

## *Retraction*

# **Retracted: Quantitative Parameters of Contrast-Enhanced Ultrasound Combined with Lung Biopsy Were Used to Evaluate the Benign and Malignant Lesions around the Lungs**

### **Journal of Sensors**

Received 13 September 2023; Accepted 13 September 2023; Published 14 September 2023

Copyright © 2023 Journal of Sensors. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### **References**

- [1] J. Sun, F. Na, B. Ma, L. Wang, H. Shi, and Y. Ding, "Quantitative Parameters of Contrast-Enhanced Ultrasound Combined with Lung Biopsy Were Used to Evaluate the Benign and Malignant Lesions around the Lungs," *Journal of Sensors*, vol. 2021, Article ID 2259408, 14 pages, 2021.

## Research Article

# Quantitative Parameters of Contrast-Enhanced Ultrasound Combined with Lung Biopsy Were Used to Evaluate the Benign and Malignant Lesions around the Lungs

Jun Sun,<sup>1</sup> Fengyu Na,<sup>2</sup> Bo Ma,<sup>3</sup> Li Wang,<sup>4</sup> Hanbing Shi,<sup>5</sup> and Yan Ding<sup>1,2</sup>

<sup>1</sup>Department of Hematology, Third Affiliated Hospital of Qiqihar Medical University, Qiqihar, 161000 Heilongjiang, China

<sup>2</sup>Department of Medical Ultrasonics, Third Affiliated Hospital of Qiqihar Medical University, Qiqihar, 161000 Heilongjiang, China

<sup>3</sup>Department of Gynaecology, Third Affiliated Hospital of Qiqihar Medical University, Qiqihar, 161000 Heilongjiang, China

<sup>4</sup>Radiographic Imaging Center, Third Affiliated Hospital of Qiqihar Medical University, Qiqihar, 161000 Heilongjiang, China

<sup>5</sup>Respiratory Department 2, Third Affiliated Hospital of Qiqihar Medical University, Qiqihar, 161000 Heilongjiang, China

Correspondence should be addressed to Yan Ding; 201901017234@stu.zjsru.edu.cn

Received 3 September 2021; Revised 15 October 2021; Accepted 28 October 2021; Published 27 November 2021

Academic Editor: Haibin Lv

Copyright © 2021 Jun Sun et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

In recent years, due to the influence of living habits and smoking, the number of lung cancer patients worldwide has increased year by year, and it has gradually developed into one of the common diseases endangering human life. CEUS can observe the lesion and realize the rapid identification of the location of the active area of the lesion. CEUS is the abbreviation of contrast-enhanced ultrasound technology. Contrast-enhanced ultrasound technology is to inject ultrasound contrast agent through a peripheral vein to perform ultrasound exploration to observe the enhancement of the internal nodules. Compared with color ultrasound, it can diagnose more accurately and improve the inspection effect. At present, this technology is used for the diagnosis of many types of space-occupying lesions, but it is rarely used for the diagnosis of lung lesions. The purpose of this study is to explore the role of CEUS quantitative parameters combined with lung biopsy in the assessment of benign and malignant peripheral lung diseases. Based on the relevant theoretical basis of CEUS and lung biopsy, 158 patients with peripheral lung disease were selected as experimental subjects, and they were divided into experimental group and control group for comparative experiments. Experiments proved the effectiveness of CEUS quantitative parameters combined with lung biopsy methods. The experimental results showed that, compared with the benign group, the time-intensity curve, the rise time, and the peak time of the malignant lesions were significantly prolonged. In addition, CEUS combined with the quantitative parameters of lung biopsy can effectively distinguish the activity of lung lesions and the site of necrosis and promote the effective increase of the positive rate of lung biopsy.

## 1. Introduction

*1.1. Background.* At present, lung cancer is one of the serious diseases that threaten human life and health. The number of lung cancer cases and deaths has been on the rise worldwide in recent years due to environmental pollution and changing living habits. Lung cancer poses a serious threat to the life safety of patients. Early detection and early treatment are conducive to the continuous improvement of treatment effect and have an obvious effect on reducing patients' sense of pain and promoting the improvement of prognosis. At

present, CT, X-ray, and fiberoptic bronchoscopy are common methods of clinical diagnosis, and their diagnostic value has been recognized. However, these diagnostic methods still have shortcomings in terms of body radiation and high diagnostic cost. Contrast-enhanced ultrasound (CEUS) is a new imaging technology. Compared with other diagnostic methods, CEUS has significant advantages, including no radiation, repeated examination, and real-time dynamics. Moreover, based on contrast-enhanced ultrasound, lung biopsy can also be performed. At present, contrast-enhanced ultrasound (CEUS) is often used in the

examination of abdominal lesions, but rarely in the clinical study of pulmonary lesions. The assessment of benign and malignant peripheral pulmonary lesions has a direct impact on the treatment of pulmonary diseases, and the timely assessment of benign and malignant lesions can buy sufficient time for the treatment of patients.

Because of the frequency and harmfulness of pulmonary diseases, the diagnosis and treatment of pulmonary diseases have always been a topic of general concern in the medical field [1]. In order to promote the improvement of its treatment methods and therapeutic effect, scholars at home and abroad have conducted a series of studies on it and achieved certain research results. In literature [2], the authors explored the mechanism of action of pulmonary diseases and analyzed the pathogenic factors of such diseases from the perspectives of living habits and physiological pathological changes. In the literature [3], the authors adopted a contrastive analysis experiment to make a comparative analysis between CEUS and conventional ultrasound technology, proving the effectiveness of CEUS in diagnosing benign and malignant abdominal diseases. In the literature [4], based on the factors of peripheral lung lesions, the authors proposed the prevention and treatment strategies for the occurrence of lesions from the perspectives of lifestyle and regular examination and proved the effectiveness of the strategies through comparative experiments.

The purpose of this study is to explore the role of contrast-enhanced ultrasound quantitative parameters combined with lung biopsy in the evaluation of the effect of pulmonary peripheral lesions benign and malignancy and function; the author based on the related theory of ultrasonic imaging and lung biopsy selected the 158 patients with lung lesions as experimental object; this paper will be divided into the experimental group and control group, comparison between the two groups of experiments, and through the experiment, it proved the ultrasonic imaging quantitative parameters' effectiveness of the united way of lung biopsy [5, 6].

