The Validity of Doppler-Ultrasound in Distinguishing of Malignant and Benign Masses in Ovaries Using Cutoff Values

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Abstract- Some studies have concluded that PI and RI play an inadequate role in distinguishing benign tumors from malignant ones; however, later studies have reported different results, showing that Doppler ultrasound is effective in differentiating malignant from non-malignant ovarian masses by using specific threshold values for both RI and PI. The presence of such conflicting data justifies our study. The purpose of this project was to use color Doppler and ultrasound imaging to differentiate between malignant and benign ovarian tumors and to verify the findings by comparing them with histopathology. Over the course of two years, 86 patients with ovarian masses were evaluated for morphologic features, pulsatility indices (PI), and resistance indices (RI) using Doppler ultrasound. Histopathologic confirmation served as the basis for the final diagnosis. The cutoff value for RI was ≤0.39 and for PI was ≤1.1, as shown in figures 1 and 2 and table 1. The sensitivity, specificity, and positive and negative predictive values were all 100%. Doppler ultrasound provides effective tools, including resistive and pulsatility indices, that can be used to differentiate between benign and malignant ovarian masses.

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Introduction

There is a 1.3% lifetime risk of developing ovarian cancer. For malignant ovarian masses, the 5-year survival rate decreases from 92.3% for cases confined to the ovarian tissues to 29.2% for those with distant metastases. In more than 59% of cases, ovarian malignant masses are discovered after spread has already occurred (1). To reduce unnecessary concern and guide decisions about the most appropriate treatment, it is critical to characterize ovarian masses and differentiate between benign and malignant disease. Conservative management or a minimally invasive approach in a general gynecological unit may be appropriate for benign pathology. In contrast, suspected malignant tumors should be referred to specialized centers for further management. Therefore, prior understanding of the characteristics of ovarian masses is crucial for both the patient and clinical service organization in terms of planning, costs, and overall management (2,3). The most widely used imaging technique for evaluating adnexal masses is transvaginal ultrasonography (TVS), and several prediction models have been developed to optimize its predictive power (3).

There are various techniques for determining the preoperative risk of malignancy in an ovarian mass. These include the Gynecological Imaging Reporting and Data System (4), risk of malignancy index models (5), basic ultrasound-based guidelines for ovarian cancer diagnosis (6), the International Ovarian Tumor Analysis (IOTA) group mathematical logistic regression models (7), and the pattern recognition method (8). Despite these developments, the subjective assessment of a mass's ultrasound characteristics by an expert operator remains the best method for characterizing ovarian masses (3).

With respect to the resistive index (RI) and pulsatility index (PI), early attempts to use these parameters in the characterization of ovarian tumors were made by several

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authors (9-11). These studies concluded that PI and RI had an inadequate role in distinguishing benign from malignant tumors. However, later studies have reported different results, showing that Doppler ultrasound can efficiently differentiate benign from malignant ovarian masses using specific threshold values for both RI and PI (12-14). The presence of such conflicting data justifies our study. The objective of this project was to use ultrasound imaging and color Doppler to differentiate between benign and malignant ovarian masses and to confirm the results by comparing them with histopathology.

Materials and Methods

The study design was a cross-sectional, single-center study. The sample was selected using a consecutive sampling method.

Over the course of two years, 86 women were assessed prospectively. We used B-mode ultrasound imaging, color Doppler, and spectral Doppler studies with a transabdominal approach using a TOSHIBA NEMIO XG real-time Doppler and ultrasound scanner with a 3.75-MHz sector transducer. A 6.0-MHz endovaginal transducer was also used for transvaginal sonography when necessary. First, B-mode ultrasonography (USG) was performed on the patients. Then, a color Doppler examination was performed without aliasing, using pulsed Doppler at the lowest pulse repetition frequency and high-sensitivity settings. Analysis of the pulsed Doppler waveform was then completed. Three separate measurements were taken, and the lowest RI and PI values were recorded. Histopathological reports were correlated with these parameters. Different PI and RI cutoff levels were evaluated for sensitivity and specificity.

