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Role of Gray Scale and Color Doppler Ultrasound in Differentiating Benign from Malignant Ovaran Masses

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Abstract: ***'Role of gray scale and color doppler ultrasound in differentiating benign from malignant ovarian masses' is a study aimed at improving ultrasound based diagnostic capabilities for ovarian lesions. The study was conducted from January 2022 - January 2023 and it demonstrated that the combination of gray scale ultrasound and doppler is mpre sensitive and specific compared to gray scale ultrasound alone in diagnosing ovarian mass.***

Keywords: Ovarian mass, IOTA, Doppler ultrasound, Gray scale ultrasound, Benign ovarian masses, Malignant ovarian masses

1. Introduction

Ovarian mass is frequently encountered among the various gynaecological conditions, and poses a great challenge in characterising the ovarian mass clinically. Hence a dedicated radiological workup is required for better assessment and further management.

Definitive diagnosis must be made as treatment approach would differ for benign and malignant masses. Ultrasonography (US) is considered as the primary imaging modality for diagnosing the presence and further evaluating nature of the ovarian mass [1]

Cross sectional imaging (both CT and MRI) has a role in staging of carcinoma and giving a clear detailing of non - diagnostic cases on ultrasound. However, these modalities are expensive and due to unavailability in all areas, they cannot be performed in all patients.

Hence a combination of clinical examination and ultra - sonography was utilised diagnostic and management purpose of ovarian masses.

2. Methodology

This is a prospective study conducted during the period from January 2022 - January 2023 in department of Radio - diagnosis, Dr. Kiran C. Patel Medical college and research institute Bharuch.

The study includes the patient referred from the department of obstetrics and gynaecology for various complains including pelvic pain, abdominal distension. etc. Detailed history, examination findings are tabulated and further imaging done.

All patients are examined on Samsung Medison with multi frequency convex array transducer (frequency range 2 to 5MHz) and multi frequency linear array transducer (frequency 5 to 12 MHz) and multi frequency endo transducer (frequency 4 to 9MHz).

The whole of the abdomen is examined in longitudinal and transverse plane giving special reference to pelvis. Trans - vaginal USG is also done in married patients after voiding of bladder, for better characterization of lesion.

The ovaries were identified and if any ovarian mass is present, morphological assessment done in reference to IOTA scoring (Table 1) so as to help categorise into benign and malignant lesions based on imaging.

Patients with suspicious malignant lesions were further evaluated for status of surrounding organs, extension into abdomen, as cites, lymph node involvement, metastasis to liver, peritoneum, serosal surface, omentum etc.

Table 1: IOTA scoring

Rules for predicting a malignant tumour (M - rules)	Rules for predicting a benign tumour (B - rules)
M1 Irregular solid tumour	B1 Unilocular cyst
M2 Presence of ascites	B2 Presence of solid components where the largest solid component is <7 mm in largest diameter;
M3 At least four papillary structures	B3 Presence of acoustic shadows
M4 Irregular multilocular solid tumour with largest diameter ≥100 mm	B4 Smooth multilocular tumour with largest diameter <100 mm
M5 Very strong blood flow (color score 4)	B5 No blood flow (color score 1)

Power and doppler flow imaging and spectral analysis were performed. Flow was noted as *present or absent* and based on location, noted in central or peripheral region or septal region and vessels being arranged regularly or randomly. [2]

On spectral Doppler the lowest RI and PI values and highest PSV are considered as the features of a malignant mass when RI <0.6 and PI <1.0 and PSV is max >15 cm/sec. Measurements are noted from three consecutive waveforms and smallest sample volume noted.

Those patients that were evaluated to have benign lesions and were symptomatic (i. e. pain or torsion) on first or follow up scan underwent surgery. Sonographic findings were then compared with intraoperative and histo - pathological findings.
Other benign lesions like follicular cysts and asymptomatic hemorrhagic cysts were put on follow up which showed resolution.

Patients with suspicious findings were surgically staged and optimally cytoreduction was performed. Decision for extent of surgery was dependent on intraoperative findings. In doubtful intra operative finding, frozen section diagnosis guided the extent of surgery. Patient operated for undiagnosed ovarian mass underwent oophorectomy.

3. Results

Of the total patients (i. e 85) assessed, 57 patients underwent surgery and sonographic findings were compared with intraoperative and histo - pathological findings.

28 patients evaluated as benign lesions on ultrasound (20 – follicular cyst and 7 - hemorrhagic cyst) were placed on follow up who showed resolution.

Results of patients who were operated were further analysed and evaluated for the purpose of this study as follows.