**1.2. Innovation.** The innovation of this article is to combine the research results of multiple scholars collected before, based on CEUS: the application of contrast-enhanced ultrasound technology is to generate dynamic image data collection, with the consent of the patient and their family members, combined with CT biopsy technology, according to the patient. In the CEUS state, puncture at the lesion site, collect real experimental data, use the SPSS statistical software to analyze the experimental data, and then use parameters to evaluate the lung lesions [7]. This study is beneficial to promote the rapid assessment of benign and malignant lung lesions and lays a theoretical foundation for future research in related fields [8].

## 2. Theoretical Basis

### 2.1. Contrast-Enhanced Ultrasound and Its Application

**2.1.1. Concept.** Some substances that can form an acoustic contrast effect are injected into the cardiovascular system

and the internal organs of the cavity [9], so as to clearly show the blood circulation status, disease, and tissue structure. This technique is contrast-contrast ultrasound [10]. Ultrasound contrast, also known as acoustic contrast, is a technique that uses contrast agents to enhance backscattered echoes and significantly improve the resolution, sensitivity, and specificity of ultrasound diagnosis. In the field of ultrasound medicine, contrast-enhanced ultrasound can be called the third revolution. This technology is currently the most advanced among various ultrasound imaging technologies [11]. In addition to conventional contrast harmonic imaging, ultrasound contrast technology also includes intermittent ultrasound imaging, energy contrast harmonic imaging, inverse pulse harmonic imaging, stimulated acoustic emission imaging, low mechanical index imaging, and contrast agent burst imaging. Regardless of the method used, an ultrasound device that can perform contrast must have sufficient bandwidth and high dynamic range and be able to provide sufficient parameters. This technology greatly improves the sensitivity to blood flow rate and tiny blood vessels in human tissues, making the provision of diagnostic information more abundant and accurate [12]. Since China introduced CEUS in 2006, the clinical application of CEUS has been widely praised [13]. At present, the clinical application of CEUS is mainly manifested in the following aspects: First, it is used to detect and evaluate the nature of tumors [14]. Contrast-enhanced ultrasound technology is mainly used in tumors and vascular diseases. Studies have shown that contrast-enhanced ultrasound is better than conventional imaging techniques such as color Doppler ultrasound and CT in detecting the number of liver tumors, especially in the detection of diseases less than 1 cm. The second is targeted guidance; the third is efficacy evaluation. Real-time dynamic scanning is the advantage of ultrasound noise, which is conducive to the diagnosis of lesions and the rapid detection of small lesions. Moreover, as a new noninvasive, nonradiation imaging technology, it can be inspected during surgery and can be inspected multiple times in a short period of time [15]. Most importantly, this CEUS technology has high safety performance and low probability of allergic reactions, so there is no need for skin testing before use. Especially in the diagnosis and treatment of some intractable diseases, ultrasound technology has outstanding value. Although it is safer to use CEUS clinically, some patients with congenital heart disease and asthma are prohibited from using it because of the need for contrast ultrasound examination during this process.

The principle of contrast-enhanced ultrasound is shown in Figure 1. Contrast-enhanced ultrasound imaging technology is a functional imaging technology that can noninvasively evaluate the blood perfusion of living tissues, reflect the physiological changes of tissues and organs, and reflect the clinical characteristics of the tumor before the tumor morphology changes or changes very little. The quantitative parameter software of contrast-enhanced ultrasound is used to analyze the continuous dynamic images of contrast-enhanced ultrasound, and the gray-scale change curve of the tissue in the area of interest is obtained, which is the time-intensity curve (TIC). The quantitative parameters of

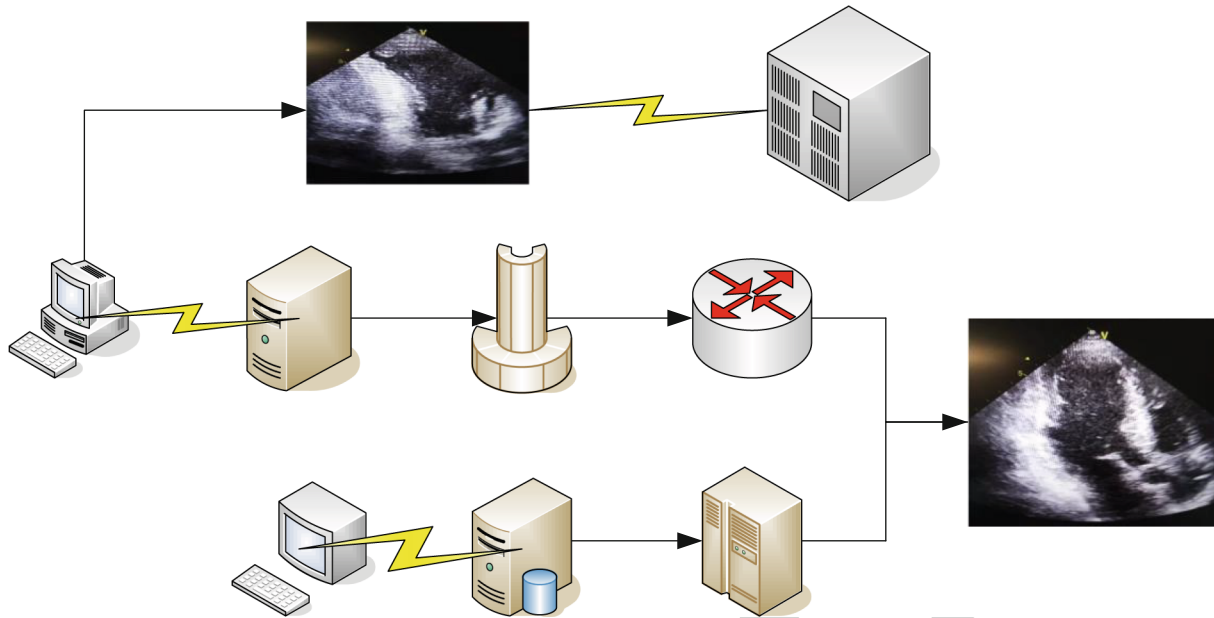


FIGURE 1: Principle of contrast ultrasound.

