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Original Article

Role of Ultrasonography and Color Doppler to Diagnosis of Pelvic Masses and its Correlation with Histopathological Findings

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Abstract

Background: Pelvic masses are quite common presentation of gynecological pathology. Ultrasonography (USG) is accepted as the primary imaging modality in the evaluation of pelvic masses, and provides the necessary information to plan out the right therapeutic approach required in the given situation. This study was conducted with a view to find out the diagnostic value of USG, color Doppler study, and correlate with histopathological diagnosis.

Objectives: To study the ultrasonographic and color Doppler findings of pelvic masses, and compare its relative efficacies with histopathological diagnosis.

Materials and Methods: A total of 50 patients were taken in the study referred from various departments. B-mode morphological criteria were used and subsequently spectral Doppler analysis was done by calculating resistive index (RI) and pulsatility index (PI) values. USG was performed by GE LOGIC P6 USG and GE-VIVID-E machine. International ovarian tumor analysis (IOTA) scoring system, RI and PI value was applied to differentiate benign and malignant pelvic masses.

Results: Studied 50 cases, benign and malignant lesions were found in patients belongs to 30-50 and 50-70 years, respectively. Out of 50 cases, 47 cases (94%) were confirmed by histopathology. USG showed an overall sensitivity of 94% and specificity of 90% in comparison to the histopathological findings. For ovarian lesions, USG using IOTA scoring system showed 98% sensitivity and 94% specificity in comparison to the histopathological findings.

Conclusion: USG is a very useful, highly diagnostic and a reliable method in the diagnosis of pelvic masses with good sensitivity and specificity.

Key words: Color Doppler, International ovarian tumor analysis, Pelvic masses, Spectral Doppler, Ultrasonography

INTRODUCTION

Pelvic masses are quite common presentation of a gynecological pathology. Differential diagnosis of pelvic masses is difficult and complex. Although the most of the pelvic masses are benign, they are associated with significant morbidity and are the most common indication for surgery. It is the risk of malignancy that propels us for early, accurate and prompt diagnosis to lessen the mortality and morbidity.

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Of all gynecological diseases, tumors of the adnexa pose one of the most difficult diagnostic puzzles. It is of great importance to differentiate these lesions and to characterize them. Lesions of ovarian origin form majority of the bulk of the adnexal masses; the management of ovarian tumors remains a common clinical gynecologic problem. The early and definitive diagnosis of ovarian malignancy is of grave clinical importance. Ultrasonography (USG) is accepted as the primary imaging modality in the evaluation of pelvic masses.

Sonography usually provides clinically important parameters for the evaluation of pelvic masses. Pelvic sonography can

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confirm the presence or absence of a suspected pelvic mass.[1]

The diagnosis of ovarian tumors is based on clinical examination, sonography, and measurements of CA-125 collectively known as triple diagnostic method.[2] Ovarian cancer is the most common cause of death from gynecological malignancy, and is the fifth most common cause of cancer deaths in women.[3]

The advent and use of diagnostic ultrasound changed the spectrum of the diagnostic approach to pelvic masses. Pelvic ultrasound today forms the primary examination mode in the evaluation of pelvic masses. It provides the gynecologist the necessary information to plan out the right therapeutic approach required in the given situation. Hence, ultrasound has become a mandatory examination in the approach to the management of pelvic masses. This study was conducted with a view to find out the diagnostic value of USG and its correlation with the clinical and histological diagnosis.

Color and pulsed Doppler has been introduced to improve the diagnostic accuracy. Early works and initial reports were encouraging with a very impressive accuracy, but today's literature is full of conflicting results with reduction of the previously promising diagnostic accuracy.

