

Research Article

Diagnostic Accuracy of Transvaginal Doppler Ultrasound in Differentiating Malignant and Benign Ovarian Masses

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Abstract

Objective: To establish the diagnostic accuracy of transvaginal Doppler ultrasound in distinguishing malignant and benign ovarian masses, taking histopathology as gold standard.

Methods: This cross-sectional study was conducted in the Department of Radiology at the Pakistan Institute of Medical Sciences, Islamabad. Total 100 patients of 25-55 years with a presence of ovarian mass on transabdominal ultrasonography were included. Patients with previous biopsy reports, chronic renal failure or a history of operations for ovarian mass were excluded. All patients underwent transvaginal ultrasonography, and ovarian lesions were assessed for their site, dimensions, margins, echogenicity, soft tissue component, septations, and nodularity on grey scale. Power Doppler examinations followed, after which patients were sent to the Department of Gynecology for surgery, and specimens were sent for histopathological analysis. All the specimens were reviewed by experienced histopathologists and were labelled as benign or malignant. TVS Doppler findings were compared with the histopathology reports. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of transvaginal Doppler ultrasound were calculated.

Results: Mean age of study patients was 43.16 ± 8.20 years. TVS Doppler ultrasound supported the diagnosis of malignant ovarian masses in 54 (54.0%) patients. Histopathology findings confirmed malignant ovarian tumor in 53 (53.0%) cases. Out of 54 TVS Doppler ultrasound positive patients, 50 patients were true positive and 04 were false positive. Out of 46, TVS Doppler ultrasound negative patients, 03 were false negative whereas 43 were true negative ($p=0.0001$). Overall sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of TVS Doppler ultrasound in differentiating malignant and benign ovarian tumors was 94.34%, 91.49%, 92.59%, 93.48% and 93.0% respectively.

Conclusion: It is concluded that Transvaginal Doppler Ultrasonography is a non-invasive imaging modality of choice with high diagnostic accuracy in differentiating between benign and malignant ovarian tumors.

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Introduction

Ovarian lesions are particularly important in medical practice due to the risk of malignancy and the limited ability to differentiate accurately

between benign and malignant lesions prior to surgery and histopathology. Therefore, the assessment and pre-operative diagnosis in the evaluation of ovarian lesions is of primary importance.¹ However, without a histopathological tissue diagnosis, a defini-

tive diagnosis cannot be made. Clinicians must therefore evaluate the likelihood of malignancy on the basis of clinical and radiological data to justify the risk of surgery.² In a study, Ahmad A et al. has shown the prevalence of malignant ovarian mass to be 46%.³ Since patients with ovarian masses usually remain asymptomatic, extensive research has been done to evaluate and develop effective screening tools for the early and accurate detection of ovarian malignancy. Serum measurement of tumor marker, CA-125 is currently most widely employed for screening purpose.^{4,5}

The purpose of imaging is to not only the detection but also the characterization of ovarian masses as benign or malignant, including the identification of atypical imaging findings that may point towards malignant pathology. Ultrasound is the initial imaging modality most commonly employed for evaluating women with suspected ovarian lesions, since it is readily available, cost effective and highly sensitive in the detection of ovarian masses. Previous studies employing transabdominal ultrasound for evaluation of pelvic pathology could not provide good results due to acoustic impedance by the pelvic soft tissue structures, poor resolution, poor transmission of ultrasound pulses in obese patients and ovaries lying outside the focal region of the transducer.⁶ Transvaginal ultrasonography employs transducer with high frequency, thus providing superior resolution and a more detailed evaluation of the female pelvis, especially the ovaries. Transvaginal doppler ultrasonography has therefore allowed detailed evaluation of ovarian tumors. The presence or absence of flow on color and power Doppler and the detection of flow velocity waveforms on spectral Doppler can be used as categorical end points.⁷ Morphological features associated with increased risk of malignancy include multilocularity, presence of papillary projections, thick septations, solid component and increased vascularity on Doppler ultrasound(USG).⁸ Transvaginal Doppler ultrasonography has thus emerged as an effective tool for evaluation and categorization of ovarian masses^{9,10}. Studies have shown that the unilocular ovarian cystic lesions are associated with a low risk of malignancy.¹¹

The available data on the diagnostic accuracy of transvaginal Doppler ultrasound in differentiating benign versus malignant ovarian masses is very

scarce, and we consequently designed this study to determine the diagnostic accuracy of transvaginal Doppler ultrasound in differentiating between malignant and benign ovarian masses. It is a simple and affordable test as well as non-invasive, requiring no hospitalization. Furthermore, it is a readily available and reliable diagnostic tool with a sensitivity of 92% and specificity of 92%.¹²

