Research Article

Preoperative evaluation of ovarian masses with color Doppler and its correlation with pathological finding

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ABSTRACT

Background: Most ovarian cancers are diagnosed in advanced stages because these tumours may not cause any specific symptoms, particularly in its early stages. Though specific risk actors have been identified there are no reliable screening tests for ovarian cancer. However, improvements in identification of women at high risk for ovarian cancer, as well as improved imaging techniques like the USG and color Doppler along with CT Scan and MRI has increased the likelihood of early detection.
Methods: The aim of the study was to evaluate the efficacy of color and spectral Doppler in diagnosing the ovarian malignancy. A Prospective randomised study was conducted at a tertiary care centre where 50 patients with ovarian masses were selected. The study design included thorough history taking and clinical examination followed by evaluation of tumour markers. USG along with color Doppler evaluation was done followed by surgery and then co-related with histopathology. The color Doppler parameters such as vascularity, distribution of vascularity, pulsatility and resistive index were also evaluated and statistical significance assessed.
Results: Color Doppler showed increased vascularity in 100% of malignant tumors in contrast to only 54.24% of benign tumors. Absent blood flow in a solid tumor almost always ruled out the possibility of malignancy. Spectral Doppler helped to assess the nature of the blood vessels picked up on color Doppler. All the patients in the malignant group and 4 patients in the borderline group had PI<1.0. Remaining 6 tumors with P1 <1.0 belonged to the benign group. Out of 15 patients with PI >1.0, 13 were benign and 2 patients had borderline tumours. RI of <0.4 was seen in 8 Patients with malignancy and RI of >0.4 was seen in 26 patients with benign lesions.
Conclusions: Color Doppler is a good non-invasive modality to differentiate benign from malignant lesions. Vascularity is most sensitive and RI is most specific. Thus, color Doppler and spectral Doppler tremendously increased the reliability in diagnosing a malignant ovarian tumor. Color Doppler served as an important tool to rule out malignancy in solid tumors if they failed to show any intra-tumoral vascularity. B-Mode USG in combination with color Doppler and spectral Doppler is proposed as the first and foremost diagnostic modality in patients with ovarian tumor, so as to establish the definite diagnosis of malignancy early in the course of the disease.

Keywords: Color Doppler, Ovarian malignancy, Adnexal masses, Pulsatility index, Resistive index

INTRODUCTION

The diagnosis of ovarian tumors remains a common clinical gynecologic problem. The early and definite diagnosis of ovarian malignancy is of grave clinical importance because prognosis depends totally on early diagnosis Ovarian tumors are the second most common malignancy of the genital system and are the most common cause of death from malignancy due to late diagnosis. The death rate from ovarian cancer far exceeds that of cervical and endometrial carcinoma combined.[1,2] Thus discrimination between malignant and benign masses is crucial as well as challenging because of the high fatality rates and atypical presentations.[3]

Table 1: The international ovarian tumor analysis (IOTA) rules.

B Rules	M-Rules
Unilocular cysts	Multilocular cysts
Presence of solid components where the largest solid component is less than 7 cms	Irregular solid tumours
Presence of acoustic shadowing	Ascites
Smooth multilocular tumour with a largest diameter less than 100 mm	At least four papillary structures irregular multilocular solid tumour with largest diameter ≥100 mm
No blood flow in duplex Doppler	At least four papillary structures irregular multilocular solid tumour with largest diameter ≥100 mm

- If one or more M features were present in the absence of B feature- Malignant
- If one or more B features were present in the absence of an M features- Benign
- If both M features and B features were present, or if none of the features was present- inconclusive