TIC objectively reflect the characteristics of the change of the contrast agent perfusion process in real-time gray-scale contrast-enhanced ultrasound examination with time.

**2.1.2. The Application of Contrast-Enhanced Ultrasound in Lung Biopsy.** Since different types of pathological changes in the lung require different treatment, it is of great significance to conduct biopsy of pathological tissue to obtain relevant pathological diagnosis. At present, the diagnosis of lung tumor is still based on pathological examination. Compared with X-ray and CT, it can realize the dynamic observation of the puncture biopsy process, so as to accurately grasp the direction, path, and specific depth of the needle, so as to avoid some important tissue structures, have higher safety, and reduce the difficulty of operation and the probability of various complications. To sum up, the application of CEUS in the diagnosis of peripheral pulmonary diseases and quantitative analysis can realize the rapid acquisition of effective information of peripheral pulmonary diseases, especially in the guidance of lung biopsy. Its application deepens the medical research on peripheral pulmonary diseases. Comprehensively, using contrast-enhanced ultrasound-guided lung biopsy, this way, it has high security and not easily gets complications, the accuracy of the biopsy is relatively high, it has many advantages, especially the final assessment result in evaluating, it has important clinical value in the surrounding lung pathological changes, and it can effectively avoid the necrotic tissue biopsies, so that the positive rate of biopsy diagnosis is greatly promoted, thus worthy of further popularization and application.

Ultrasound contrast agent is an important guarantee for the realization of ultrasound contrast technology. For different applications, different contrast agents need to be selected. The most interesting is the microbubble contrast agent used to observe the state of tissue perfusion. Small bubbles with a diameter of less than 10 microns are usually

called microbubbles. The first-generation contrast agent microbubbles contain air, and the envelope is generally a polymer such as albumin or galactose. The physical characteristics of the first generation of ultrasound contrast agents, including thicker envelopes, poor elasticity, and easy soluble air in water, determine its short duration and easy rupture, thus limiting the time for observation and diagnosis in clinical applications. The second-generation ultrasound contrast agent is a thin and soft bubble with a high-density inert gas (not easily soluble in water or blood) with a thin outer membrane. The diameter is generally about 2-5  $\mu\text{m}$ . It has a long stable time and good vibration and echo characteristics.

The diameter of ultrasound contrast agent should be small enough, smaller than the diameter of red blood cells (7  $\mu\text{m}$ ), to ensure that it can pass through the pulmonary capillaries and enter the arterial circulation. And it has enough stability; the residence time in the blood allows ultrasound imaging to show the process of perfusion (enhancement) and clearance (decrease) in the tissue. It is nontoxic and can be degraded or excreted eventually. And it can produce abundant harmonics, so it is not easy to produce artifacts so that it can be better observed.

The pore size of nanomaterials is expressed as follows.

$$Eg_{ps} = \Delta E_g \approx \frac{h^2 \pi^2}{2R^2} \times \frac{1}{\mu} - Eg_{ref}. \quad (1)$$

The surface coefficient of nanoparticles will change correspondingly during the preparation process.

$$c_\tau = \tau_0 + \alpha g b \rho = \tau_0 + \alpha b \rho^{p-N},$$

$$\tau = \left[ \frac{Gb}{2\pi L(1-\nu)} \right] [2 - 4 \cos^2 \varphi]. \quad (2)$$

Among them,  $c_r$  is the surface coefficient, and  $\tau_0$  is the value of the initial strain force.

The linear model formula can be expressed as follows:

$$y = \beta_1 x_{i1} + \dots + \beta_n x_{in} + \alpha. \quad (3)$$

In response phase, GenProof(M,T,chal,pk), after cloud storage receives the set of challenge information pairs, it runs evidence generation algorithm and calculates the following:

$$\mu_j = \sum_{\{(i,v_i)\}} v_i m_{ij}, \quad (4)$$

where  $j = 1, 2, \dots, s$ , and

$$\sigma = \prod_{\{(i,v_i)\} \in Q} \sigma_i^{v_i} \in G. \quad (5)$$

Then, it will be the evidence of data integrity.

$$p = \left\{ \left\{ \mu_j \right\}_{1 \leq j \leq s}, \text{sig}_{sk}(f(R)) \right\}. \quad (6)$$

Assuming that the state of the financial crisis of a listed company is  $\delta_i$ , the value is  $[0,1]$ , and the Cox model defines the log-likelihood function formula as follows:

$$Y(\lambda) = \prod_{i=1}^n \left[ \frac{1}{\left( \sum_{j \in U(t_i)} \exp(\lambda' K) \right)} \right]^{\delta_i}, \quad (7)$$

$$U(t_j) = \{m : t_m \geq t_j\}.$$

According to the derivation of the Lagrangian function, the dynamic equation of the system can be obtained, as follows:

$$T_i = D_{i1}\theta_1 + D_{i2}\theta_2 + \dots + D_{i56}\theta_{56} + D_i,$$

$$TF_{c,j} = \frac{n_{c,j}}{\sum_k n_{k,j}}, \quad (8)$$

$$X_n = (X_1, \dots, X_n).$$

In the data, the bootstrap method is replaced with Monte Carlo samples with a sample size of  $n$ :

$$\theta_{j,b} = r \sum_{k=1}^s \theta_{j,b}^k, \quad (9)$$

$$\xi(\theta) = S \sum_{j=1}^s \xi_j.$$

The organic film sensitivity value is expressed as follows.

$$m = \frac{k_B T}{aGb^2} \left[ \ln \left( \frac{V}{b^3} \right) \right]^{-1} + \rho V. \quad (10)$$

The Lagrangian function is defined as  $L = H - Q$ , where  $L$  is the Lagrangian function,  $H$  is the kinetic energy of the system, and  $Q$  is the potential energy of the system. Then,

$$F_i = \frac{\partial}{\partial t} \left( \frac{\partial L}{\partial \dot{x}_i} \right) - 1, \quad (11)$$

$$T_i = \frac{\partial}{\partial t} \left( \frac{\partial L}{\partial \dot{y}_i} \right) - \frac{\partial L}{\partial y_i}.$$