There were total of 17 malignant lesions and 40 benign lesions noted

Table 2: Distribution of masses according to menopausal status

S No.	Menopausal Staus	Benign	Malignant	Total
1.	Pre - Menopausal	29	4	33
2.	Post - Menopausal	11	13	24
	Total	40	17	57

Table 3: Iota findings

Sr	B1	B2	B3	B4	B5	M1	M2	M3	M4	M5	No	IOTA diagnosis		HPE diagnosis		T%
												Benign	*Malignant*	*Benign*	*Malignant*	
1	✓				✓						10	10	-	10	0	0
2				✓	✓						3	3	-	3	0	0
3		✓		✓							11	11	-	10	1	90
4						✓					4	-	4	1	3	75
5									✓		4	-	4	1	3	75
6								✓		✓	4	-	4	0	4	100
7		✓		✓				✓			4	4	-	3	1	25
8		✓									2	2	-	2	0	0
9	✓	✓			✓						3	3	-	3	0	0
10								✓	✓	✓	2	-	2	0	2	100
11						✓				✓	1	-	1	0	1	100
12									✓	✓	1	-	1	0	1	100
13							✓	✓	✓	✓	1	-	1	0	1	100
14					✓	✓					2	2	-	2	0	0
15	✓		✓								5	5	-	5	0	0

Table 4: Comparison of IOTA and histopathological diagnosis

	Pathological Findings	
IOTA Score	Malignant	Benign
Test Positive	15	3
Test Negative	2	37

Sensitivity of IOTA scoring in determining malignant lesions is 88.2%

Specificity of IOTA scoring in determining malignant lesion is 92.5%

Positive predictive value of IOTA scoring is 83.3%

Negative predictive value of IOTA scoring is 94.9%

Table 5: Sensitivity and specificity of RI and PI values

	Sensitivity	Specificity
RI<0.6	100	70%
RI<0.4	26.6	90%
PI<0.8	80	90%
PI<1.0	100	80%

This study proved that sensitivity of spectral flow analysis is better if cut of values are RI <0.6 and PI <1.0 as compared to RI <0.4 and PI <0.8

This study also showed the special role of Doppler in labelling the solid tumor of ovary as benign if it did not show any significant vascularity.

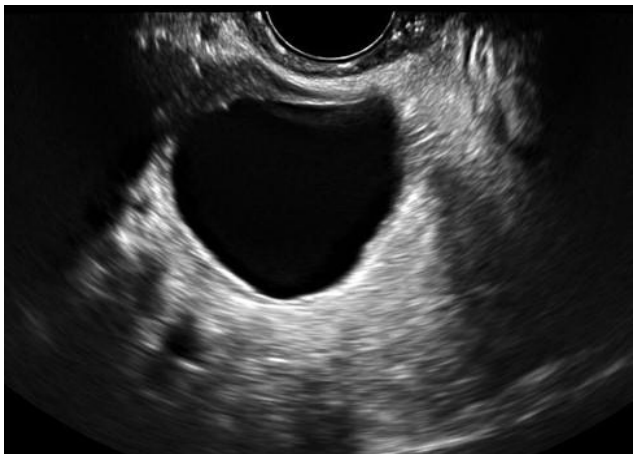
The definitive diagnosis of malignancy is only done if color Doppler showed intra tumoral vascularity (mainly central) and spectral Doppler showed low resistance velocity waveform in intra tumoral vessels.

Table 6: Distribution of final pathological diagnosis

Diagnosis (Benign)	No. of Lesions
Chocolate cyst	6
Haemorrhagic cyst	7
Serous cystadenoma	9
Mucinous cystadenoma	6
Mature teratoma	11
Fibroma	1

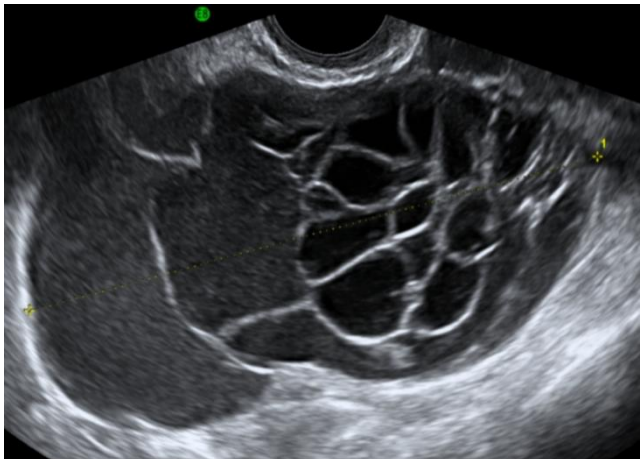
Diagnosis (Malignant)	No. of Lesions
Serous cystadenocarcinoma	10
Mucinous cystadenocarcinoma	3
Dysgerminoma	2
Immature teratoma	1
Granulosa cell tumour	1

