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Original Article

# Pre-operative Evaluation of Ovarian Masses with Color Doppler and its Correlation with Pathological Finding

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## Abstract

**Introduction:** The management of ovarian tumors remains a common clinical gynecologic problem. The early and definite diagnosis of ovarian malignancy is of grave clinical importance. Recently, the role of color and spectral Doppler in the diagnosis of ovarian malignancy has been a subject of enormous debate.

**Aim:** The purpose of the study was to evaluate the efficiency of color flow Doppler and its parameters with pulsatility index (PI) and resistive index (RI), to discriminate the benign and malignant ovarian masses.

**Methods:** In 24 months period selected 100 patients, in whom adnexal mass was detected by ultrasound and had further evaluated by Color flow Doppler at the radiology department. PI was calculated from the reproducible spectral waveforms generated from flow central to peripheral within the mass or adjacent to the mass. The resistive index was calculated as the mean of three consecutive waveforms with the lowest RI. Each lesion was categorized on the basis of gray scale morphology as benign, borderline, and malignant. Other parameters such as a wall and septal thickness and echogenicity also were recorded. These image-guided indices were further confirmed with histopathological findings to differentiate benign and malignant ovarian tumors.

**Results:** Of the 100 patients 85 were benign, two were borderline, and 13 were a malignant ovarian mass with mean age 35.2, 45.0, and 48.3, respectively. The threshold of PI >1 and RI >0.4 was diagnosed as benign. PI <0.8 and RI <0.4 were low and used as predictors of ovarian malignancy. Similarly, other parameters were calculated to discriminate the lesion.

**Conclusion:** The study showed a high positive predictive value of high impedance flow in benign and predominant low impedance flow in the malignant lesion. In the present study, fairly good specificity and sensitivity with PI <1 and the resistive index <0.4 were achieved in ovarian malignancy. Color Doppler study was the diagnostic modality of choice for the patients with adnexal mass to establish the diagnosis of malignant ovarian tumors.

**Key words:** Ovarian malignancy, Pelvic doppler, Tumor neovascularization

## INTRODUCTION

Adnexal region constitutes fallopian tubes, ovaries, broad ligament and associated blood vessels, and nerve supply. Ovarian tumor alone contributes to two-third of the adnexal masses. Evaluation of adnexal masses remains a huge challenge in gynecology.[1] Ultrasonography is the primary imaging modality of the evaluation of adnexal masses of ovarian origin and the characterization of the masses in details. Transvaginal ultrasonography is the standardized tool to evaluate adnexal masses.[2] The differentiation of benign and malignant adnexal masses is of great therapeutic importance. Hence, the prompt and intensive pre-operative evaluation of all adnexal masses decides the course and outcome of the management.[3] Ovarian tumor accounts for the second most common malignancy of the genital system and is mostly asymptomatic till the later stages in two-third of the cases. Prompt and early diagnosis of the ovarian malignancy is the cornerstone for prognosis and outcome. Clear discrimination of the benign and malignant is crucial and very important due to the high fatality rates.[4] The patients in the prepubescent and postmenopausal age

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group with adnexal masses should be evaluated thoroughly, since one-third masses could be malignant. Patients in the reproductive age group presenting with adnexal masses should be evaluated to rule out ectopic pregnancy.[5] High sensitivity and positive predictive values are achieved while in the pre-operative evaluation of adnexal masses, especially in differentiating benign and malignant tumors, when B-mode ultrasonography in combination with color and spectral Doppler. Doppler waveform characteristics, resistivity index (RI), pulsatility index (PI), and peak systolic value (PSV) correlate well with malignancy.

### Aim

The aim of the study was to study the pre-operative evaluation of ovarian masses with color Doppler flow imaging and its correlation with histopathological findings, to assess the diagnostic reliability of Doppler sonography findings, and to differentiate malignant and benign ovarian masses.

## MATERIALS AND METHODS

This study was an observational longitudinal prospective study, performed at the Department of Obstetrics and Gynaecology, Madras Medical College, from October 2017 to October 2018. The study was performed on the 100 patients with adnexal masses who were attending gynecology outpatient department and admitted in the gynecology ward for evaluation. All these patients were included in the study based on inclusion and exclusion criteria.

