Trends in Oncology Vol 6 Issue 1 2024

Original Research Article

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The Application Value of Color Doppler Ultrasonography in the Differential Diagnosis of Ovarian Tumors

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Abstract: Objective: To explore the application value of color Doppler ultrasonography in the differential diagnosis of ovarian tumors. **Methods:** Eighty-six patients with ovarian tumors admitted to our hospital from March 2019 to April 2023 were selected as the research objects. All patients underwent color Doppler ultrasonography, and the diagnostic results, blood flow grading, and blood flow parameters were compared. **Results:** The diagnostic rates of benign and malignant tumors were 47.67% and 52.33%, respectively. There was a statistically significant difference in the comparison of blood flow grading and blood flow parameters ($P < 0.05$). **Conclusion:** The application of color Doppler ultrasonography in the differential diagnosis of ovarian tumors can provide blood flow parameters for the analysis and judgment of benign and malignant tumors, thereby helping doctors better analyze the disease condition. This method is worthy of further promotion and application.

Keywords: Color Doppler ultrasonography; ovarian tumors; differential diagnosis

In recent years, the application of imaging examinations in tumor staging and differential diagnosis has become increasingly widespread, providing significant assistance in tumor differentiation diagnosis. Color Doppler ultrasonography is an important diagnostic tool, with high accuracy in distinguishing tumor types. In the process of differentiating ovarian tumors, the use of color Doppler ultrasonography can provide reliable diagnostic results for doctors, thereby assisting them in better formulating treatment plans. In order to further understand the application value of color Doppler ultrasonography in the differential diagnosis of ovarian tumors, a study was conducted.

1.Materials and Methods

1.1 General Information

Eighty-six patients with ovarian tumors admitted to our hospital from March 2019 to April 2023 were selected as the research subjects. The ages ranged from 18 to 65 years old, with a mean age of (47.21±3.51) years. Inclusion criteria: ① Confirmed diagnosis of ovarian tumor; ② Age ⩾ 18 years old; ③ Underwent color Doppler ultrasonography examination; ④ Signed informed consent form. Exclusion criteria: ① Patients with cognitive, mental, and communication disorders; ② Patients with concurrent uterine fibroids; ③ Critically ill patients. There was no statistically significant difference in the general data of the patients ($P > 0.05$).

1.2 Methods

All patients underwent color Doppler ultrasonography examination, with examinations performed abdominally and vaginally. The equipment used for the examination was the GE E8 model. Firstly, abdominal

ultrasound examination was performed on the patients. Patients were instructed to drink plenty of water before the examination to fill the bladder. After the pre-examination preparations were completed, the patients were guided to lie flat on the examination bed, with their clothing covering the abdomen untied to ensure exposure of the abdomen. The probe frequency was selected as 1-5MHz, and scans were performed on areas such as the uterine cavity and adnexa. Tumors, internal blood flow conditions, and their blood flow spectra were recorded until the examination was completed. For vaginal ultrasound examination, patients needed to empty the retained urine in the bladder beforehand. If the patient could urinate shortly after the abdominal examination, the vaginal examination could be performed immediately; otherwise, the patient needed to wait for a period of time. After the patient was ready, the lithotomy position was taken, and the probe was disinfected with a disinfectant coupling agent and covered with a condom. The probe frequency was set to 5-9MHz, and then the probe was slowly inserted into the vagina for examination of various sections of the uterus, ovaries, and surrounding tissues. Blood flow imaging was used to examine blood flow and vascular conditions.

1.3 Observational Indicators

The tumor type was determined based on the examination results: benign or malignant. The Adier method [2] was used to grade the tumor mass, mainly including four levels: Grade 1: Blood flow signal information was found inside and around the ovarian mass; Grade 2: No vascular distribution was found inside the ovarian mass, with vascular dots or short streaks observed around it; Grade 3: Simple sparse straight vessels were found inside the ovarian mass; Grade 4: Irregular reticular vessels were found inside the ovarian mass. Blood flow parameters were compared, including pulsatility index, peak systolic velocity, mean velocity, and resistance index.

1.4 Statistical Analysis

Statistical software SPSS 23.0 was used for data analysis. Measurement data and count data were expressed as ±s and (n, %) respectively. The t-test and chi-square test were used to analyze differences. The standard for significance testing was set at $P<0.05$, indicating statistical significance.