Using the Breslow method, the cumulative basic risk  $R_0(t_m)$  at time  $t_i$  can be obtained:

$$\hat{R}_0(t_m) = \sum_{t_j \leq t_i} \left[ \frac{\delta_i}{\sum_{j \in U(t_m)} \exp(\hat{\lambda} x_j)} \right]. \quad (12)$$

In the iterative process, if the centroid points no longer change, terminate and output the centroid point.

$$d^j = \min \left( \left\| z^{(j)} - u^j \right\|_2 \right). \quad (13)$$

For each factory  $i$  and product  $p$ , the purchase of raw materials plus the production of products should equal the amount of products shipped from the factory to the warehouse plus the amount of raw materials consumed.

$$PU_{jpt} + \sum_{i \in \text{OUT}(P)} W_{ijpt} = \sum_k Q_{jkpt}^{PL} + \sum_{i \in \text{IN}(P)} W_{ijpt}. \quad (14)$$

The original inventory plus the transportation volume from the factory to the warehouse equals the flow from the warehouse to the market plus the final inventory. The formula is as follows:

$$\text{INV}_{kpt-1} + \sum_j Q_{jkpt}^{PL} = \sum_l Q_{klpt}^{WH} + \text{INV}_{kpt}. \quad (15)$$

The average square deviation between model estimates is minimized.

$$\min (m^2) = \sum_{l=1}^n \left[ x'(L) - y(L) \right]^2. \quad (16)$$

Among them,  $x(L)$  is the measured value. Data transmission needs to be carried out at all times during the operation.

$$L[C] = \left( 1 - \frac{R_{ppk}}{R_{H_1}} \right) \left( 1 + \frac{U_{sc}(U_H + U_{H_1})}{2} \right). \quad (17)$$

In the formula,  $L[C]$  is the total amount of data transmission of data transmission.



The prediction of the target by the extended Kalman filter is as follows:

$$\begin{aligned}\hat{X}(k+1|k) &= A(\Delta\tau_k)\hat{X}(k|k), \\ P(k+1|k) &= A(\Delta\tau_k)P(k|k)A(\Delta\tau_k)^T + Q(\Delta\tau_k).\end{aligned}\quad (18)$$

**2.2. Lung Biopsy.** A percutaneous lung biopsy, called a lung biopsy, is used to diagnose peripheral lung types and diffuse lesions. At the present stage, lung biopsy is mainly performed by needle biopsy. In most cases, the upper lobe and hilar lesions are punctured in the supine position from the front, the tongue lobe and middle lobe lesions are punctured in the lateral position, and the lower lobe basal segment and dorsal segment lesions are punctured in the prone position. The puncture layer is determined as the lesion center, and the shortest distance between the skin and the lesion, that is, the vertical or horizontal distance between the two, is selected as the puncture route, and the location of blood vessels and nerve knife should be avoided during the puncture. When the lesion is located in the posterior segment of the blade tip, the insertion may also be oblique in order to avoid the critical site. When determining the puncture location and specific path, the specific lesion location and lesion area shown on CT should be referred to, and the puncture point location should be marked with a marker pen. After the needle enters the lesion, the patient holds his or her breath. Multipoint fan-shaped sampling was performed by pulling the puncture needle to obtain relevant lung specimens, and pathological examination was conducted after obtaining the samples. After the lung biopsy is completed, the patient's condition should be observed within 2-4 h after completion. In addition, many complications often occur in the process of lung biopsy, and common complications include pneumothorax, bleeding, and tumor proliferation, which should be dealt with in time once complications occur. Lung biopsy is a direct and effective way to evaluate peripheral lung lesions and is widely used in clinical diagnosis. Lung biopsy is mainly suitable for the following conditions: first, the isolation of the lung and the formation of nodules; secondly, there is metastatic tumor in the lung, which needs to be determined according to the type of lung tissue, and the primary lesion should be explored. Third, other technical examinations fail to identify lung diseases; fourth is to evaluate the benign and malignant properties of lung tumors; fifth, there are mutations in the lung that require a microbiological examination. To sum up, lung biopsy can timely realize the diagnosis and evaluation of lung disease types, thus providing an important basis for timely treatment of the disease.

The lung biopsy technique is shown in Figure 2. CT-guided puncture biopsy has complex operations, has high technical requirements and radiation, and cannot monitor the puncture status in real time, while fiberbronchial biopsy is generally only suitable for central lung lesions, and the success rate of puncture for lesions below segmental bronchus is extremely low, only 25%-78%. For peripulmonary lesions close to the pleura, conventional ultrasound-guided needle biopsy has been used more and more because of its

advantages such as simplicity, convenience, real-time monitoring, and high safety.

### 3. Experimental Research

**3.1. Research Objects and Data.** In this paper, 158 patients with peripheral pulmonary lesions confirmed by CT scan in a third-grade hospital from January 2019 to March 2020 were selected as experimental subjects, including 109 male patients and 49 female patients, with the age ranging from 16 to 88 years old and the average age of the patients being 60.7 years old. There was no statistical difference in basic data between the two groups. These patients were randomly divided into an experimental group and a control group, with 97 in the experimental group and 61 in the control group. Contrast-enhanced ultrasound was performed before lung biopsy in patients in the control group, and conventional ultrasound was performed between lung biopsies in patients in the experimental group. Prior to the CEUS test and the lung biopsy, the patient and his/her family members signed the consent form for the experiment. The experimental study in this paper was conducted with the approval of the ethics committee of our hospital.

**3.2. Contrast-Enhanced Ultrasound Examination.** The diagnosis was made with a color Doppler instrument, which used a C5-1 probe, and the frequency of the instrument was 1-5 MHz. The location, size, and internal echo of the lesion were observed and recorded after the routine ultrasonic examination. Patients in the experimental group determine the appropriate sound window; to adjust to the imaging mode, select sound novelty as contrast agents and the cell suspension configuration, through the elbow superficial vein which will configure 2 ml cell suspension into the body; then, the injection of saline is in a total of 5 ml of lesions in patients with continuous observation, and observation time is 3-5 min, to generate dynamic image data acquisition, the time-intensity curve, lesions rise time, and tmax data for analysis.