Case Series

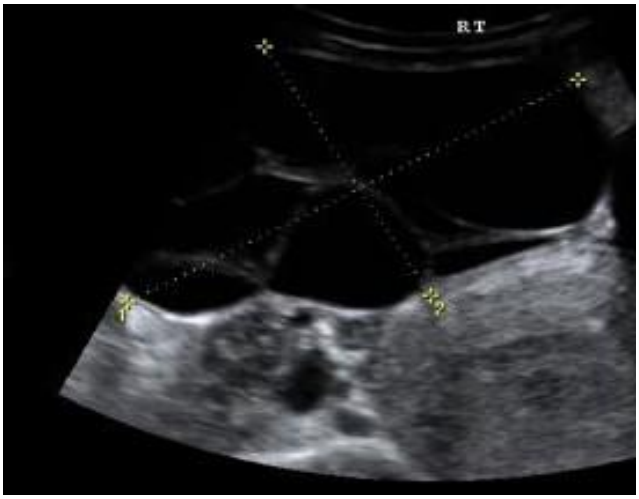


Case 1
Anechoic cystic lesion with no evidence of echoes and septations and no evidence of internal vascularity. Lesion was categorised as benign on IOTA scoring (B1 and B5) and given diagnosis of **simple follicular cyst.** Lesion showed resolution on follow up scan.

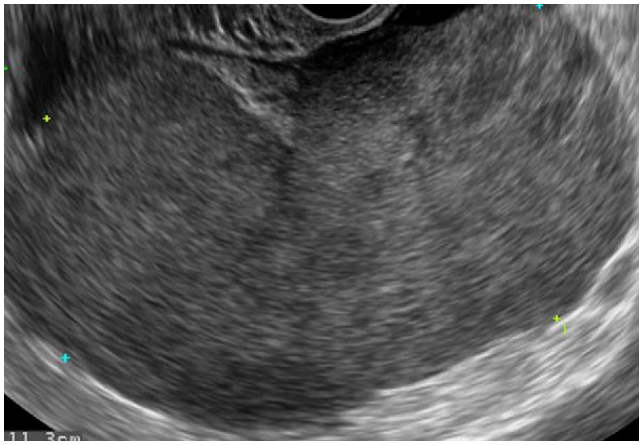
Case 2
Cystic lesion with echoes and septations with no solid area and vasculairty. Lesion was categorised as benign on IOTA scoring (B1 and B5) and diagnosed as **hemorrhagic cyst** which showed improvement on subsequent scans.



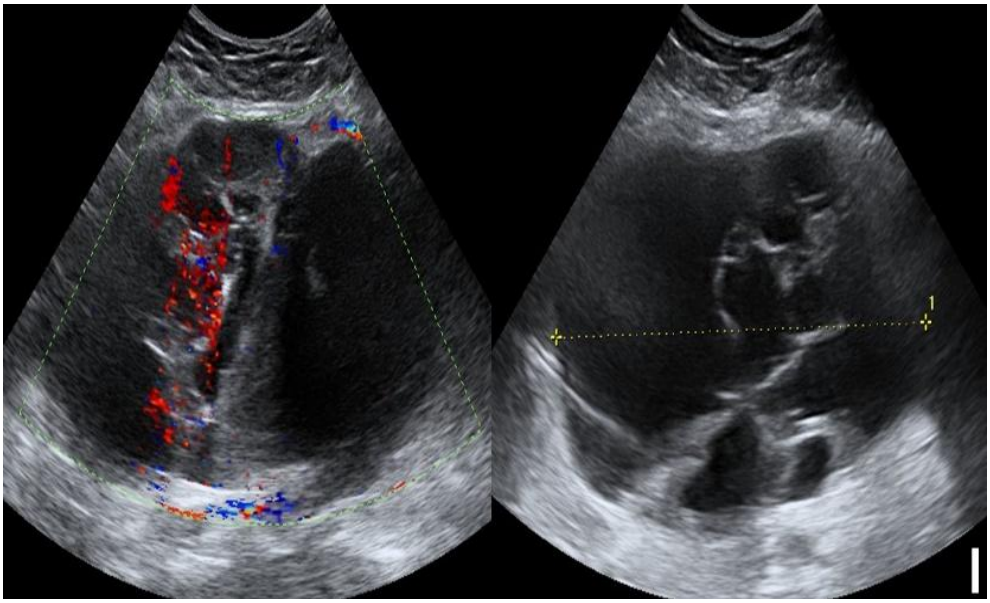
Case 3: Cystic lesion with internal echoes and thick septations with no evidence of internal vascularity and diagnosed. Lesion was categorised as benign on IOTA scoring (B4 and B5) and diagnosed as **mucinous cystadenoma** on histopathology