MATERIALS AND METHODS

This study was conducted in Department of Radiodiagnosis, Sukh Sagar Medical College and Hospital, Mukanwara, Jabalpur, Madhya Pradesh. 50 patients were taken in the study with informed consent, referred from gynecology and another department. Relevant investigations were done according to their clinical findings. Using a 3-5 MHz Convex Array Transducer through a transabdominal (TAB) approach, B-mode USG, color Doppler, and spectral Doppler were performed. Transvaginal sonography was also performed using 8-10 MHz Vaginal Transduser. B-mode morphological criteria were used for our study. Subsequently, color and pulsed Doppler imaging was performed. Flow results were recorded as being absent or present and further as normal or abnormal. Vessel location arrangement and morphology were noted. Spectral Doppler analysis was performed by calculating resistive index (RI) and pulsatility index (PI) values, and the lowest values recorded in the masses are noted.

RI ≤0.4 and PI ≤1.0 were taken as cutoff for ovarian malignancy.

Inclusion Criteria

1. Female patients prepubertal to post-menopausal of all age group presenting with symptoms such as pain in abdomen/pelvis, PV bleeding, PV white discharge, urinary and gastrointestinal pressure symptoms and palpable mass.
2. Furthermore, asymptomatic patients where pelvic mass detected at time of routine pelvic examination or at the time of USG transabdominal (TAB) and transvaginal sonography done for other diagnoses.

Criteria for Exclusion

1. Patients with ovulation induction drugs
2. Patients who will not undergo fine needle aspiration cytology or histopathological evaluation
3. Those patients who will be lost in follow-up
4. Patients with ectopic pregnancy are excluded
5. Patients with normal pregnancy.

All of them were subjected to TAB USG with full bladder technique with 3.5 MHz probe and if required then transvaginal sonography with empty bladder technique with 6.5 MHz except for the unmarried female patients. TAB and transvaginal USG were performed with the use of diagnostics GE LOGIC P6 USG and GE-VIVID-E ultrasound system. Observations included size, shape, and echo texture of the pelvic masses in sagittal and transverse planes. International ovarian tumor analysis (IOTA) scoring system was applied to differentiate benign and malignant ovarian tumors.

Statistical Analysis

A statistical analysis was performed using SPSS software, version 20.0 (SPSS, Inc., USA). The Chi-squared test and independent sample *t*-test were used to compare categorical and continuous variables, respectively. Data were presented as a mean ± standard deviation or proportion as appropriate. The $P < 0.05$ was considered to be significant.

RESULTS

About 50 cases of pelvic masses were evaluated and found that benign lesions were seen in patients between 3rd and 5th decades, whereas malignant lesions were usually found in patients between 5th and 7th decades (Table 1 and Chart 1). The majority of the lesions were ovarian in origin 46%, followed by uterine origin 32% and cervix 8% and endometrial cavity 8%, pelvic abscess 4%, and fallopian tube 2% (Tables 2,3 and Chart 2). Out of 50 cases, 47 cases (94%) were confirmed by histopathology in following manner fibroid (24%), adenomyosis (08%), endometrial Ca (06%), Ca cervix (08%), vesicular mole (02%), ovarian dermoid (08%), mucinous cystadenoma (02%), serous

cystadenoma (12%), serous cystadenocarcinoma (08%), mucinous cystadenocarcinoma (06%), dysgerminoma (02%), fibrothecoma (02%), granulosa cell tumor of ovary (02%), and abscess (04%) (Table 4 and Chart 3). Overall, 23 (46%) cases of ovarian lesion 11 cases (52.38%) are benign, shows normal color flow pattern with RI more than 0.4, and PI more than >1.00 and 10 cases (47.62%) are malignant shows abnormal color flow pattern with RI <0.4 and PI <1.0 (Tables 5-8). Vessels location of ovarian masses was also detected by the color Doppler and out of 21 ovarian masses 9 shows peripheral vessel location, 03 shows septal location, 04 shows septal + central, 03 shows peripheral + septal, and 02 shows peripheral + septal vessel location. Central and septal vascularity was found in 65% of the malignant masses, whereas peripheral vascularity was present in 25% of the cases (Table 9 and Chart 4). Overall in our study, USG showed a sensitivity of 94% and specificity of 90% for pelvic masses and 98% sensitivity and 94% specificity ovarian lesions (Figures 1-5) .