Inclusion criteria

Patients aged 25-55 years who were referred with an ovarian mass were enrolled in the study.

Exclusion criteria

Patients with anechoic cysts that disappeared during follow-up, those with pelvic masses of uterine origin identified either during surgery or in the histology report, and those who did not complete the required follow-up period were excluded from the study.

Ethically, this study was approved by the Committee of Research Ethics of the College of Medicine (code 31/659 on March 13th, 2025). Every patient enrolled provided written informed consent.

Results

Characteristics of women with ovarian tumors are presented in Table 1. The mean age of women with malignant tumors was reported to be significantly higher than that of women with benign tumors, 41.24±9.05 years versus 31.12±5.07 years, respectively (P<0.001). No significant differences in laterality or tumor size were observed between the malignant and benign groups (P>0.05). The study included 65 benign ovarian tumors and 21 malignant ovarian tumors.

The cutoff value for RI was ≤0.39, and for PI it was ≤1.1, as shown in figures 1 and 2 and in table 2. The specificity, sensitivity, and both negative and positive predictive values were all 100%.

Table 1. Characteristics of women with ovarian tumors

Characteristics		Malignant n = 21	Benign n = 65	P
Age	**Mean ±SD**	41.24 ±9.05	31.12 ±5.07	<0.001 S
	Range	28 -55	25 -45	
Laterality	**Right**	11 (52.4 %)	32 (49.2 %)	0.892 N
	Left	10 (47.6 %)	33 (50.8 %)	
Size	**Mean ±SD**	6.95 ±1.60	7.25 ±2.22	0.577 N
	Range	5 -10	5 -18	
PI	**Mean ±SD**	0.90 ±0.14	1.92 ±0.11	<0.001 S
	Range	0.7 -1.1	1.8 -2.1	
RI	**Mean ±SD**	0.34 ±0.03	0.71 ±0.03	<0.001 S
	Range	0.3 -0.39	0.65 -0.76	

SD: Standard deviation; PI: pulsatility index; RI: resistive index

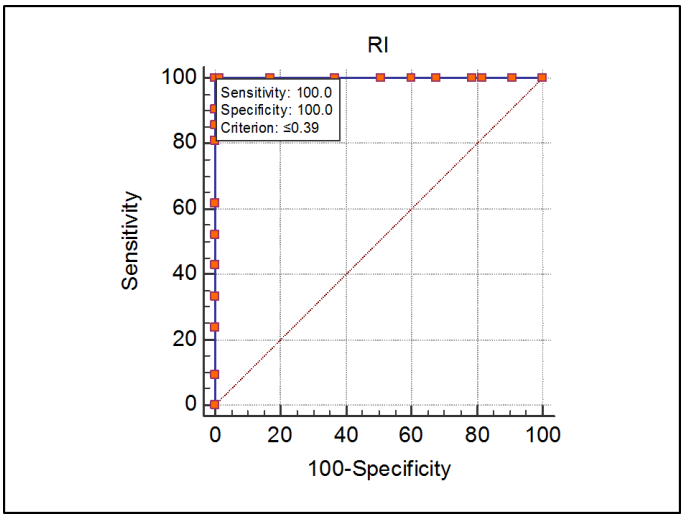

Figure 1. "Receiver operating curve (ROC)" which was performed to find the resistive index cutoff value to segregate between being and malignant ovarian masses