Recently the role of color and spectral Doppler in the diagnosis of ovarian malignancy has been a subject of enormous debate with varying opinions on the efficacy of color and spectral Doppler.[4] Because population-based screening is not currently approved by the ACOG.[5] Incidental or symptomatic adnexal masses should be examined thoroughly for the presence of malignancy. Various scoring systems, mathematical models, and software programs, which were based on sonographic findings, were proposed for better discrimination of malignant ovarian tumors. The most widely used of these predictive systems is the risk of malignancy index (RMI) proposed by Jacobs et al.[6] The RMI is a simple scoring system incorporating basic sonographic parameters, serum cancer antigen 125 (CA-125) levels, and menopausal status. Sonography is a useful tool for

determination of malignancy, and nearly precise diagnosis with sensitivity of greater than 95% and specificity of approximately 90% for malignancy is possible in experienced hands.[7,8] However, in settings with less experienced sonographers, standardized techniques, definitions, and values are necessary. In an effort to achieve this, the International Ovarian Tumor Analysis (IOTA) group gave clear definitions and measurements to describe the sonographic features of adnexal tumors (Table 1).[9]

The simple rules yielded conclusive result 95% sensitivity and a specificity of 96%.

Aims and objectives

Pre-operative evaluation of ovarian masses with Color Doppler flow imaging and its correlation with intraoperative and histopathological findings, to assess the diagnostic reliability of Doppler sonography findings to differentiate malignant and benign ovarian masses.

METHODS

This study involves observational longitudinal prospective analysis of fifty non-consecutive patients admitted in gynecology ward of tertiary care hospital for a period of 2 years, for evaluation and operative intervention for ovarian masses. Patients of infective pathology and other adnexal masses were excluded. After enrollment Detailed history taking including age, symptoms, menstrual history, family history of ovarian cancer was sought, General and pelvic examination and Blood investigations were done followed by Trans-vaginal gray-scale sonography and color Doppler sonography-parameters assessed included Maximum tumor volume, locularity, gray scale morphology, presence or absence of papillary projections/solid areas echogenicity, ascites, presence of vascularity, distribution of vascularity, morphology of flows, resistance index (RI), pulsatility index (PI), highest peak systolic velocity (PSV), morphological index (MI) using DePriest morphological scoring system.[10] Tumor marker and computerized tomography and MRI examination (wherever required) was also done. All patients underwent operative procedure (laparoscopy and laparotomy) specimen was sent for histopathology.

Scanning procedure

All women were scanned trans abdominally and transvaginally with real time gray scale ultrasound examination followed by color Doppler sonography. The location of the tumor was recorded as unilateral/ bilateral, tumour volume, septal thickness, papillary projections were looked for. The echogenicity of the tumor was defined as solid if solid tissue constituted at least 80% of the tumor and as cystic if solid tissue constituted less than 80%. If any solid component was noted within the cystic lesion, the percentage of the solid tissue was calculated.

Subsequently, the percentage of the solid component was calculated by the formula (volume of the solid component/volume of the tumor) × 100. After standard gray mode morphological examination the entire tumor was surveyed by color Doppler Sonography and presence of vascularity assessed, if no blood flow was detected after 10 minutes of scanning, the tumor was considered to have no flow. When blood flow was detected within the septa it was characterized as septal, in solid tumor areas, it was categorized as central, whereas when blood flow was localized in the cyst wall, it was categorized as peripheral.

In the areas of flow detected, the pulsed Doppler mode was activated, and flow velocity waveforms were obtained .The peak systolic velocity (PSV, centimeters per second), pulsatility index (PI), and Resistive index (RI) were electronically calculated from the waveforms.

PI = peak systolic flow - end-diastolic flow mean systolic flow

RI = peak systolic flow - end-diastolic flow Peak systolic flow

At least 2 readings were taken for each vessel and the lowest value was used for statistical analysis. A PI <1.0 or RI <0.4 was considered suggestive of malignancy.

Histopathology

Specimen obtained at surgery was mounted on blocks and one section per centimeter was taken for examinations by pathologist tumor were classified in accordance with the system recommended by World Health Organization. FIGO staging was done On basis of the their tumor potential they were broadly divided into 'benign', 'malignant' and 'borderline' for the purpose of further analysis.

RESULTS

The various parameters of Doppler sonography were then analysed with respect to the three groups (based on histopathology) namely: (A) Benign (B) Borderline (C) Malignant.