Methods

This cross-sectional validation study is conducted in the Radiology Department of Pakistan Institute of Medical Sciences, Islamabad. The duration of the study was six months, from 31st December 2015 to 30th June 2016. The sample size was calculated as 100 cases taking 95% confidence level with expected prevalence of malignant ovarian mass as 46%, sensitivity 92% with 8% margin of error and specificity 92.0% with 8% margin of error of transvaginal Doppler sonography in differentiating benign and malignant ovarian masses.^{3,13} The patients, with an age range of 25-55, showing a presence of ovarian mass on transabdominal ultrasonography (showing any of the following features; multiple loculations, papillary projections, internal solid component, thick septae measuring >3mm, free peritoneal fluid and metastasis) of any size and >3 months duration participated. Patients with history of previous surgery for ovarian mass, having biopsy proven report, with chronic liver disease (evaluated with clinical profile and previous investigations), not fit for anesthesia, not willing for surgery or those who were unmarried were excluded from the study. Firstly ethical review board consent was taken, then patients were selected who were fulfilling the study inclusion and exclusion criteria. Informed consent was obtained from all study patients following which transvaginal Doppler sonography with high frequency 7 MHz probe of Toshiba Xario equipped to perform color, power as well as pulsed Doppler analysis was conducted, utilizing standard technique in the presence of female staff. Ovarian lesions were assessed for their site, dimensions, margins, echogenicity, soft tissue component, septations, and nodularity on grey scale. A power Doppler examination followed. Necessary adjustments were made for an accurate assessment of the lesions including color scale. The color box was adjusted such that it included the whole lesion. During examination, care was taken to apply as little

pressure as possible to avoid vessel compression and allow visualization of small vessels. The power Doppler analysis was taken as positive, if at least a single vessel was detected within the lesion showing arterial waveform on pulsed Doppler. Spectral waveform was obtained for at least three different vessels. The resistive index was calculated automatically by built-in software of the ultrasound machine using the formula:

$$RI = (PSV - MDV) / PSV$$

The highest of these values was taken into account. Each ultrasound examination was conducted by the radiologist (having five years of experience) and was examined for benign or malignant ovarian mass as per operational definition. All study patients underwent surgery, and the specimens were sent for histopathological examination in the department of Pathology, where the histopathology report was prepared by the consultant pathologist (with at least five years of experience). TVS Doppler findings were compared with the histopathology report. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of transvaginal Doppler sonography in evaluating ovarian masses, taking histopathology as the gold standard were calculated using a 2×2 table.

Results

Mean age of study patients was 43.16 ± 8.20 years with a range of 25-55 years. Majority of the patients 44 (44.0%) were between 46 to 55 years of age, as shown in Table I.

Mean duration of disease was 7.43 ± 4.12 months (Table II). Mean size of lesion was 28.71 ± 12.42 mm, as shown in Table III. Percentage of patients according to menopausal history is shown in Table IV.

All the patients were subjected to transvaginal Doppler sonography. TVS Doppler ultrasound supported the diagnosis of malignant ovarian masses in 54 (54.0%) patients. Histopathology findings confirmed malignant ovarian tumors in 53 (53.0%) cases. Out of 54 positive patients on TVS Doppler ultrasound, 50 patients were True positive while 04 patients turned to be False positive. Out of 46 negative patients on TVS Doppler ultrasound, 03 patients turned out to be False negative whereas 43 patients

were True negative (shown in Table 5). p value was found to be 0.0001 by chi square test.

Table 1: %Age of Patients According to Age Distribution

Age (years)	No. of Patients	%
25-35	19	19.0
36-45	37	37.0
46-55	44	44.0
Total	100	100.0
Mean $\pm$ SD = 43.16 ± 8.20 years		

Table 2: %Age of Patients According to Duration of Disease

Duration of lesion (months)	No. of Patients	%
3-12 months	62	62.0
>12 months	38	38.0
Total	100	100.0
Mean $\pm$ SD = 7.43 ± 4.12 months.		

Table 3: %Age of Patients According to Size of Lesion

Size of lesion (mm)	No. of Patients	%
≤ 30 mm	51	51.0
>30 mm	49	49.0
Total	100	100.0
Mean $\pm$ SD = 28.71 ± 12.42 mm.		

Table 4: %Age of Patients According to Menopause History

Menopause history	No. of Patients	%
Pre-menopause	60	60.0
Post-menopause	40	40.0
Total	100	100.0

Table 5: Summary of Results.

