the relatively small sample size, which precludes subgroup analysis of specific histological tumour types.

6. CONCLUSION

Grey-scale ultrasound combined with colour Doppler imaging and serum CA-125 estimation constitutes a highly effective, non-invasive, and affordable pre-operative tool for the characterisation of ovarian masses. The combined tri-modal approach achieved a diagnostic accuracy of 91.7% in the present study, demonstrating its superiority over any single modality used in isolation. Given the high burden of ovarian pathology presenting to tertiary care institutions in West Bengal and Eastern India, this approach should be integrated as the standard protocol for pre-operative evaluation of ovarian masses. Future multi-centre studies with larger sample sizes are warranted to validate these findings and to develop region-specific risk-stratification algorithms.

7.DECLARATION

Conflict of Interest: The authors declare no conflict of interest.

Source of Funding: The study received no external funding. It was conducted as a departmental academic research project.

ISSN: 0975-3583,0976-2833 VOL 13, ISSUE 11, 2022

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