**3.3. Lung Puncture Biopsy.** Lung biopsies are performed by needle biopsy. Biopsy tools mainly include the BARD automatic biopsy gun, which has a range of 15 mm to 22 mm, as well as 18G needle. According to the patient's CEUS status, puncture operation was performed at the significantly improved location in the lesion of the experimental group. The optimal puncture route was determined in the control group based on the results of conventional ultrasound examination. Lung biopsy specimens from both groups were immobilized with 5% formalin, followed by pathological examination. After completion of the puncture, keep observing the patient for half an hour. If the patient has significant physical discomfort, inform the patient about the matters needing attention, send the patient back to the ward, and make follow-up observation and record of the patient's post-operative conditions in all aspects.

**3.4. Experimental Data Statistics.** After the completion of the experiment, the SPSS statistical software was used to analyze the experimental data, and the experimental data obtained

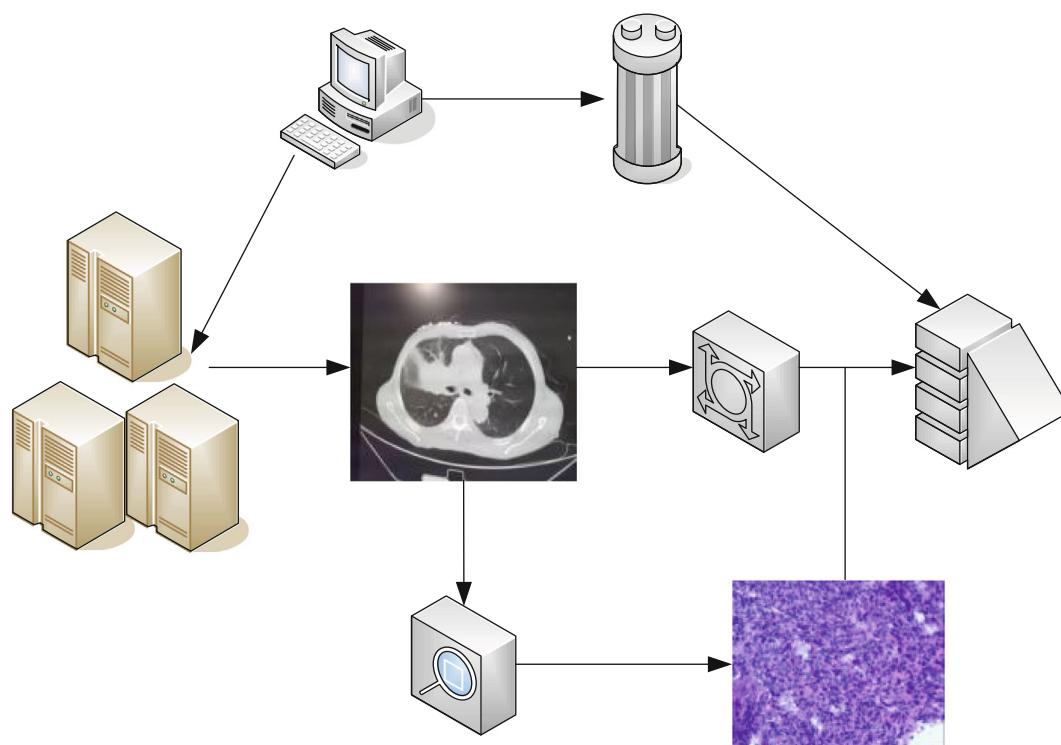


FIGURE 2: Principle of lung biopsy technique.

by the experiment were expressed in the form of  $x \pm s$ . After the statistics of experimental data is completed, the computer graphics software is used to draw data charts, and relevant experimental conclusions are drawn based on the analysis of data charts. In addition, in order to ensure the accuracy of the experimental results in this paper, the author also logged on data websites such as Wan Fang and CNKI, collected a total of 12 relevant research literatures, and collected and sorted out the data in these research literatures, and these data provided sufficient data support for the experimental research in this paper.

## 4. Experimental Analysis and Discussion

### 4.1. Experimental Results

**4.1.1. Diagnosis Results.** Figure 3 shows the diagnostic results of lung biopsy in the two groups. It can be seen from the data in the figure that in the experimental group, 40 patients were diagnosed as benign by lung biopsy, 52 as malignant, and 5 as nonqualitative. In the control group, 29 patients were diagnosed as benign by lung biopsy, 22 as malignant, and 10 as inconclusive.

Table 1 shows the comparison between the quantitative parameters of contrast-enhanced ultrasound in different stages of peripheral lung cancer. Among them, PI and ISI of stages III and IV lung cancer were higher than those of stages I and II, and there was a statistical difference ( $p < 0.05$ ). There was no statistical difference between different stages of TE, TTP, and BI ( $p > 0.05$ ).

The contrast of contrast enhancement types between benign and malignant lesions is shown in Figure 4. Among the 35 cases in the experimental group, 34 cases obtained clear pathological results through puncture. One case of lung abscess was classified as uneven enhancement due to boundary enhancement, and the other cases were enhanced in varying degrees. According to the pathological results, they were divided into benign group and malignant group. In the benign group, 10 cases showed uneven enhancement, 6 cases showed uniform enhancement, and 4 cases showed uniform enhancement. In the malignant group, 22 cases showed uneven enhancement and 2 cases showed uniform enhancement. The difference between the two groups was statistically significant by Fisher exact probability test ( $p = 0.048 < 0.05$ ).

The comparison of puncture results between the control group and the experimental group is shown in Table 2. The results of puncture complications in the two groups were compared. There were no complications in the experimental group, and one patient in the control group had a small amount of hemoptysis and improved without special treatment. There was no significant difference in the incidence of complications between the two groups ( $p = 1.000 > 0.05$ ).