	Positive result on TVS Doppler	Negative result on TVS Doppler	<i>p</i> -value
Positive on Histopathology	50 (TP)*	03 (FN)***	0.0001
Negative on Histopathology	04 (FP)**	43 (TN)****	
* -TP=True positive ** -FP=False positive *** -FN=False negative **** -TN=True negative			

Thus sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of TVS Doppler ultrasound in differentiating malignant and benign ovarian tumors was

94.34 %, 91.49%, 92.59%, 93.48% and 93.0% respectively (Figure 1)

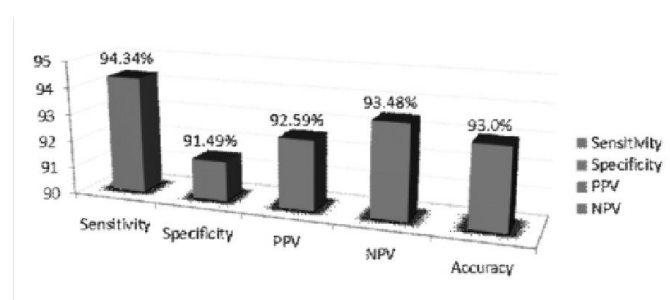


Figure-1: Diagnostic Accuracy of TVS Doppler in differentiating between Malignant and Benign Ovarian Masses.

Discussion

Pelvic examination has considerable limitations in the identification of adnexal lesions, even in the presence of general anesthesia.¹² In contrast, diagnostic ultrasound carries a high sensitivity for the detection of ovarian masses. However, its sensitivity in detection of stage I ovarian tumors is only 50%, and it has low specificity for categorization of ovarian mass as benign or malignant. Ultrasound screening of asymptomatic women for detection of ovarian malignancy can lead to false-positive results and unnecessary surgeries for benign lesions.¹³ This study aims to determine the accuracy of transvaginal Doppler ultrasound in differentiating between benign and malignant ovarian lesions, taking histopathology as the gold standard, and its validity as an effective and non-invasive diagnostic tool for the pre-operative evaluation and categorization of ovarian masses, so as to obviate unwarranted surgeries.

Age range of study patients was 25-55 years with mean age of 43.16 ± 8.20 years. All the patients were subjected to transvaginal Doppler sonography. TVS Doppler ultrasound supported the diagnosis of malignant ovarian masses in 54 (54.0%) patients. Histopathology findings confirmed malignant ovarian tumors in 53 (53.0%) cases. Out of 54 positive patients on TVS Doppler, true positive patients were 50 while 04 turned to be false positive. Out of 46 negative patients on TVS Doppler ultrasound, 03 patients turned out to be false negative whereas 43 patients were true negative ($p=0.0001$). Sensitivity, specificity, PPV, NPV and diagnostic accuracy of TVS Doppler ultrasound in malignant

and benign ovarian tumors was 94.34%, 91.49%, 92.59%, 93.48% and 93.0% respectively. These results are comparable to previously conducted similar studies in diagnosing malignant ovarian tumors.

Majeed H conducted a study on 37 patients with ovarian masses. Out of these, 19 had benign morphological features on ultrasonography, and 18 were malignant. All the 19 benign lesions on ultrasound were confirmed on histopathology. Three out of these 19 cases had a resistive index (RI) of less than 0.4. Out of 18 malignant-looking lesions on ultrasonography, seven turned out to be benign, two non-neoplastic, and nine malignant on histopathology. Eight of these cases had RI greater than 0.4, and only 2 had RI less than 0.4. It was thus found that sensitivity and specificity of RI in diagnosing ovarian malignancy was 18.18% and 84.61% respectively. Positive predictive value (PPV) of RI to categorize ovarian masses was only 33.33%, whereas NPV was 70.96% and accuracy 64.86%.¹²

Radhamani and coworkers studied 100 women with clinical suspicion of ovarian mass. 87 patients were benign on sonography and 11 were malignant. On Doppler USG, the malignant ovarian masses showed increased vascularity. Sensitivity, specificity of clinical findings, sonography, Doppler, CA 125 and risk of malignancy index were also calculated.¹³

Detailed imaging evaluation of pelvic organs has significantly improved, since the introduction of trans abdominal ultrasound for the assessment of pelvic pathology. Pelvic ultrasonography is a non-invasive, readily available and cost effective imaging modality and whenever possible, transvaginal ultrasound should be preferred to transabdominal ultrasound because it possesses a higher sensitivity and specificity, in contrast to transabdominal ultrasound.¹⁴⁻¹⁵

In another study by Gupta et al, TVS Doppler USG sensitivity found was 98% and specificity was 94%. In addition to visualization of color flow, they also considered localization of vessel within the ovarian tumor. They also considered pelvic masses other than ovarian masses including uterine fibroids and endometrial carcinomas.¹⁶

Sehgal N selected 60 patients who underwent USG and Doppler evaluation. 33 patients were diagnosed

to have benign disease (55%) and 27 were found to be malignant. On USG 62.96% of malignant masses were solid with ill-defined margins. Combined grey scale and Doppler examination showed sensitivity of 81.4% and specificity of 93.9%.¹⁸

It is thus concluded that trans-vaginal Doppler ultrasonography is a non-invasive modality of choice with high diagnostic accuracy in differentiating between benign and malignant ovarian masses pre-operatively, helping surgeons in decision making by obviating unwarranted surgeries.