A total of 50 patients were enrolled in the study. The number of patients under each category following histopathological analysis is shown in Figure 1.
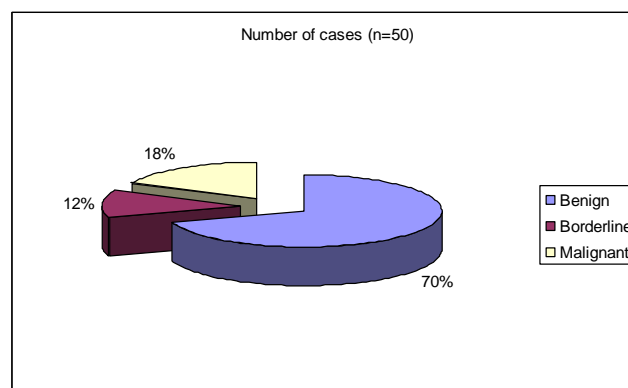

Figure 1: Distribution of cases in study population.

Demographic profile

Age distribution

The mean age were 37.32±12.85 years ranging from 17 years to 75 years. The mean age in the benign group was 33.29±11.24 years, 45.50±5.43 years in the borderline group and 47.56±14.71 years in the malignant group. The difference in age in between the three groups was statistically significant (p=0.004).

Table 2: Age group distribution of the cases of the three groups.

	Age group					Total
	≤25 years	26-35 years	36-45 years	46-55 years	>55 years	
Benign	9 (25.7%)	15 (42.9%)	5 (14.3%)	4 (11.4%)	2 (5.7%)	35
Borderline	0	0	3 (50%)	3 (50%)	0	6
Malignant	1 (11.2%)	0	2 (22.2%)	3 (33.3%)	3 (33.3%)	9

CA-125

CA 125 estimation was done as it is one of the established method which aids in differentiation of ovarian masses pre-operatively. However for statistical analysis CA-125 was the only considered as it done for all the patients under study. The cut-off value over which the mass was considered as malignant was ≥35 IU/ml. The mean value of CA-125 in the benign group was 17.68±13.41 IU/ml, 23.09±19.80 IU/ml in the borderline

group and 528.44±111.83 IU/ml in the malignant group. The difference in between the three groups was statistically significant (p=0.001).

However, when the subgroup analysis was done the data was significant in between benign and malignant groups (p value 0.001). It was also noted that 80% of patients in study had CA-125 <35 IU/ml, rest had levels >35 IU/ml.

Gray scale morphology

The tumour masses are classified into solid, solid-cystic and cystic based on gray scale morphology. On one hand 71.4% of the benign tumours were cystic, on the other all the borderline tumours and 7 of the 9 malignant tumours were solid cystic on gray scale morphology. The data with respect to gray scale morphology was statically significant (p value 0.002). In this study only one benign tumour was noted to have solid consistency (Table 3).

Papillary projections

60% of all tumours exhibited papillary projections on transvaginal sonography. All the malignant neoplasms and 5 of six borderline variety belonged to the above mentioned group. In the benign group 16 tumours exhibited papillary projections, while in remaining 19 tumours papillary projections were absent. The data was statistically significant at the p value 0.006. The subgroup analysis revealed that the data was significant in between benign and malignant groups with p value 0.003 (Table 3).

Table 3: Gray scale morphology characteristics of tumours including papillary projections.

Gray scale morphology	Benign	Borderline	Malignant	Total (n=50)
Cystic	25 (71.4%)	0	2	27
Solid-cystic	9	6 (100%)	7 (77.8%)	22
Solid	1	0	0	1 p value 0.002
Papillary projections				
Absent	19	1	0	20
Present	16	5	9	30 p value 0.006

Color Doppler ultrasound

Doppler parameters were optimized for detection of flow and calculation of impedance indices. Flow results were documented as being absent or present. The vessel location was also noted. On spectral Doppler, the lowest resistive index (RI) and pulsatility index (PI) detected at any point in the mass were used for analysis. However, the third variable maximum peak systolic velocity was recorded for a limited number of patients, so it was not included for analysis. The Doppler findings were considered as being suggestive of malignancy when RI <0.4 and PI <1.0.