**4.1.2. Complications.** Figure 5 represents the data investigation and recovery of two groups of patients with complications, and complications through investigation found that in the experimental group, there is 1 hemoptysis patient after the operation, in the control group, 3 patients after surgery produce hemoptysis, in the experimental group, there is

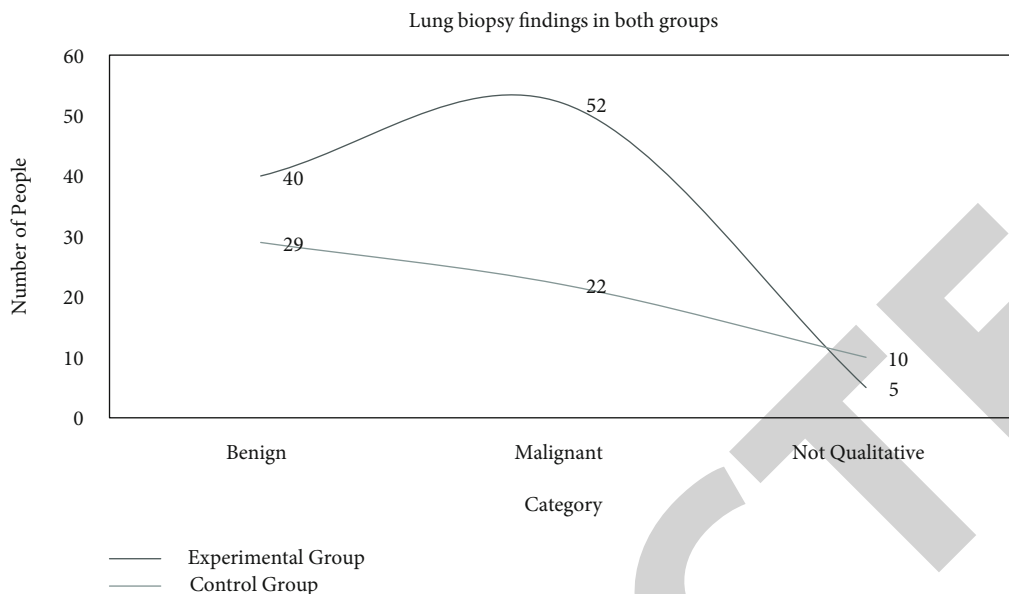


FIGURE 3: Lung biopsy diagnosis results of the two groups.

TABLE 1: Comparison of quantitative parameters of contrast-enhanced ultrasound in different stages of peripheral lung cancer.

	I and II stages	III and IV stages	<i>t</i>	<i>p</i>
TE	16.18 ± 5.37	15.90 ± 5.16	0.14	0.89
TTP	27.1 ± 5.29	25.70 ± 6.22	0.80	0.43
BI	18.50 ± 5.64	16.70 ± 4.90	1.10	0.28
PI	64.90 ± 18.18	87.20 ± 13.02	-4.38	0.00
ISI	57.70 ± 14.33	76.22 ± 9.48	-4.693	0.00

TABLE 2: Comparison of puncture results between the control group and the experimental group.

Group	Positive puncture	Negative puncture	Positive rate of puncture
Control group	28	8	77.78%
Experimental group	34	1	97.14%

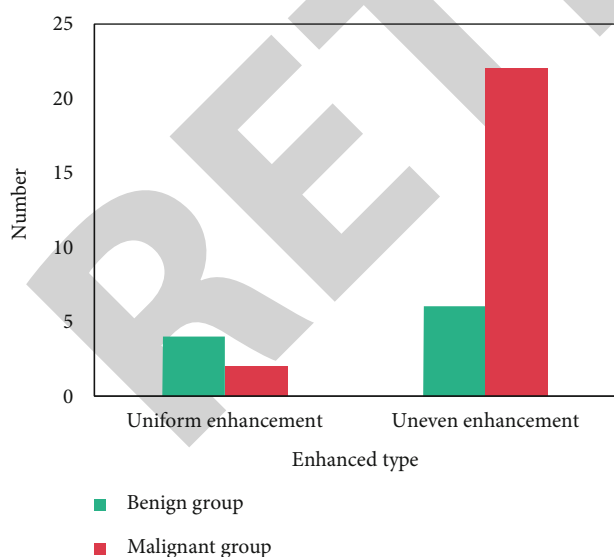


FIGURE 4: Contrast of contrast enhancement types between benign and malignant lesions.

Figure 2, the probability of complications in the experimental group was 2.06%, while the probability of complications in the control group was 4.92%. However, the final recovery effect of complications in both groups could reach 100%. This indicates that the probability of complications of CEUS quantitative parameters combined with lung biopsy in the evaluation of peripheral pulmonary lesions is relatively low, which proves the safety of this diagnostic method.

The comparison between the initial enhancement type of lung lesions and the benign and malignant pathological results is shown in Figure 6. In this study, 27 patients in the contrast-enhanced ultrasound group with pathological results, 21 patients began to enhance from the periphery of the lesion, including 11 benign lesions and 10 malignant lesions. There were 6 patients with enhancement from the center of the lesion, including 4 benign lesions and 2 malignant lesions. Chi-square test was used to compare the initial enhancement type of pulmonary lesions with benign and malignant,  $p = 0.535 > 0.05$ , and the difference was not statistically significant, that is, there was no significant difference in the initial enhancement type of contrast-enhanced ultrasonography between benign group and malignant group.

1 at the end of surgery in patients with pneumothorax after 1 day, or more patients in the case of no special treatment are gradually improving. As can be seen from the data in

In the benign group, the comparison of contrast-enhanced ultrasound parameters between lesions and bile duct wall is shown in Table 3. In the benign group, there was no significant difference in the imaging parameters



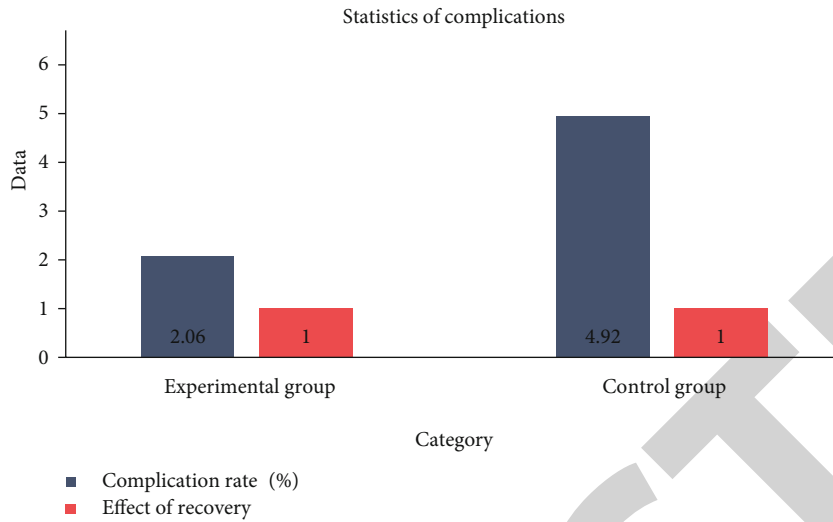


FIGURE 5: Complication investigation in the two groups.