Table 1: Age wise incidence

Age group (years)	Number of cases (%)
10-20	03 (06)
21-30	09 (18)
31-40	10 (20)
41-50	12 (24)
51-60	09 (18)
61-70	07 (14)
Total	50 (100)

Table 2: USG site of lesion

USG site of lesion	Number of cases (%)
Uterus	16 (32)
Cervix	04 (08)
Endometrial cavity	04 (08)
Right ovary	06 (12)
Left ovary	05 (10)
Bilateral ovaries	06 (12)
Right adnexa	04 (08)
Left adnexa	02 (04)
Pelvic abscess	02 (04)
Fallopian tube	01 (02)
Total	50 (100)

Table 3: USG diagnosis

USG diagnosis	Number of cases (%)
Fibroid	13 (26)
Adenomyosis	03 (06)
Endometrial Ca	03 (06)
Ca cervix	4 (08)
Vesicular mole	1 (02)
Hydrosalpinx	1 (02)
Ovarian torsion	2 (04)
Ovarian lesions	21 (42)
Pelvic abscess	2 (04)
Total	50 (100)

USG: Ultrasonography

DISCUSSION

A total of 50 patients who presented with pelvic mass were part of this study spread over a period of 1 year. Out of 50 cases, 3 cases were wrongly diagnosed on USG. Ultrasound diagnosis in all the patients is confirmed either

