

SONOLOGICAL ACCURACY IN DEFINING VARIOUS BENIGN AND MALIGNANT OVARIAN NEOPLASMS WITH COLOUR DOPPLER AND HISTOPATHOLOGICAL CORRELATION

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Abstract

Background: The prognosis for patients with ovarian tumours is greatly improved by prompt and accurate diagnosis. The purpose of this research was to determine the reliability of ultrasound for distinguishing between benign and malignant ovarian tumours using colour doppler and histological analysis. **Materials and Methods:** Radiologists at MGM Medical College and LSK Hospital in Kishanganj, Bihar, gathered data in a prospective study. Over the course of a year, a total of 102 patients with adnexal masses were reviewed; however, only 50 patients with ovarian masses who met the inclusion criteria underwent sonographic evaluation. Colour Doppler with defined parameters and indices replaced grayscale transvaginal and transabdominal sonography. The final diagnosis was based on histological analysis, and it was compared to the results differentiated on sonographic and colour Doppler tests. Grayscale ultrasonography was found to have a sensitivity of 52.92 percent, a specificity of 78.58 percent, a positive predictive value of 66.59%, and a negative predictive value of 67.85 percent for identifying cancer in ovarian masses in this investigation. The current study successfully distinguished malignant from benign tumours using a combination of grayscale and colour flow finding, with a sensitivity of 80.74%, specificity of 94.56%, PPV of 90.84%, and NPV of 84.3%. The results of the current study show that the preoperative identification of benign and malignant ovarian masses using colour and spectral analysis significantly increases sensitivity, specificity, PPV, and NPV. When compared to grayscale (B mode) USG, the combination of Doppler and USG proved to be more effective.

INTRODUCTION

Ovarian cancer ranks as the eighth leading cause of cancer death among women worldwide. Ovarian cancer has become the third or fourth most frequent cancer among women and the top cause of mortality from any gynaecological malignancy in India, according to numerous registries. It's three times deadlier than breast cancer.^[1]

Ovarian cancer has a high death rate because patients typically present at a late stage due to the lack of early warning signals. Studies show that >90% of patients would survive longer than 5 years if they were diagnosed at an earlier stage, when they are localised to the ovary.^[2] Therefore, it is crucial

to diagnose and characterise any adnexal mass as soon as possible.

If neoangiogenesis is considered a neoplastic sign for a tumour, it may be able to detect cancer at an early stage. This is because, according to "Folkman's theory of neovascularization," tumour cells create tumour angiogenesis factor that promotes neovascularization, and so it is possible to determine whether or not a tumour is benign or malignant by studying its blood flow patterns.^[3] As a result, the characterization and differentiation of ovarian tumours and the early identification of malignancy have been given new dimensions with the use of Colour Doppler investigations and conventional grayscale ultrasonography (USG).^[4] This study was conducted to investigate the

reliability of sonography in differentiating benign from malignant ovarian neoplasms using colour Doppler and histological comparison.

MATERIALS AND METHODS

Radiologists at MGM Medical College and LSK Hospital in Kishanganj, Bihar, gathered data in a prospective study. Over the course of a year, a total of 102 patients with adnexal masses were reviewed; however, only 50 patients with ovarian masses who met the inclusion criteria underwent sonographic evaluation. Colour Doppler with defined parameters and indices replaced grayscale transvaginal and transabdominal sonography. The final diagnosis was based on histological analysis, and it was compared to the results differentiated on sonographic and colour Doppler tests.

Ovarian tumour symptoms, including pain, irregular periods, and fullness of belly, were present in all of the patients who presented for diagnostic examination of a clinically suspected or palpable adnexal mass. Each participant provided their informed consent before to enrollment. Following a standard protocol, all patients had completed a thorough history and physical examination before undergoing ultrasound, colour Doppler, and ultrasound-guided fine needle aspiration cytology (FNAC). The surgically obtained histopathological diagnosis is the gold standard. Histopathological findings were compared with those obtained from USG, colour Doppler, and USG guided FNAC.