Vascularity

In this study, 34 tumours were found to be vascular. This included all the malignant and borderline neoplasms and 19 benign neoplasms. None of the malignant and borderline tumours were found to be avascular. However, for statistical calculations the borderline group was clubbed with the malignant group. When the data in between the two groups was analysed it was found to be highly significant at the p value of 0.001 (Table 4).

Table 4: Presence/absence of flow of blood in tumors.

Vascularity	Benign	Borderline	Malignant	Total
Present	19 (54.3%)	6 (100%)	9 (100%)	34
Absent	16	0	0	16 (p value 0.001)

It was noted that 58.82% of vascular tumours had peripheral vascular distribution. However, central vascular distribution was noted in one benign neoplasm and one malignant tumour (with septal vascular distribution). 11 of 15 malignant tumours had peripheral blood supply.

Resistive index

The value of RI<0.4 was considered as an indicator of malignant lesion. In this study, the RI was<0.4 in 6 patients of the malignant group and 1 patient of the borderline group. Only 1 patient of benign group had RI>0.4. But 3 patients of malignant group and 5 patients of the borderline group had RI>0.4. The data for RI was statistically significant in between the three groups (p 0.002) (Table 5).

Table 5: Resistive index in the tumor groups.

RI	Benign	Borderline	Malignant	Total
<0.4	1	1	6	8
≥0.4	18	5	3	26 (p value 0.002)

For statistical evaluation the borderline tumour group was combined with the malignant group and data was analysed. The mean RI in the benign group was 0.52±0.16. The mean RI in the malignant group was 0.39±0.12. The difference in RI in between the two groups was statistically significant (p value 0.005) (Table 6).

Table 6: RI values in the two tumour groups.

RI	Benign	Malignant
Mean with standard deviation	0.52±0.16	0.39±0.12
Minimum	0.42	0.20
Maximum	0.70	0.60

Pulsatility index

The value of PI <1.0 was considered as an indicator of malignant lesion. All the patients in the malignant group and 4 patients in the borderline group had PI<1.0. Remaining 6 tumours with P1<1.0 belonged to the benign group. Out of 15 patients with PI>1.0, 13 were of benign group and 2 patients belonged to the borderline group. The p value of 0.003 suggested statistical significance for P1 in between the groups (Table 7).

Table 7: Pulsatility index in the tumor groups.

PI	Benign	Borderline	Malignant	Total
<01.0	6	4	9	19
≥1.0	13	2	0	15 (p value 0.003)

For statistical evaluation the borderline tumour group was combined with the malignant group and data was analysed. The mean PI in the benign group was 0.98±0.28. The mean PI in the malignant group was 0.75±0.17. The difference in PI in between the two groups was significant (p value 0.002) (Table 8).

Table 8: PI values in the two tumour groups.

PI	Benign (Mean±SD)	Malignant (Mean±SD)
Mean with standard deviation	0.98±0.28	0.75±0.17
Minimum	0.9	0.45
Maximum	1.40	0.99

Table 9: Spearman coefficient of correlation between CA-125, RI & PI.

Parameters	CA-125	R1	PI	Total (n=50)
CA-125	1	0.014	0.055	17
R1	0.014	1	0.896	31 (62%)
PI	0.055	0.896	1	2 p value 0.167

Correlation was then studied in between the three parameters CA-125, RI and PI. Positive correlation was noted in between the three variables which were statistically significant at p value of 0.01 (Table 9).

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 pre-operative evaluation of ovarian masses and its correlation with histopathology. In addition, we also assessed the efficacy of CA-125 serum concentration estimation and transvaginal B mode ultrasonography in differentiating malignant and benign ovarian tumors. We however, have excluded patients with advanced disease to avoid bias and this explains the absence of such a group in our study.