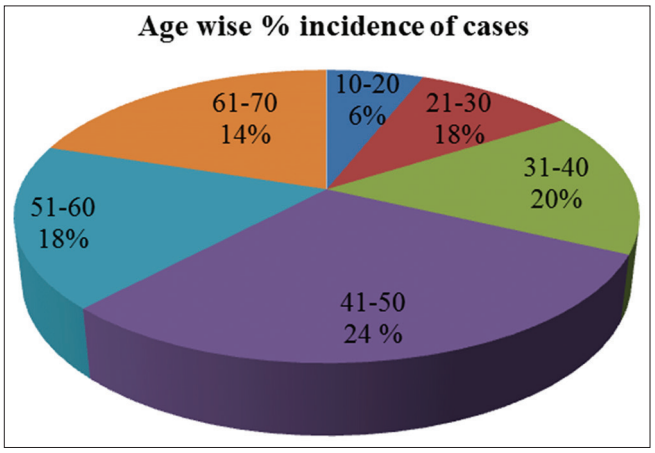

Chart 1: Chart showing age wise frequencies of pelvic masses

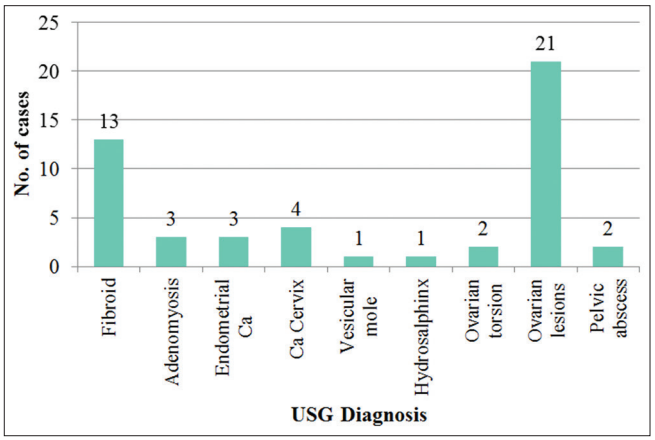

Chart 2: Ultrasonography diagnosis

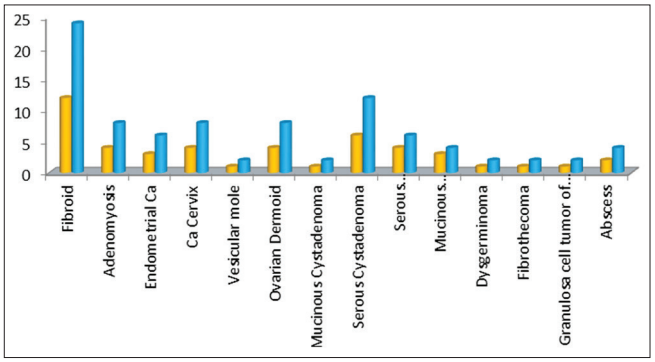

Chart 3: Histopathological diagnosis

Table 4: Histopathological diagnosis

Histopathological diagnosis	Number of cases (%)
Fibroid	12 (24)
Adenomyosis	04 (08)
Endometrial Ca	03 (06)
Ca Cervix	04 (08)
Vesicular mole	01 (02)
Ovarian Dermoid	04 (08)
Mucinous Cystadenoma	01 (02)
Serous Cystadenoma	06 (12)
Serous Cystadenocarcinoma	04 (08)
Mucinous Cystadenocarcinoma	03 (06)
Dysgerminoma	01 (02)
Fibrothecoma	01 (02)
Granulosa cell tumor of ovary	01 (02)
Abscess	02 (04)
Total	47 (94)

Table 5: Malignancy positive ovarian lesions after histopathology

Ovarian lesions	Number of cases (%)	*P* value
Malignancy negative	11 (52.38)	<0.05
Malignancy positive	10 (47.62)	<0.05
Total	21 (100)	

Table 6: Cases diagnosed on USG proved by histopathology

USG diagnosis	Number of cases (%)
Correct/equivocal	47 (94)
Wrong	03 (06)
Total	50 (100)

USG: Ultrasonography

Table 7: Doppler flow study

Total number	21	*P* value
Normal flow	11	<0.05
Abnormal flow	10	<0.05

Table 8: Spectral Doppler indices

RI and PI	Total	*P* value
RI < 0.40 and PI < 1.00	10	<0.05
RI > 0.40 and PI > 1.00	11	<0.05

RI: Resistive index, PI: Pulsatility index

Table 9: Vessel location

Vascularity	Total
Peripheral only	09
Septal only	03
Septal+central	04
Peripheral+septal	03
Peripheral+septal+central	02

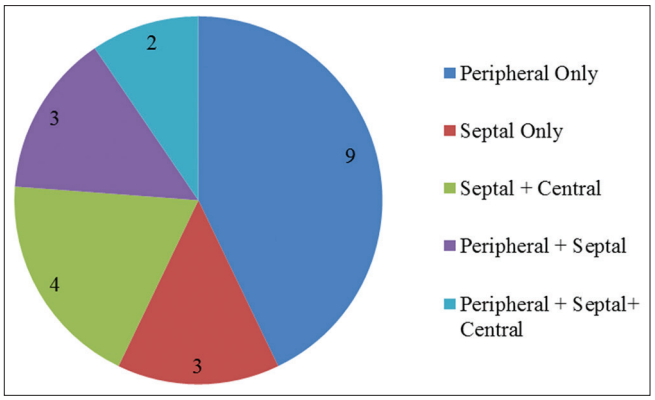

Chart 4: Vessel location

Figure 1: B/L ovarian cyst

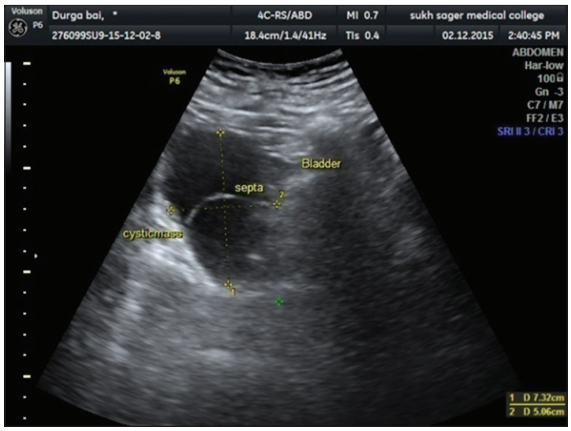

Figure 2: Right ovarian serous cystadenoma

on histopathology, post-operative findings or on follow-up ultrasound scans. USG showed a sensitivity of 94% and specificity of 90% in comparison to the histopathological findings. In our study, the majority of cases 24% were in the age group of 41-50 years. The majority of cases 46% were arising from ovary and 32% from uterus, 8% were cervical lesions, 8% originated in the endometrial cavity and 4% were pelvic abscess and 2% from the fallopian tube. In