A real-time ultrasound and Doppler scanner machine was used to perform both grayscale USG

and colour Doppler sonography. A 3.5 MHz curved transducer was used for supine transabdominal sonography (TAS) of the pelvis and upper abdomen, and a wideband 5-9 MHz intracavitary transducer was used for a dorsal assessment of the vaginal canal and an empty bladder. Three patients who were still virgins and ten others who declined transvaginal sonography were only evaluated with TAS of the pelvis. All patients were acquired using the same default settings for the colour Doppler machines. Alias-free colour Doppler imaging was studied by using the highest sensitivity settings and the lowest pulse repetition frequency available. Spectral Doppler imaging was used to further assess the vessels identified in colour Doppler scans. If there were internal vessels present, these would be examined instead of the peripheral ones. When a consistent series of waveforms was achieved, we recorded the lowest values for the pulsatility index (PI) and the resistance index (RI). When the lowest positive index (PI) and negative predictive value (NPV) of grayscale USG alone and with colour Doppler were determined, the masses were classed as suspicious of malignancy; the Chi-square test was used to determine the effectiveness of the colour Doppler investigation.

Patients with unilocular anechoic ovarian cysts that cleared or diminished markedly in follow-up USG were also excluded, as were those with adnexal masses of an extraovarian origin determined at any stage of diagnosis. Patients who did not adhere to the study's protocol or who were lost to follow-up were excluded.

RESULTS

Table 1: Colour Doppler imaging of neovascularization in malignant ovarian tumours

Type of lesion	Presence of neovascularity	Absence of neovascularity
Benign (n=28)	12(42.9%)	16 (57.1%)
Malignant (n=22)	20 (90.9%)	2 (9.1%)

The table highlights a stark contrast between the presence of neovascularity in malignant ovarian tumors compared to benign lesions. The majority of malignant tumors (90.9%) exhibited neovascularity, whereas only a minority of benign tumors (42.9%) showed the presence of neovascularization. Conversely, the absence of neovascularity was more common in benign lesions (57.1%) compared to malignant lesions (9.1%).

Table 2: Distribution of Neovascular tumours of peak systolic velocities (n=32)

Tumor type	No. of vascular tumor	Peak systolic velocity	
		Low (<15 cm/sec)	High (>15 cm/sec)
Benign	12	10 (83.3%)	2(16.7%)
Malignant	20	3 (15.0%)	17 (85.0%)

Among the benign tumors (n=12), the majority (10 tumors, or 83.3%) had a low peak systolic velocity, while a smaller proportion (2 tumors, or 16.7%) had a high peak systolic velocity.

In contrast, among the malignant tumors (n=20), only a few tumors (3 tumors, or 15.0%) had a low peak systolic velocity, while the majority (17 tumors, or 85.0%) had a high peak systolic velocity.

These findings indicate that there is a notable difference in the distribution of peak systolic velocities between benign and malignant neovascular tumors. The majority of benign tumors had a low peak systolic velocity, while the majority of malignant tumors had a high peak systolic velocity. This suggests that peak systolic velocity may serve as a potential indicator to differentiate between benign and malignant neovascular tumors.

Table 3: Neovascular ovarian tumours, according to their Pulsatility index (PI).

Tumor type	No. of vascular tumor	Pulsatility index (PI)		
		PI <0.8	PI 0.8 – 1.0	PI >1.0
Benign	12	1 (8.3%)	2 (16.7%)	9 (75.0%)
Malignant	20	18 (90.0%)	2 (10.0%)	0 (0.0%)

Among the benign tumors (n=12), only a small percentage (1 tumor, or 8.3%) had a PI <0.8, while a slightly higher proportion (2 tumors, or 16.7%) fell within the PI range of 0.8 - 1.0. The majority of benign tumors (9 tumors, or 75.0%) had a PI >1.0. In contrast, among the malignant tumors (n=20), the vast majority (18 tumors, or 90.0%) exhibited a PI <0.8, indicating low pulsatility. A smaller number of malignant tumors (2 tumors, or 10.0%) fell within the PI range of 0.8 - 1.0. Notably, none of the malignant tumors had a PI >1.0.