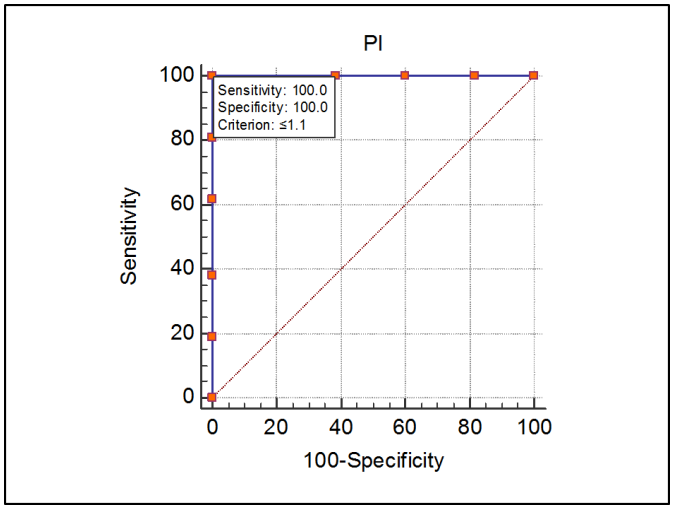

Figure 2. "Receiver operating curve (ROC)" which was performed to find the pulsatility index cutoff value to segregate between being and malignant ovarian masses

Table 2. The results of receiver operating curve analysis pertaining to resistive and pulsatility indexes

Characteristic	PI	RI
Cutoff	≤1.1	≤0.39
AUC	1.000	1.000
95 % CI	0.958 to 1.000	0.958 to 1.000
Specificity %	100	100
Sensitivity %	100	100
Negative predictive value	100	100
Positive predictive value	100	100
P	< 0.001 S	<0.001 S

Discussion

Many women undergo operative intervention for suspected adnexal tumors, most of which are ultimately found to be benign, creating a diagnostic dilemma. Because of its high sensitivity in detecting and confirming ovarian tumors, distinguishing them from those originating in the uterus, and ruling out other conditions, ultrasound is typically preferred as the first line imaging modality for assessing ovarian tumors (15).

This study aimed to evaluate the diagnostic accuracy of color Doppler in the identification and characterization of ovarian tumors before operative intervention and to compare the results with histological findings.

Das *et al*., (16) reported that 100% of tumors with malignant behavior had an RI <0.6, while 11.4% of benign tumors had an RI <0.6 when an RI cutoff of <0.6 was used as an indicator of malignancy. The specificity, sensitivity, negative predictive value, and positive predictive value for this cutoff were 100%, 82.1%, 72.2%, and 100%, respectively.

In a previous study, 82.5% of tumors with malignant potential and 6.81% of benign tumors had an RI <0.6 (17). In our investigation, specificity, sensitivity, negative predictive value, and positive predictive value were all 100% using a cutoff value of RI ≤0.39.

In another investigation, the specificity and sensitivity of color Doppler in identifying tumors with malignant behavior were 72% and 82%, respectively, using a resistance index cutoff value of 0.6 (18). According to a published article, 8.5% of tumors with benign behavior had a pulsatility index of less than 0.8, whereas 91.3% of tumors with malignant potential had a pulsatility index <0.8 (19). This cutoff value has been considered a predictor of malignant lesions. Das *et al*., (16) reported that the specificity of PI was 87.5%, the sensitivity was 84%, the negative predictive value was 77.8%, and the positive predictive value was 91.3% when using a PI cutoff of <0.8.

In our investigation, PI demonstrated specificity, sensitivity, negative predictive value, and positive predictive value using a cutoff PI <1.1.

When choosing surgical candidates, preoperative assessment of the anticipated scope of the surgical approach is crucial. A multidisciplinary team approach should be used to assess elderly patients with involvement of upper region of abdomen, gross ascites, and metastases to pleural cavity and abdominal cavity (20). This study's main drawback is that, due to the exclusion criteria, we were only capable of enrolling a limited patients' number. Vascular indexes (RI <0.39 and PI <1.1) were reported to be associated with malignant behavior in color Doppler sonography.

Doppler Ultrasound can provide efficient tools including resistive and pulsatility indexes that possess the capacity to differentiate among malignant and benign ovarian masses.

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