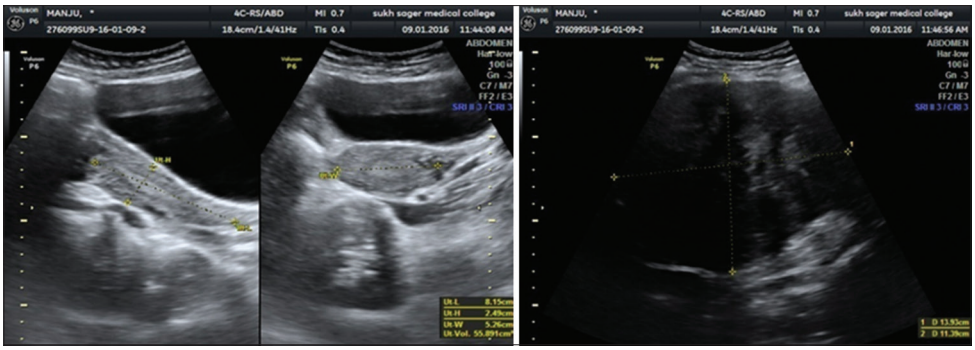

Figure 3: Large pedunculated uterine fibroid (arising from fundus)

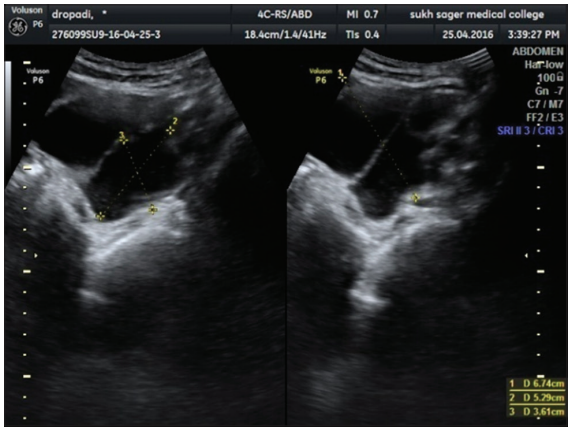

Figure 4: Right ovarian mucinous cystadenoma

our study, majority of the cases were uterine fibroid 24%. In our study, ultrasound in fibroid had a sensitivity of 94% and a specificity of 90%. Out of total 13 cases of fibroid, 10 cases were of intramural 2 cases were of subserosal and 1 case was of submucosal fibroid. 1 case is wrongly diagnosed as an intramural fibroid, which turned out to be adenomyosis of uterus on histopathology.

Evaluation of Ovarian Masses

The pre-operative imaging characterization of an ovarian mass directly affects surgical decisions and subspecialty referral and is, therefore, important for patient treatment.

Sonomorphology

While evaluating the usefulness of gray scale morphology for differentiation of malignant from benign masses Stein *et al.*[4] found a sensitivity of 98%, specificity of 62%, negative predictive value (NPV) of 99% and positive predictive value (PPV) of 50%. Buy *et al.*[5] using similar technique reported a sensitivity of 88% and specificity of 82%. Timor Trisch *et al.*[6] with the help of morphologic scoring system yielded a sensitivity of 94%, specificity of 87%, and a PPV of 60%. Madan *et al.*[7] reported a sensitivity of 92.5% using sonomorphology.