Ethical Approval: Given

Conflict of Interest: The authors declare no conflict of interest

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References

1. Abbas AM, Zahran KM, Nasr A, Kamel HS. A new scoring model for characterization of adnexal masses based on two-dimensional gray-scale and colour Doppler sonographic features. *Facts Views Vis Obgyn*. 2014; 6(2): 68–74.
2. Shah D, Shah S, Parikh J, Bhatt GJ, Vaishnav K, Bala DV. Doppler Ultrasound: A Good and Reliable Predictor of Ovarian Malignancy. *J Obstet Gynaecol India*. 2013; 63(3): 186–189
3. Ahmad A, Zamir S, Saghir NJ. Characterization of adnexal masses on trans abdominal ultrasonography and CT scan. *Ann Pak Inst Med Sci*. 2013;9(1):48-51.
4. Jothy MS, Padmasekar A. Sonomorphology and colour flow Doppler studies in differentiating between benign and malignant ovarian masses. *IJRCOG*. 2017;6(2):365.
5. Zhao F, Zhang H, Ren Y, Kong F. Transvaginal sonographic characteristics of paraovarian borderline tumor. *Int J Clin Exp Med*. 2015;8(2): 2684–2688.
6. Smorgick N, Maymon R. Assessment of adnexal masses using ultrasound: a practical review. *Intl J Women's Health*. 2014;6(4):857–863.
7. Hafeez S, Sufian S, Beg M, Hadi Q, Jamil Y, Masroor I. Role of ultrasound in characterization of ovarian masses. *Asian Pacific J Cancer Prevention*. 2013; 14(1): 603-606.
8. Jung SI. Ultrasonography of ovarian masses using a pattern recognition approach. *Ultrasonography*. 2015; 34(3):173-182.
9. Pozniak MA, Allan PL. *Clinical Doppler Ultrasound*. 3rd edition. China. Elsevier. 2014.
10. Liu Z, Yang F, Zhang Y, Yu H, Zhu H, Yang R, et al. Conventional Doppler and contrast enhanced Ultrasonography in differential diagnosis of ovarian masses. *ell Physiol Biochem*. 2016;39(14):2398-2408.
11. Andreotti RF, Timmerman D, Benacerraf BR, Bennett GL, Bourne T, Brown DG, et al. Ovarian-Adnexal Reporting Lexicon for Ultrasound: A White Paper of the ACR Ovarian-Adnexal Reporting and Data System Committee. *JACR*. 2018; 15(10):1415-1429.
12. Majeed H, Ramzan A, Imran F, Rehman M. Validity of resistive index for the diagnosis of malignant ovarian masses. *JPM*. 2011;61(4):1104.
13. Radhamani S, Akhila MV. Evaluation of Adnexal Masses - Correlation of Clinical, Sonological and Histopathological Findings in Adnexal Masses. *International Journal of Scientific Study*. 2017; 4(11): 88-92.
14. Timmerman D, Calster BV, Testa A, Savelli L, Fischerova D, Froyman W, et al. Predicting the risk of malignancy in adnexal masses based on the Simple Rules from the International Ovarian Tumor Analysis. *Am journal of Obs and Gyn*. 2017;214(4): 424-437.
15. Jabeen R, Khan SA, Naveed S. Risk of malignancy index in the preoperative evaluation of patients with ovarian masses. *Rawal Medical Journal*. 2015;40(1): 78-80.
16. Gupta KP, Jain SK. Role of Ultrasonography and Color Doppler to Diagnosis of Pelvic Masses and its Correlation with Histopathological Findings. *International Journal of Scientific Study*. 2016; 4(3): 147-153.
17. Sharadha SO, Sridevi TA, Renukadevi TK, Gowri R, Debbarman B, Indra V. Ovarian Masses: Changing Clinico Histopathological Trends. *The Journal of Obstetrics and Gynecology of India*. 2015; 65(1): 34–38.
18. Sehgal N. Efficacy of color doppler ultrasonography in differentiation of ovarian masses. *Journal of midlife health*. 2019;10(1):22-28.