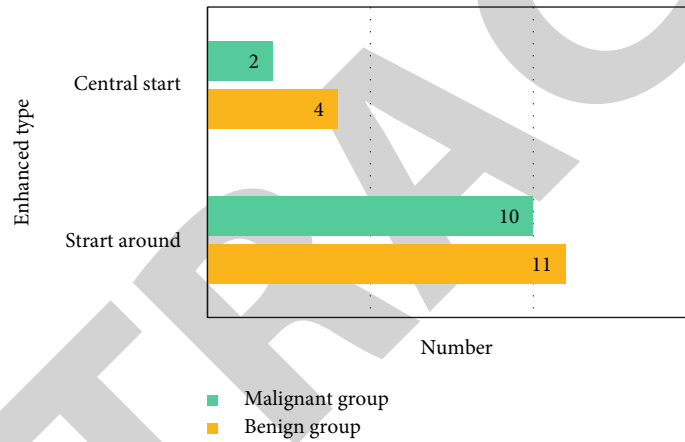


FIGURE 6: Comparison of initial enhancement type of lung lesions with benign and malignant pathological results.

TABLE 3: Comparison of contrast-enhanced ultrasound parameters between lesions and bile duct wall in the benign group.

Index	Lesion	Bile duct wall	<i>t</i> value	<i>p</i> value
Peak time	35.48 ± 4.88	35.96 ± 4.95	0.36	0.717
Area under the curve	486.62 ± 111.46	506.78 ± 129.88	0.62	0.541
Gradient	0.53 ± 0.09	0.55 ± 0.07	0.67	0.505

TTP, AUC, and grad between the lesion and the bile duct wall,  $p > 0.05$ .

4.1.3. *Conventional Ultrasonic Manifestations.* Table 4 shows the routine ultrasonographic manifestations of patients with peripheral pulmonary lesions. As can be seen from the data in the table, a total of 158 patients in the two groups presented unilateral single lesions. As can be seen from the data in the table, the ultrasonic manifestations of 111 patients out of 158 patients were hypoechoic, accounting for 70.25%, the ultrasonic manifestations of 37 patients were extremely hypoechoic, accounting for 23.42%, and the ultrasonic manifestations of mixed echogenicity were only 10 patients,

accounting for 6.33%. Figure 7 shows the conventional echogenicity of the patients under the comparison of pathological results. As can be seen from the data in the figure, among the 69 patients with benign lesions, 43 patients showed hypoechogenicity (62.32%), 20 patients showed extremely hypoechogenicity (28.99%), and 6 patients showed mixed echogenicity (8.70%). Among the 74 patients with malignant lesions, 57 (77.03%) presented low echo, 13 (17.57%) presented very low echo, and 4 (5.40%) presented mixed echo.

The time relationship between the arrival of contrast medium in 95 cases of peripheral lung lesions and adjacent lung tissues is shown in Figure 8. It can be seen from Figure 8 that the CEUS real-time comparative observation

TABLE 4: Conventional ultrasound manifestations of peripheral lung lesions.

Group	Pathological changes		Largest diameter (cm)	Echo (very low/low/mixed)
	Upper/lower	Upper/middle/lower leaf		
Experimental group ( <i>n</i> = 97)	16/29	25/3/24	5.65 ± 2.32	25/68/4
Control group ( <i>n</i> = 61)	6/17	16/1/21	5.72 ± 2.06	12/43/6

\*Data are based on the results of an experimental investigation.

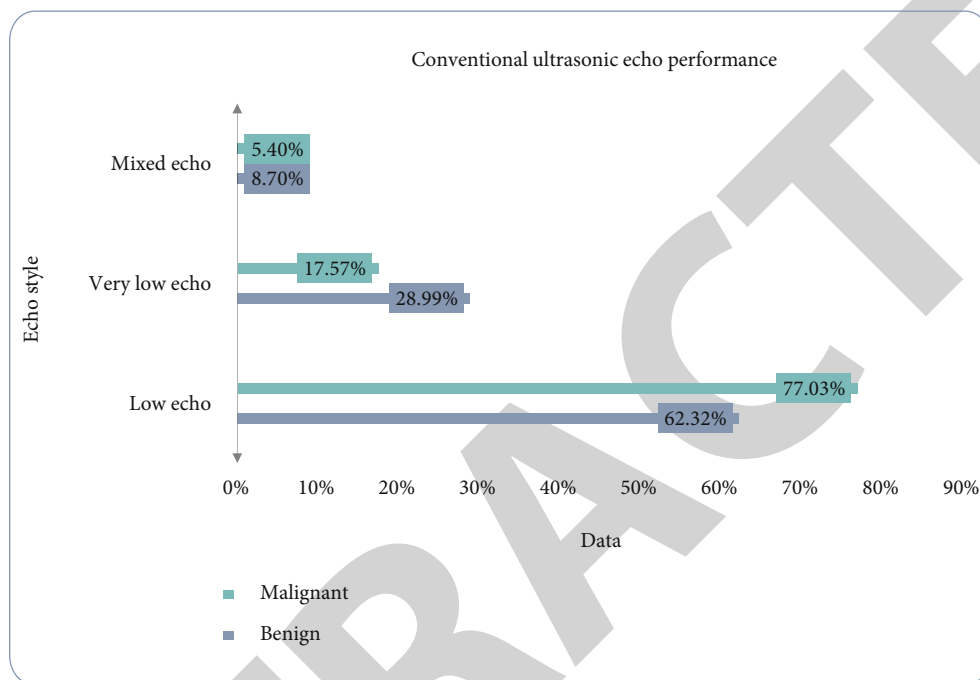


FIGURE 7: Pathological findings: routine echocardiography.