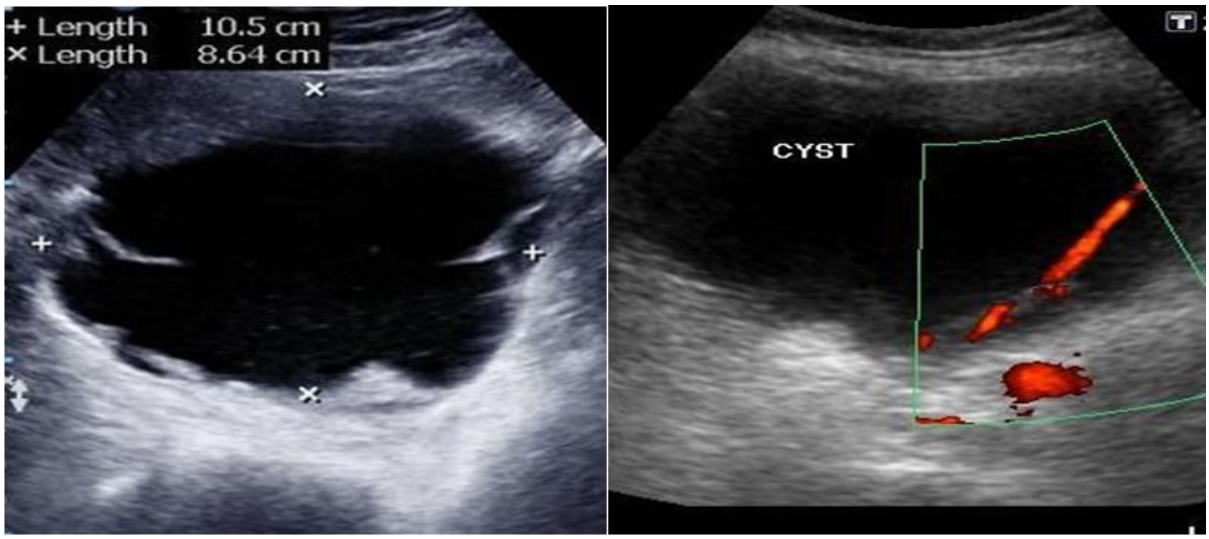
Case 4: Multiloculated anechoic cystic lesion with evidence of thin septations in it and showing peripheral vascularity on color doppler showing its benign nature. Furthermore was given IOTA score B4 and B5 and diagnosed as **serous cystadenoma** on histopathology



Case 5: Heterogenous lesion (Solid mass with cystic degenerative areas within it) with ascites. Color doppler shows no vascularity hence depicting its benign nature. IOTA score B5 was applied. Lesion was diagnoised as **ovarian fibroma** on histopathology



Case 6: Cystic lesion. with multiple internal septations which show vascularity and color doppler shows significant RI and PI values. IOTA descriptors M4 and M5 were applied
Lesion was diagnosed as **mucinous cystadenocarcinoma** on histopathology



Case 7: Cystic lesions with internal echoes and papillary projections and projections showing vascularity. IOTA descriptors M1, M4 and M5 were applied. Lesion was diagnosed as **serous cystadenocarcinoma** on histopathology

4. Discussion

In this study 33 are pre - menopausal patients and 24 are post - menopausal patients.

72.5% of the benign cases belonged to the pre menopausal category and 76.5% of malignant cases belonged to the post menopausal category.

In our study using IOTA scoring in sonographic evaluation out of 17 malignant masses confirmed by histopathological diagnosis 15 were classified as malignant and rest 2 could not be determined. And out of 40 benign cases 37 were determined as benign and 3 were not determined making sensitivity 88.2%, specificity 92.5%. PPV 83.3% and NPV 94.9%.

In our study on Doppler spectral analysis with using of cut off criteria PI<1.0 we got sensitivity 100% and specificity 90% and using PI <0.8 we got sensitivity 80% and specificity 90%.

With the cutoff of RI<0.6 we got sensitivity 100% and specificity 80%.

With the cut off value of RI<0.4 we got sensitivity 26.6% and specificity 90%

5. Conclusion

The study concludes that the combination of gray scale ultrasound and doppler significantly improves the diagnostic capabilities for ovarian lesions. This approach is more sensitive and specific compared to using gray scale ultrasound alone, making it a valuable tool in areas with limited access to advanced imaging and diagnostic modalities.

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