We in our study used a morphological scoring system as used by Kurjak *et al.*,[8] while evaluating ovarian masses by B-mode USG. In our study, the ovarian masses were evaluated on the basis of locularity, nature of fluid, inner margin of mass, papillary growth, solid area, presence of peritoneal fluid, and whether the mass is unilateral or bilateral. Each such characteristic was assigned a particular scoring. On the basis of such cumulative scoring, the masses were classified as definitely benign (score <2), equivocal (score 3 and 4), and suspicious (score >5).

In using the aforesaid morphological scoring system, we obtained a sensitivity of 85% and specificity of 53.33% although the PPV was low at 54.83%, NPV was high at 84.21%. The sensitivity and specificity of our study correlated well with that of Stein *et al.*[4] and Madan *et al.*[7]

Sensitivity of our study also matched well with that of Buy *et al.*[5] and Timor Trisch *et al.*[6] However our study show much lower specificity, although the NPV corroborated well with aforesaid studies.

Presence of Vascularity

Most of the recent studies using color Doppler have succeeded in demonstrating blood flow within the ovarian masses. In our study, vascularization was observed in 66% of the benign masses and 90% of the malignant masses.

Our study which corroborated well with that of Taori *et al.*[9] which shows presence of vascularity in benign tumors 42.24%, malignant 92.59%.

In our study, the presence of flow showed a sensitivity of 90% and specificity of 33.33%, PPV of 47.36%, and NPV of 83.33%. These observations corroborated well with the findings of Stein *et al.*[4] who reported a sensitivity of 77% and specificity of 69%, PPV of 49%, and NPV of 89% and PPV of 49% for the presence of flow within the ovarian masses.

Vessel Location

Vessels location was classified according to their location in the tumor as central, peripheral, and septal and combination of all the above. Central and septal vascularity was found

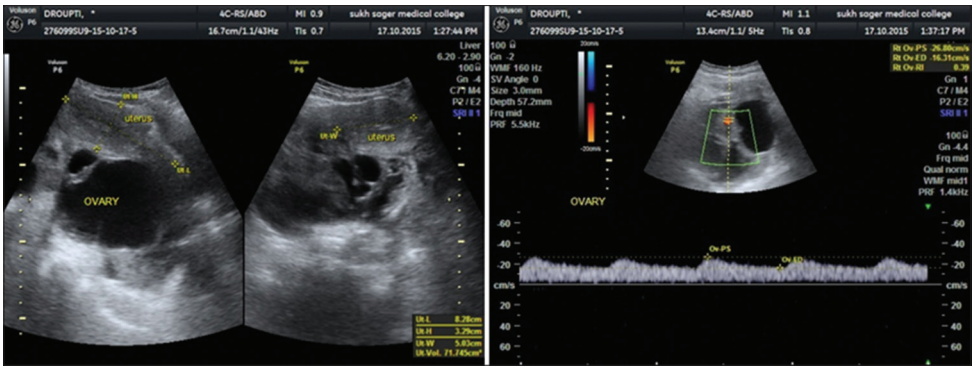

Figure 5: Right ovarian mucinous carcinoma (RI value: <0.4)

in 65% of the malignant masses, whereas peripheral vascularity was present in 25% of the cases. These findings correlate quite well with the findings of Taori *et al.*[9] and Valentin.[10]

Doppler Indices

Pulsatility and RI

Pulsed Doppler vascular resistance to blood flow had been and still one of the major features in the assessment of tumor vascular characteristics. It is a fact that difference in vascularity exists and blood vessels in malignant adnexal lesions show lower resistance to blood flows than in benign adnexal mass. Different studies suggest different cut-off values. Carter *et al.*[11] and Taori *et al.*[9] used pre-established cutoff criterion of PI <0.8 and RI <0.6 for malignant lesions. Although most other including Kurjak *et al.*[8] and Buy *et al.*[5] used the cutoff criterion of PI <1.0 and RI <0.4 for malignant lesions. In our study, we used the cutoff criterion of PI <1.0 and RI <0.4 for malignant lesions.