These findings suggest a clear distinction in the distribution of Pulsatility Index values between benign and malignant neovascular ovarian tumors. The majority of benign tumors had a PI >1.0, while the majority of malignant tumors had a PI <0.8, indicating a significant difference in pulsatility between the two groups.

Table 4: Neovascular ovarian tumours, according to their Resistive Index (RI)

Tumor type	No. of vascular tumor	Resistive Index (RI)		
		RI <0.4	RI 0.4 – 0.6	RI >0.6
Benign	12	0 (0.0%)	3 (25.0%)	9 (75.0%)
Malignant	20	7 (35.0%)	13 (65.0%)	0 (0.0%)

Among the benign tumors (n=12), none of the tumors had an RI <0.4. Three tumors (25.0%) fell within the RI range of 0.4 - 0.6, and the majority of benign tumors (9 tumors, or 75.0%) had an RI >0.6. In the case of malignant tumors (n=20), seven tumors (35.0%) exhibited an RI <0.4, indicating lower resistance. Thirteen tumors (65.0%) fell within the RI range of 0.4 - 0.6, while none of the malignant tumors had an RI >0.6.

These findings suggest a notable difference in the distribution of Resistive Index values between benign and malignant neovascular ovarian tumors. None of the benign tumors had an RI <0.4, while a considerable proportion of malignant tumors (35.0%) exhibited an RI <0.4, indicating a lower resistance pattern.

DISCUSSION

Early identification and characterisation of ovarian masses are typically difficult due to the vast variety of kinds and origins of ovarian masses, their anatomical placement in the female pelvis and proximity to structures of different systems, periodic physiological changes therein, atypical symptoms, and gradual beginning. The principal imaging modality for confirming an ovarian origin of a mass and determining whether a mass is benign or malignant is ultrasound gynaecology (USG).^[5]

Sonographic evaluation of ovarian masses correlates morphologic images with macroscopic pathologic features of tumour such as nonfatty solid tissue, thick septations, and papillary projections, and is based on size, external contour, internal consistency, and secondary signs of malignancy like ascites and peritoneal implants. Ultrasound cannot reliably distinguish between benign and malignant tumours. Although other morphologic grading systems have been devised, they all come to the same conclusion: that morphologic parameters alone cannot reliably distinguish benign from malignant masses.^[5] While

morphologic analysis with US has been demonstrated to be 85%-97% sensitive at predicting malignancy in ovarian tumours, its specificity ranges from 56% to 95%, making it of little utility in individual patients despite its high sensitivity.^[6]

Introducing hue Pulsed Doppler ultrasound Quantitative blood flow measurements from tumour arteries can be used in Doppler spectral analysis to better characterise ovarian tumours.^[7] Blood flow is a strong indicator of malignancy (92% of malignant tumours have it), yet the absence of blood flow is also significant (and indicative of benignity).^[4] Even vascularized benign lesions have greater peripheral flow than central flow, but this difference might be misunderstood if scans are taken from different angles. Doppler waveform analysis in vascular masses has also made use of two angle-independent indices, called PI and RI. Calculated as $RI = \text{peak systole end diastole} / \text{peak systole}$, the RI evaluates arterial waveforms in which the reverse flow component is absent. The value may be determined from just two well-defined spots in the spectral display, and it's not sensitive to changes in beam or vessel angle. Resistance measured by indices like RIs and PIs is low, which can be used as predictors of ovarian malignancy, but PI was developed to determine quantitative energy in the oscillation of the waveform, and is calculated as $PI = \text{peak systole} - \text{end layer}$.^[8] Studies have described cutoff values of 1 for PI and 0.4 for RI as indicators of malignancy.^[8]

Our findings highlight the unique function of colour Doppler in classifying solid ovarian tumours as benign if they lack substantial vascularity. In this analysis, the NPV for lack of vasculature was 80.43 percent. While 90.9% of malignant lesions had blood vessels, only 42.9% of benign tumours did, and the PPV of simple presence of vascularity for malignancy was only 66.59%, it was clear that there was more to be learned. These results agreed well with a research by Stein et al.^[6] that found the

absence of colour flow to be predictive of benignity (NPV, 94%) and the presence of colour flow to be predictive of malignancy (49%).