Demographic profile

Our study included 50 patients from the age ranging between 17 to 75 years. Age is the most important independent risk factor for ovarian cancer in the general population Thus, adnexal masses in postmenopausal women are more likely to be malignant than those in premenopausal women. In our study also, we noted that the risk of malignancy increased with increasing age. Also, it was seen that in the benign group 68.6% of patients were less than 35 years of age. It was also seen that amongst the 9 postmenopausal females 4 had malignancy.

Gray scale ultrasound

In asymptomatic women with pelvic masses, transvaginal ultrasonography is the imaging modality of choice which has been widely used lately to study size and morphology of ovarian tumors for predicting malignant nature. Sensitivity ranging from 60% to 95% and specificity of 65-95% has been reported.[19] It was only after the IOTA study that the clear definitions of ultrasonography parameters were formulated and these were used in subsequent studies.[9] In our study we also same definitions of various morphological parameters have been used to validate comparison. We followed the De Priest Ultrasound score to predict malignancy.[10] The morphological score of a mass ≥5 was considered as malignant. In this study we found that most of the benign tumors (n=25) measured <10 cms. This measurement was more than 5 cms for the malignant group (p value 0.018). This was in accordance to the data reported by Tailor et al20 in which benign lesions had mean diameter of 6.98cms and malignant lesions measured 9.81cms (p value 0.013). In the present study, most of the benign lesions were unilocular (77.1%) and all the borderline lesions and most of the malignant lesions were multilocular (77.8%) (p value 0.000). Tailor et al reported that 67.3% of the benign tumors and 46.7% of the

malignant lesions were unilocular.[20] Similarly, Kobal B et al reported 31.8% of benign lesions and 62.5% malignant lesions were multilocular.[23] Thus the present study and other studies mentioned above suggest that the malignant lesions are predominantly multilocular. The gray scale morphology in our sample size revealed that 71.4% of the benign tumors were cystic. However, all the borderline tumors and 7 of 9 malignant tumors were solid cystic.

Papillary projections

One of the most consistent findings seen in various studies was presence of papillary projections and their correlation with malignant potential of ovarian mass. The consistency of this parameter in predicting malignancy has provided it place in the various morphological scoring systems. In this study, 60% of all tumors exhibited papillary projections on transvaginal sonography. All the malignant neoplasms and 5 of six borderline variety belonged to the above mentioned group. In the benign group 16 tumors exhibited papillary projections, while in remaining 19 tumors papillary projections were absent (p value 0.006). The papillary projections as a predictor of malignancy had very high sensitivity of 93.33 % but lower specificity (54.29%). Tailor et al reported the presence of papillary projections in 9.6% of benign lesions and in 73.3% of malignant lesions. This similar pattern was also noted by Kobal B et al23 in their study. L Valentin et al noted papillary projections in 64%, 67% and 41% cases in the borderline group, patients with epithelial cancer stage-I and patient with epithelial cancer stage-IV respectively (p value 0.0034).[23,24]

Morphological scoring system

De Priest morphological ultrasound score was used to predict malignancy.[10] The morphological score of a mass ≥5 was considered as malignant. The sensitivity, specificity, positive predictive value and negative predictive value in the present study were 100%, 48.57%, 45.45% and 100%. The results of our study are comparable to those reported by De Priest et al in their original article.[10] The mean value of MI for benign lesions was 4.89±2.20 and 8.93±1.53 for malignant lesions. As noted in various studies gray scale morphology has high sensitivity in diagnosing ovarian malignancy but low specificity. The similar results were noted in our study.

Color Doppler sonography

In this study, we found PI as a single parameter proved to be the better index for discrimination between benign and malignant ovarian tumors. At the cut-off of 1.0, sensitivity, specificity, positive predictive value and negative predictive values were 86.67%, 68.42%, 68.42% and 86.67% respectively. These values were better than those for RI at cut-off value 0.4. The sensitivity, specificity, positive predictive value and negative