Madan *et al.*[7] using 52 patients in his study found that peak systolic velocity (PSV) is a better discriminator of malignant versus benign ovarian masses, showing lesser degree of overlap as compared to resistive and pulsatility indices. We in our study did not use PSV as criteria in distinguishing malignant from benign masses. Our study included spectral indices of RI and PI which showed high sensitivity and specificity, whereas Madan *et al.*[7] found a considerable overlap in values of these two spectral indices.

However, Buy *et al.*[5] evaluated 115 patients with ovarian masses using spectral Doppler and with the use of RI ≤0.4 accuracy was 77%, sensitivity 18%, and specificity was 98%. For a PI ≤1.0 accuracy was 68%, sensitivity 71% and specificity was 67%. The authors were of the opinion that color and spectral Doppler USG yields important data regarding the nature of ovarian tumor before surgery. Our study while evaluating the role of color Doppler used similar Doppler indices as that of used by with RI cutoff value of <0.4 for diagnosing malignant masses showed the sensitivity of 55%, specificity of 3.33%, PPV of 84.61% and NPV of 75.67%. PI with cutoff value of <1.0 resulted in a sensitivity of 90%, specificity of 63.33%, PPV of 62.06% and NPV of 90.47%. Thus, our study had a harmonious result with that of Buy *et al.*[5]

Guerriero *et al.*[12] performed a study on 826 complex ovarian mass. The authors opined that color and spectral Doppler was more accurate in the diagnosis of adnexal malignancies in comparison with gray scale sonography because of significantly higher specificity. The result of their study was validated by the study conducted in our institution.

Chou *et al.*[13] used color Doppler USG to evaluate 114 adnexal masses before surgery. RI was used to determine the peripheral resistance of intratumoral vessels. The blood flow is considered normal when RI was >0.5 and abnormal when it was <0.5. The authors reached a conclusion that using color and spectral Doppler a very high sensitivity and NPV were obtained. Similar results were also obtained in our study.

Weiner *et al.*[14] examined the impedance to blood flow by color flow imaging in 53 ovarian masses before exploratory laparotomy. The sensitivity and specificity of the pre-operative PI using a cutoff value of 1.0 in detecting malignant tumors were 94% and 97%, respectively. The authors opined that color flow imaging may be a useful clinical tool in the pre-operative evaluation of ovarian masses.

Pulsed and vascular resistance to blood flow had been and still one of the major features in the assessment of tumor vascular characteristics. It is a fact that difference in vascularity exists and blood vessels in malignant lesions show lower resistance to blood flow that in benign masses. Although the different authors suggest different cutoff values, we have found that levels of 0.40 and 1.0 for RI and PI, respectively, are the best discriminatory values for differentiation between benign and malignant ovarian masses. We believe that the major problem in observed overlap as reported by quite a few studies is due to variation of RI and PI results with the same tumor because of different areas of vascularization (pre-existing and newly

formed vessels) inside the tumor. There for in our opinion, optimal ovarian lesion characterization appears to be obtained through the combination of gray scale morphology and color Doppler flow imaging information. Thus, B mode USG in combination with color Doppler and spectral Doppler is proposed as the first and foremost diagnostic modality for the patients suspected with ovarian lesions. This will go a long way in establishing an early and definitive diagnosis of ovarian malignancy, thus having a profound effect on patient management.

CONCLUSION

In our study, USG showed an overall sensitivity of 94% and specificity of 90% in comparison to the histopathological findings. For ovarian lesions, USG using IOTA scoring system showed 98% sensitivity and 94% specificity in comparison to the histopathological findings. Hence, USG makes possible to establish the diagnosis quickly and thus start appropriate treatment early with reduction of false-positive findings and invasive procedures. In conclusion, sonography with a good equipment when appropriately performed by an experienced radiologist, using a proper methodology and standard guidelines has proved to be a very useful highly diagnostic and a reliable method with good sensitivity and specificity.

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