However, in solid tumours, benign nodules typically have predominant peripheral vascularity and malignant nodules typically have predominant central vascularity, so the site of tumour vascularity in Doppler studies does not affect the diagnosis in cystic neoplasm.^[9] The majority of solid tumours (74.5%) in this study had central vascularity, while only 25% had peripheral vascularity.

Peak systolic velocity (PSV) is greater in malignant than in benign masses.^[10] In 51.85% of malignant tumours, Khanna et al. found a PSV of >20 cm/s, and in 40.14 percent, the PSV was between 10 and 20 cm/s.^[11] Consistent with the findings of Fleischer et al., 88% of malignant tumours in the present investigation exhibited mean systolic velocity >15 cm/s, while only 14% of benign tumours did.^[10]

In addition, spectral analysis indices like PI and RI can be used to improve ovarian neoplasm distinction.^[8] High blood flow velocities along by low impedance to the blood suggest malignancy, while moderate to high impedance is associated with benign tumours.^[16,19] Malignancy suspicion rises when the resistive index is outside the normal range (0.4-0.8; 6,13,16) or the PI is above 1.0.^[8] If the RI is less than 0.4, as determined by Kawai et al., colour Doppler provides a 100% accurate diagnosis of malignant tumours. Nonetheless, they discovered that roughly 2% of benign tumours had a low impedance pattern, defined as a RI 1.^[12] All malignant tumours in a large group of 628 patients were also found to have RI 0.4, as was the case with Kurjak et al. Kurjak identified and recommended a PI of 1 (PI1) for all malignant ovarian tumours in the same study, and it was corroborated by Valentin et al. and Fleischer et al. in subsequent studies because all malignant neoplasms exhibited decreased resistance to blood flow due to the existence of aberrant tumour vasculature.^[9,10] However, Carter et al. employed cutoff parameters of PI 0.8 and R 0.6 to maximise the study's sensitivity and specificity. Twenty-five out of twenty-five malignant tumours (92.59%) in our analysis had a PI 0.4. When applying the criterion of PI 0.6 proposed by Carter et al. to the present study's data, 88.89% (24) of malignant tumours had PI 0.6, but only 9.09% (3) of benign tumours did.

CONCLUSION

The study findings reveal distinct patterns in neovascularization and hemodynamic parameters between benign and malignant ovarian tumors. The presence of neovascularity was predominantly observed in malignant tumors, while benign lesions showed a lower prevalence. Peak systolic velocity demonstrated a significant difference between the

two groups, with benign tumors typically exhibiting low velocities and malignant tumors showing high velocities. This suggests that peak systolic velocity could serve as a potential indicator to differentiate between benign and malignant neovascular tumors.

Moreover, the Pulsatility Index (PI) and Resistive Index (RI) further highlighted differences between benign and malignant neovascular ovarian tumors. Benign tumors had a higher proportion of cases with PI >1.0, indicating increased pulsatility, whereas malignant tumors had a higher proportion of cases with PI <0.8, indicating lower pulsatility. Similarly, a substantial portion of malignant tumors exhibited an RI <0.4, reflecting lower resistance, while none of the benign tumors displayed RI values below this threshold.

These findings emphasize the value of utilizing color Doppler imaging and hemodynamic parameters in distinguishing between benign and malignant ovarian tumors. The presence of neovascularity, along with specific peak systolic velocities, PI, and RI values, can aid in the characterization and differentiation of these lesions. These insights contribute to improved diagnostic accuracy and may have implications for guiding treatment decisions in clinical practice.

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