2. Results

2.1 Diagnostic Results

The examination results determined 45 cases of malignant tumors and 41 cases of benign tumors, with diagnostic rates of 52.33% and 47.67%, respectively.

2.2 Comparison of Blood Flow Grading

The proportion of Grade 1 and Grade 2 blood flow in both types of tumors was greater than that in malignant tumors, while the proportion of Grade 3 and Grade 4 was smaller than that in malignant tumors ($P < 0.05$). See **Table 1**.

Table 1 Comparison of Blood Flow Grading[*n*,%]

Type	Example number	Level 1	Level 2	Level 3	Level 4
Optimum	41	19(46.34)	15(36.59)	4(9.76)	3(7.31)
Malignant	45	0(0.00)	6(13.33)	17(37.78)	22(48.89)
x^2		26.767	6.285	9.127	17.981
P		0.000	0.043	0.010	0.000

2.3 Comparison of Blood Flow Parameters

The pulsatility index and resistance index of malignant tumors were greater than those of benign tumors, while the peak systolic velocity and mean velocity were lower than those of benign tumors (P <0 .05). See **Table 2**.

Table 2 Comparison of Blood Flow Parameters [n, $\overline{\chi} + s$]

Type	Example number	beat rhythmically index	Peak systolic period current velocity(cm/s)	mean flow velocity(cm/s)	Blood flow resistance Force index
Optimum	41	1.29±0.21	13.67±4.59	9.18±3.36	0.58±0.02
Malignant	45	0.93±0.18	21.68±4.97	11.89±3.87	0.46±0.08
x^2		8.495	7.770	3.475	9.739
P		0.000	0.000	0.001	0.000

3. Discussion

Tumors are one of the significant challenges faced by the medical community, characterized by prolonged treatment processes and often difficult to cure, leading many patients to endure significant physical and psychological pressure. Analysis of the GLOBOCAN 2020 database shows that China has 4.57 million new cancer cases, accounting for 23.7% of the global total, with the United States, India, Japan, Germany, and others following closely, indicating a high incidence of tumors globally. In the past decade, the proportion of female tumor patients among all tumor patients has been gradually increasing, especially for breast and ovarian tumor patients. Ovarian tumors are reproductive system tumors occurring in the ovaries, and once diagnosed as malignant tumors, they face a high risk of death. Early diagnosis is crucial in treating ovarian tumors. Early detection and treatment can significantly increase the 5-year survival rate of patients, highlighting the importance of early diagnosis. Imaging examinations are crucial in differential diagnosis. Analyzing factors such as the size, morphology, echo, and hemodynamic indicators of ovarian masses can further confirm the type of tumor, thereby avoiding treatment delays due to misdiagnosis .Imaging examination methods mainly include CT, MRI, angiography, and ultrasound. CT and MRI are effective in determining tumor size, location, and vascular distribution around the tumor. Angiography is also important for observing the blood flow perfusion pattern of ovarian masses, including methods such as CEUS, CECT, and CE-MRI. Ultrasound is an important tool for examination, capable of further assessing the three-dimensional situation of tumors and the status of surrounding tissues, with an accuracy rate of up to 90%.

Color Doppler ultrasound, also known as color Doppler, is an imaging instrument that assesses tumor size, morphology, and the distribution of surrounding tissues and organs based on changes in sound waves. It is commonly used for differential diagnosis of ovarian tumors. CT, MRI, and other imaging examinations may be influenced by factors such as abdominal effusion, adnexa, and the uterus, leading to erroneous results. However, color Doppler ultrasound can distinguish between the above conditions or organs and tumors, thereby determining whether the mass is a tumor or the benignity or malignancy of the tumor .Generally, hemodynamic examination under color Doppler ultrasound can reveal a higher integrity of the capsule in benign tumors, with no apparent damage. At this point, the distribution of blood vessels within the tumor is not obvious, mainly around the tumor. Malignant tumors, due to their long development time and rapid growth, may have a ruptured capsule, resulting in a richer distribution of blood vessels within the tumor. Additionally, through 3D or 4D color ultrasound, the morphology of the tumor can be confirmed, and further differentiation can be made based on the size of the tumor. Furthermore, the presence of ascites can be evaluated through color Doppler ultrasound, which is a method for distinguishing between benign and malignant tumors. Generally, benign tumors have no or very little ascites, while malignant tumors tend to have more ascites. It can be said that color Doppler ultrasound provides significant assistance in the differential diagnosis of ovarian tumors. Through color Doppler ultrasound, the size, type, or staging of the tumor can be further determined, laying the foundation for subsequent treatment of patients.