### Inclusion Criteria

Patients with complaints of mass per abdomen, pain abdomen, menstrual symptoms having an adnexal mass on bimanual examination, and infertility having an adnexal mass on clinical examination or ultrasound examination were included in the study.

### Exclusion Criteria

Unilocular cystic masses <5 cm which on HPE turned out to be extra-ovarian such as uterine or broad ligament cyst were excluded from the study. Ectopic pregnancy, ovarian masses in pregnancy women, masses which turned out to be inflammatory in pathology (tubo-ovarian masses, abscess, etc.). Detailed history taking including age, symptoms, menstrual history, and family history of ovarian cancer was sought, general and pelvic examination and blood investigations were done followed by transvaginal gray-scale sonography and color Doppler sonography-parameters assessed.

## RESULTS

It is evident from the age distribution table that the majority of group benign subjects belonged to 21–40 years age category (48.24%) with a mean age of 35.19 years, majority of group borderline subjects belonged to 41–60 years age category (100%) with a mean age of 45.00 years, and majority of group malignant subjects belonged to 41–60 and 61–80 years age category equally (38.46%) with a mean age of 48.31 years.

The inner wall structure table that majority of group benign subjects had a smooth inner wall (65.88%), the majority of group borderline had an irregular inner wall (100%), and the majority of group malignant subjects had an irregular inner wall and papillary projections equally (38.46%).

The wall thickness table that majority of group benign subjects had a thin wall (83.52%), the majority of group borderline had thin and thick wall equally (50%), and the majority of group malignant subjects had a thick wall (76.92%).

The septal thickness table that majority of group benign subjects had thin septal (97.65%), the majority of group borderline had thin and thick septal equally (50%), and the majority of group malignant subjects had thick septal (84.62%).

The echogenicity status table that majority of group benign subjects had anechoic mass (95.29%), the majority of group borderline had low echogenic mass (100%), and the majority of group malignant subjects had echogenic mass (46.15%).

The vascularity status table that majority of group benign subjects had mass without vascularity (96.47%), the majority of group borderline had mass with vascularity (100%), and the majority of group malignant subjects had mass with vascularity (100%).

The location status table that majority of group benign subjects had mass in peripheral location (80.00%), the majority of group borderline had mass in peripheral location (100%), and the majority of group malignant subjects had mass in peripheral + central location (84.62%).

The PI distribution table that majority of group benign subjects belonged to < 1.0 PI category (75.29%) with a mean PI of 0.90, majority of group borderline subjects belonged to < 1.0 PI category (100%) with a mean PI of 0.87, and majority of group malignant subjects belonged to < 1.0 PI category equally (100%) with a mean PI of 0.64.

The resistive index distribution table that the majority of group benign subjects belonged to ≥ 0.4 RI category (75.29%) with a mean RI of 0.53, the majority of group borderline subjects belonged to ≥ 0.4 RI and < 0.4 RI category equally (50%) with a mean RI of 0.44, and majority

of group malignant subjects belonged to ≥ 0.4 RI category equally (100%) with a mean RI of 0.35.

The color Doppler imaging table that the majority of group benign subjects exhibited mean PSV score of 13.62, mean Sassone score of 6.10 and mean color score of 2.06. Similarly, group borderline subjects exhibited mean PSV score of 14.28, mean Sassone score of 8.00, and mean color score of 2.50. Similarly, group malignant subjects exhibited mean PSV score of 30.13, mean Sassone score of 11.08, and mean color score of 23.69 [Table 1].

The gray scale morphology status table that majority of group benign subjects had cystic mass (92.94%), the majority of group borderline had cystic and solid mass equally (50%), and the majority of group malignant subjects had solid mass (61.54%).