predictive values were 46.67%, 94.74%, 87.5% and 69.63% respectively. In spite of its high specificity, RI as a single parameter is less useful in the present study as it has very low sensitivity. Also as noted in other studies the mean values of RI and PI in this study for benign lesions were more than malignant lesions. The values of RI and PI were 0.52±0.16 and 0.98±0.28 for benign lesions and 0.39±0.12 and 0.75±0.17 for malignant lesions. The difference in data for RI and PI values in between the benign and malignant groups was statistically significant at p value of 0.005 and 0.002 respectively. As noted in other studies overlap between benign and malignant ovarian tumors for RI and PI values was also noted.
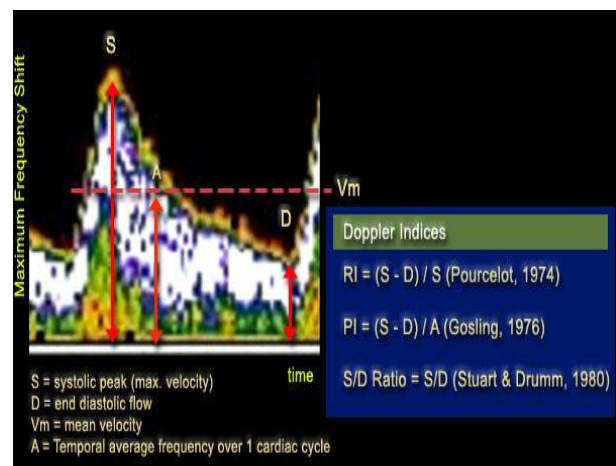

Figure 2: Doppler flow indices.

Angiogenesis and neovascularization in malignant tumors result in a high number of additional, atypical tumor vessels, which cause a decreased blood flow resistance. The resistivity index and pulsatility index of the Doppler waveform have been measured in ovarian tumors by several investigators. Some authors have suggested that color Doppler sonography is more sensitive and specific than transvaginal sonography alone. In our study cut off values of 0.4 and 0.1 for RI and PI respectively as the demarcation between benign and malignant for ovarian tumors was used.

Vascularity

Junasz B et al successfully demonstrated the presence of new vessels in the ovarian and endometrial cancers.[25] In the present study out of 50 tumors, 34 tumors were vascular. This included all the malignant and borderline neoplasms and 19 benign neoplasms. None of the malignant and borderline tumors were found to be avascular. This data is in concordance with the findings of Timor-Tritsch and colleagues who have reported that lack of blood flow in an ovarian tumor as detected by color Doppler may preclude cancer.[26] To further add on most of the studies in world literature have consistently detected blood flow in the malignant lesions, while some

other workers believe that absence of vascularity does not always rule out malignancy.

Vascularity as a predictor of malignancy achieved sensitivity, specificity, positive predictive value and negative predictive value of 100%, 45.71%, 44.12% and 100%. The vascularity as a single parameter though supplements the ultrasound, but it does not increase the specificity obtained on ultrasound alone as shown in Table 10.

Table 10: Sensitivity, specificity, positive predictive value and negative predictive value of CA-125, transvaginal ultrasound (papillary projections (PP) and morphological index (MI)) and color Doppler ultrasonography (vascularity (V), RI and PI).

Modality		Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	False Positive (%)	False Negative (%)
CA-125		46.67	91.43	70	80	53.33	8.57
TVS	PP	93.33	54.29	46.67	95	45.71	6.67
	MI	100	48.57	45.45	100	51.43	0
CDS	V	100	45.71	44.12	100	54.29	0
	RI	46.67	94.74	87.5	69.23	5.26	53.33
	PI	86.67	68.42	68.42	86.67	31.58	13.33

For the purpose of statistical analysis the borderline group was combined with the malignant group.

Table 11: Summary of important studies done in world literature.