Research has found that in the early stages of tumor growth, the growth rate is relatively slow compared to the later stages. The tumor is enveloped and covered by a capsule. Due to the slow growth, the capsule can grow along with the cancer cells. At this stage, there are basically no blood vessels and blood flow inside the tumor. However, as the tumor progresses to the later stages, its growth rate accelerates. With the increase of cancer cells, the stress on the tumor capsule increases, leading to the occurrence of capsule rupture. Capillaries will enter the tumor mass from the rupture site, forming irregular reticular structures inside, and blood flow activity becomes more frequent. Based on the characteristics of the tumor, it is possible to determine the stage of tumor development, and color Doppler ultrasound can be used to examine the above conditions by evaluating the vascular and blood flow situation within the mass for differentiation. Compared to CT or MRI examinations, this examination has higher specificity because CT or MRI primarily judge based on the characteristics of the tumor edge, such as smoothness or the presence of spicules. However, color Doppler ultrasound can obtain blood flow parameters and classify them accordingly, thus

providing diagnostic results. Currently, color Doppler ultrasound has become an important auxiliary tool for differentiating ovarian tumors, with a misdiagnosis rate of less than 10% and a very high diagnostic rate. For tumors that cannot be determined, a biopsy can be performed to further evaluate the development of cancer cells. Furthermore, during the examination, factors such as the uterus, adnexa, and abdominal effusion also affect the diagnostic results. The accuracy of CT or MRI in assessing these influencing factors is relatively low. However, color Doppler ultrasound can accurately identify these influencing factors because the speed of ultrasound propagation varies in different media. Based on the frequency of the reflected waves, the reflecting medium can be determined, thus making a judgment on the target.

The results of this study show that in the differential diagnosis of benign and malignant tumors, the diagnostic rates for benign and malignant tumors are 47.67% and 52.33%, respectively. Analysis and research on the blood flow grading of benign and malignant tumor patients revealed that the blood flow grading of benign tumors mainly concentrated in Grade 1 and Grade 2, whereas the number of Grade 1 and Grade 2 cases in malignant tumors was relatively small. This is because benign tumors have a complete capsule, so the distribution of internal blood vessels is very minimal, whereas malignant tumors are the opposite. This indicates that the results of blood flow grading examination through color Doppler ultrasound can accurately determine the blood situation of benign and malignant tumors. This result is also evident in the distribution of Grade 3 and Grade 4, where benign tumors have more Grade 3 and Grade 4 cases compared to malignant tumors. Both the mean blood flow velocity and peak systolic velocity in malignant tumors are lower than those in benign tumors. From the blood flow parameter results, the examination results are consistent with theory, and both pulsatility index and resistance index also show differences, with the resistance index (RI) of ovarian malignant tumors ranging from 0.25 to 0.49, lower than that of ovarian benign tumors. Therefore, color Doppler ultrasound examination can further determine the type of tumor based on factors such as tumor size, morphology, and blood flow grading, thereby avoiding diagnostic errors. Although color Doppler ultrasound has a high accuracy rate in differential diagnosis, providing doctors with imaging judgment basis, certain precautions need to be taken during the examination process. For example, patients should be instructed to drink plenty of water before abdominal examination to adequately fill the bladder and empty the bowels to eliminate interference from intestinal gas. Failure to do so may result in the inability to distinguish between the bladder and the tumor or other influencing factors during the examination, leading to invalid examination results or the need for a re-examination, which may delay patient treatment. Before vaginal examination, patients need to be guided to maintain the correct position, empty their bladder and bowels, and observe the uterus from multiple directions to avoid interference from obstructions on the examination results. For examination content that cannot be confirmed, multiple and repeated observations should be made to make accurate judgments.

In summary, the application of color Doppler ultrasound in the differential diagnosis of ovarian tumors can provide blood flow parameters for the analysis and judgment of benign and malignant tumors, thereby assisting doctors in better analyzing the disease situation. This method is worthy of further promotion and application.

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