Sensitivity is very high, meaning that 100% of those with malignant mass will have a positive test with PI fixed at < 1.00. Specificity of serum-ascites albumin gradient is very low, meaning that 17% of those without malignant mass will have a negative test with PI fixed at < 1.00. The diagnostic effectiveness or diagnostic accuracy is low in relation to the detection of malignant mass with PI fixed at < 1.00. Sensitivity is very high, meaning that 91% of those with malignant mass will have a positive test with PI fixed at < 0.80. Specificity is very high, meaning that 90% of those without malignant mass will have a negative test with PI fixed at < 0.80. The diagnostic effectiveness or diagnostic accuracy is high in relation to the detection of malignant mass with PI fixed at < 0.80. Sensitivity is very high, meaning that 100% of those with malignant mass will have a positive test with RI fixed at < 0.60. Specificity is very low, meaning that 22% of those without malignant mass will have a negative test with RI fixed at < 0.60. The diagnostic effectiveness or diagnostic accuracy is low in relation to the detection of malignant mass with RI fixed at < 0.60. Sensitivity is very high, meaning that 85% of those with malignant mass will have a positive test with RI fixed at < 0.40. Specificity is very low, meaning that 98% of those without malignant mass will have a negative test with RI fixed at < 0.40. The diagnostic effectiveness or diagnostic accuracy is high in relation to the detection of malignant mass with RI fixed at < 0.40 [Table 2].

**Table 1: Color Doppler imaging**

| Color Doppler imaging | Benign | Borderline | Malignant | *P*-value |
|---|---|---|---|---|
| | Mean±SD | Mean±SD | Mean±SD | |
| PSV | 13.62±3.79 | 14.28±1.34 | 30.13±5.82 | <0.001 |
| Sassone score | 6.1±1.15 | 8±0 | 11.08±2.25 | <0.001 |
| Color score | 2.06±0.33 | 2.5±0.71 | 3.69±0.75 | <0.001 |

SD: Standard deviation, PSV: Peak systolic value

## DISCUSSION

There have been numerous studies in the world literature evaluating the role of color Doppler to distinguish between benign and malignant ovarian neoplasms, but the results have been conflicting. The present study evaluates the role of color Doppler sonography in the pre-operative evaluation of ovarian masses and its correlation with histopathology.

This is evident by the increased mean age in group borderline compared to group benign (mean increased difference of 9.81 years, 22% higher), increased mean age in group malignant compared to group borderline (mean increased difference of 3.31 years, 7% higher), and increased mean age in group malignant compared to group benign (mean increased difference of 13.12 years, 27% higher).[6]

In our study, the inner wall structure status between benign, borderline, and malignant groups was meaningfully significant. This is evident by the increased irregular inner wall structure incidence in group borderline compared to group benign (percentage increased difference of 68.24 points, 68% higher), increased inner wall structure with papillary projections incidence in group malignant compared to group borderline (percentage increased difference of 38.46 points, 100% higher), and increased irregular inner wall structure and papillary projection incidence in group malignant compared to group benign (percentage increased difference of 42.81 points, 56% higher). Valentin *et al.* noted papillary projections in 64%,

**Table 2: Accuracy analysis**

| Variables | Sensitivity (%) | Specificity (%) | Positive likelihood ratio | Negative likelihood ratio | Disease prevalence (%) | Positive predictive value (%) | Negative predictive value (%) | Accuracy (%) |
|---|---|---|---|---|---|---|---|---|
| PI <1.00 | 100.00 | 16.88 | 1.2 | 0 | 21.43 | 24.71 | 100.00 | 34.69 |
| PI index <0.80 | 90.48 | 89.61 | 8.71 | 0.11 | 21.43 | 70.37 | 97.18 | 89.80 |
| Resistive index <0.60 | 100.00 | 21.18 | 1.27 | 0 | 13.27 | 16.25 | 100.00 | 31.63 |
| Resistive index <0.40 | 84.62 | 97.40 | 32.58 | 0.16 | 14.44 | 84.62 | 97.40 | 95.56 |

PI: Pulsatility index

67%, and 41% cases in the borderline group, patients with epithelial cancer Stage-I and patient with epithelial cancer Stage-IV, respectively ($P = 0.0034$).[7,8]