Study	Modality & cases	Parameters	Results	Comments
Marchesini AC et al[33]	TVS & CDS (n=67, bl-52, ml-15)	RI, PI, PSV. EDV in two vessels intraclass coefficient of correlation (ICC) was calculated for all above	**RI:** SE-84.6%, SP-86.7%, ICC-0.60 **PI:** SE-69.2%, SP-93.3%, ICC-0.65 **TVS:** SE-80%, SP-65.4%	PSV and EDV present poor intra-tumoral reliability. the lower RI evaluated in at least two distinct sites of the tumor, was able to improve the performance of grey scale
R Madan et al[30]	TVS & CDS (n=74)	Morphologic indexing, color flow imaging, spectral imaging & HPE correlation	Sonomorphology highest SE (92.5%) & NPV (92.8%) Vessel morphology & arrangement highest SP (96.8%) & PPV (95.2%) PSV better than RI & PI Sonomorphologic+Vascular scoring improved	Considerable overlap in morphologic scoring. Therefore multiparameter analysis incorporating morphologic scoring, vessel location, vessel arrangement and spectral waveform
Hamper UM et al[32]	TAS, TVS, CDS & pathological correlation (n= 31)	RI, PI	Benign lesions (n=25) RI:0.77 ± 0.22 PI:1.93 ± 1.02 Malignant lesions (n=6) RI:0.5 ± 0.17 PI:0.77 ± 0.33	High PI & RI indicate benign adnexal processes
Fleischer AC et al[31]	TAS, TVS, CDS & pathological correlation (n= 62)	PI PPV NPV	PI < 1.0 for ml PPV: 83% &NPV: 98% for CSD	CDS seems to be accurate to exclude malignancy, however misdiagnosis may occur in cases of inflammatory & metabolically active benign masses

Tumor vessels can be grossly categorized as central or peripheral.[27] Although this classification is somewhat misleading anatomically, it is helpful in describing the location of tumor vessels that are detectable with ultrasound. Peripheral tumor vessels are derived from pre-existing vessels in the affected region, whereas central vessels are newly formed in response to tumor-elaborated angiogenic factors or intra-tumoral necrotic processes. Benign lesions are usually supplied by

peripheral and pericystic vessels, while malignant tumors more often have a central type of vascular supply.

Ueland et al also concluded that morphological indexing is an accurate and inexpensive method to differentiate benign and malignant lesions and addition of color Doppler ultrasonography did not improve diagnostic accuracy of MI.[22] Kurjak et al reported that the pattern of blood flow could also differentiate between the ovarian tumors. Peripheral bold flow is usually suggestive of benign tumors and central blood flow characterizes malignant tumor.[28] Witczak K et al also stressed that central vessel localization was the single most significant attribute in tumor malignancy differentiation (with p value <0.0001).[29] However, our study showed contrasting results. Out of the 34 vascular tumors, 20 had peripheral blood supply. This included 12 benign tumors, 2 borderline tumors and 6 malignant tumors. This discrepancy is attributed to the fact that most of the malignant tumors were solid cystic (n=7) which accounted for peripheral bold flow.

As evident from the above discussion and the values in Table 10 all the parameters are helpful in predicting the malignant potential of a tumor, but all of them have their own limitations when used alone.

CONCLUSION

This study shows that,

- Age is a statistically significant risk factor for occurrence of ovarian malignancy.
- Postmenopausal status was consistently found to carry increased risk of malignancy
- CA125 of ≥35 IU/ml was found to be indicative of malignant potential
- *Grey scale morphology:* tumor diameter >10 cms, tumor volume of >500 cm^3, multilocularity, solid-cystic morphology, presence of papillary projections, mixed echogenicity, presence of ascites and DePriest morphological index of ≥5 were indicative of malignant ovarian lesion.
- *Color Doppler sonography:* presence of vascularity, RI <0.4 PI >1 were found to corroborative with malignancy. Vascularity and PI are more sensitive parameters while RI is more specific.
- Conservative surgery was preferred modality of treatment in benign lesions while extensive radical surgeries were done for malignant lesions.

As per this study we recommend that initial clinical pelvic examination should be done thoroughly, as it is an art which cannot be replaced by a sophisticated diagnostic gadget. This should be supplemented by transvaginal sonography as an initial diagnostic tool to predict malignancy in ovarian mass. The addition of Doppler for cases in which sonography findings are inconclusive can be helpful, this will save both time and cost. Doppler sonography when used by experienced examiners provides significant additional diagnostic information that can confirm a tentative diagnosis based on morphological criterion and would seem prudent in management decisions.

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