In our study, the vascularity status between benign, borderline, and malignant groups was meaningfully significant. This is evident by the increased incidence of mass without vascularity in group benign compared to group borderline (percentage increased difference of 96.47 points, 100% higher), and the incidence of mass with vascularity in group malignant and borderline compared to group benign (percentage increased difference of 96.47 points, 100% higher). Juhász *et al.* successfully demonstrated the presence of new vessels in the ovarian and endometrial cancers.[9]

In our study, the location status between benign, borderline, and malignant groups was meaningfully significant. This is evident by the increased incidence of peripheral + central mass location in group malignant compared to group benign/borderline (percentage increased difference of 82.26 points, 97% higher) and increased incidence of peripheral mass location in group benign/borderline compared to group malignant (percentage increased difference of 74.62 points, 83% higher). Tumor vessels can be grossly categorized as central or peripheral.[10] Although this classification is somewhat misleading anatomically, it is helpful in describing the location of tumor vessels that are detectable with ultrasound.

In our study, the PI distribution between benign, borderline, and malignant groups was meaningfully significant. This is evident by the decreased mean PI in group borderline compared to group benign (mean decreased difference of 0.04 points, 4% lower), decreased mean PI in group malignant compared to group borderline (mean decreased difference of 0.23 points, 26% lower). and decreased mean PI in group malignant compared to group benign (mean decreased difference of 0.27 points, 29% lower).

In our study, the resistive index distribution between benign, borderline, and malignant groups was meaningfully significant. This is evident by the decreased mean RI in group borderline compared to group benign (mean decreased difference of 0.09 points, 17% lower), decreased mean resistive index in group malignant compared to group borderline (mean decreased difference of 0.09 points, 21% lower), and decreased mean resistive index in group malignant compared to group benign (mean decreased difference of 0.18 points, 34% lower).

In our study, the color Doppler imaging (PSV, Sassone, and color scores) distribution between benign, borderline, and malignant groups was meaningfully significant.

This is evident by the decreased mean PSV score in group borderline compared to group benign (mean decreased difference of 0.66 points, 5% lower), decreased mean PSV score in group malignant compared to group borderline (mean decreased difference of 15.86 points, 53% lower), and decreased mean PSV score in group malignant compared to group benign (mean decreased difference of 16.51 points, 55% lower).

This is evident by the decreased mean Sassone score in group borderline compared to group benign (mean decreased difference of 1.90 points, 24% lower), decreased mean Sassone score in group malignant compared to group borderline (mean decreased difference of 3.08 points, 28% lower), and decreased mean Sassone score in group malignant compared to group benign (mean decreased difference of 4.98 points, 45% lower).

This is evident by the decreased mean color score in group borderline compared to group benign (mean decreased difference of 0.44 points, 18% lower), decreased mean color score in group malignant compared to group borderline (mean decreased difference of 1.19 points, 32% lower), and decreased mean color score in group malignant compared to group benign (mean decreased difference of 1.64 points, 44% lower).

The gray scale morphology status between group benign, borderline, and group malignant was meaningfully significant. This is evident by the increased incidence of cystic mass location in group benign compared to group borderline (percentage increased difference of 42.94 points, 46% higher), the increased incidence of solid mass in group malignant compared to group borderline (percentage increased difference of 11.54 points, 19% higher), and increased incidence of solid mass in group malignant compared to group benign (percentage increased difference of 54.58 points, 89% higher). Tailor *et al.* reported that 67.3% of the benign tumors and 46.7% of the malignant lesions were unilocular.[11] Similarly, Kobal *et al.* reported 31.8% of benign lesions and 62.5% malignant lesions were multilocular.[7]

## CONCLUSION

In our study, pre-operative evaluation of the malignant ovarian masses with color flow Doppler and it's parameters of PI <0.8 and resistivity index <0.4 were considered for analysis. These indexes were well correlated with histopathological findings of malignant ovarian masses. The current study attempted to assess the accuracy of color Doppler image indexes as a diagnostic tool to discriminating the benign and malignant ovarian masses. This clinical application is a new modality for assessing the malignant ovarian tumors in the field of gyneoncology.

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