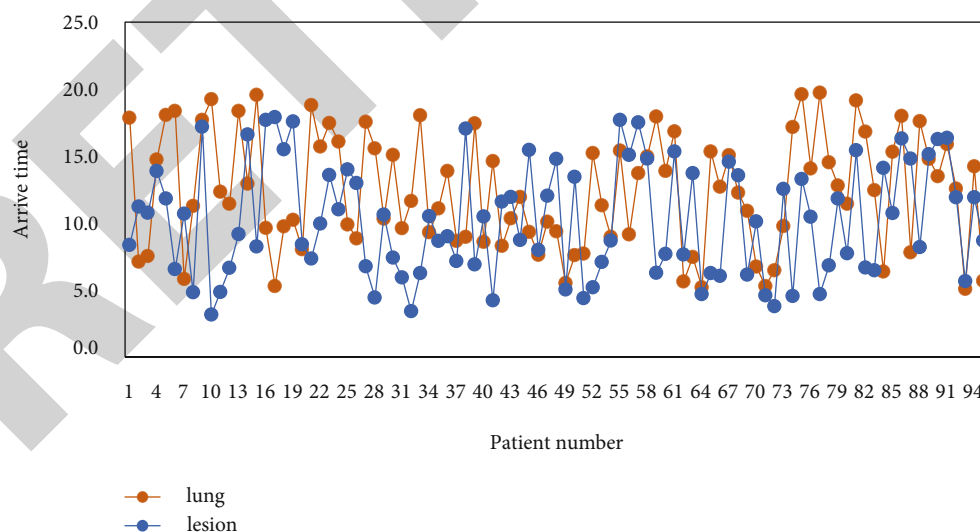


FIGURE 8: Time relationship of contrast medium reaching 95 cases of peripheral lung lesions and adjacent lung tissues.

method shows that the time curve of the contrast medium starting to reach the benign lesions is closer to the time curve of the normal lung tissue than that of the malignant lesions. The time of contrast medium reaching peripheral malignant lung lesions and the time difference between lesion and lung

tissue were significantly higher than those in peripheral benign lung lesions ( $p < 0.05$ ).

The comparison between the new diagnostic criteria and the traditional diagnostic criteria for differential diagnosis of peripheral lung lesions is shown in Table 5. The sensitivity,

TABLE 5: Comparison of new diagnostic criteria and traditional diagnostic criteria in differential diagnosis of peripheral pulmonary lesions.

Diagnosis method	Sensitivity	Specificity	Positive predictive value	Accuracy	Accuracy
Traditional diagnostic criteria	72.7%	82.5%	85.1%	68.7%	76.8%
New diagnostic criteria	96.4%	97.5%	98.1%	95.1%	96.8%

specificity, positive predictive value, and negative predictive value of the new CEUS real-time comparative observation diagnostic standard in differentiating benign and malignant peripheral pulmonary lesions were higher than those of the traditional CEUS initial increase time diagnostic standard. The diagnostic accuracy of the two diagnostic criteria was compared. Chi – square value = 5.621,  $p < 0.05$ . It shows that the new diagnostic standard is better than the traditional standard in the diagnosis of peripheral pulmonary diseases.

#### 4.1.4. CEUS Appearance and Quantitative Parameters.

Table 6 and Figure 9, respectively, show the experimental lung biopsy in patients with benign and malignant lung peripheral lesion TIC parameter comparison, and this group of patients with contrast-enhanced ultrasound enhancement combining data can be found in the chart; the experimental group of 97 patients had a clear diagnosis of 92 patients, patients had benign lesions of 40, ultrasound is homogeneous, and enhancement are nine patients with uneven enhancement of 31. There were a total of 52 patients with malignant lesions, 6 patients with uniform enhancement, and 46 patients with nonuniform enhancement. In addition, CEUS was used to collect and collate relevant quantitative parameters such as intensity curve, lesion ascent time, and peak reaching time, as shown in Table 2. As can be seen from the data in Table 2, compared with the benign group, the time-intensity curve, lesion ascent time, and peaking time of patients with malignant lesions were significantly longer. This characteristic of quantitative parameters can be used as an important basis for the evaluation of benign and malignant lesions around the lung.

The contrast-enhanced time of benign and malignant lesions of gallbladder is shown in Table 7. The comparison of contrast-enhanced ultrasound features of benign and malignant gallbladder lesions is shown in Table 8. Comparing the characteristics of contrast-enhanced ultrasound between the malignant group and the benign group, there were significant differences in the beginning enhancement time, enhancement regression time, peak regression time, enhancement start regression time, late enhancement level, enhancement mode, and capsule wall integrity between the two groups ( $p < 0.05$ ).

The comparison of quantitative parameters of contrast-enhanced tic curve between benign and malignant groups is shown in Table 9. AT in benign group was less than that in the malignant group, and there was a significant difference between the two groups ( $p < 0.05$ ). There was no significant difference in RT, TTP, IMAX, and RS between the two groups ( $p > 0.05$ ).

The comparison of the time and time difference between the arrival of contrast medium to lung lesions and adjacent lung tissues is shown in Table 10. The time AT2 of contrast

medium reaching lung lesions in the benign group was less than that in malignant group, and there was a significant difference between the two groups ( $p < 0.05$ ). The time difference  $\Delta$  at between the benign group and adjacent lung tissue was less than that in the malignant group, and there was a significant difference between the two groups ( $p < 0.001$ ).

The comparison of color blood flow signals of benign and malignant lesions between the control group and the experimental group is shown in Figure 10. According to the Adler semiquantitative method, the richness of color blood flow signals in lesions was divided into four grades. Most of the color blood flow signals in benign lesions were grade 0 or grade I, and most of the color blood flow signals in malignant lesions were grade I or grade II. The difference was statistically significant by Chi-square test.

## 4.2. Discussion

### 4.2.1. Quantitative Parameters of CEUS.

As mentioned above, the lungs contain two blood supply systems, the lung and the bronchial artery. Bronchial artery blood supply is the main category of pulmonary lesions, and pulmonary artery involvement in blood supply is relatively rare. Due to the different nature of the lesions, the distribution of blood flow is also different, and the changes of blood dynamics are also different. Therefore, the intensity curve of TIC time can be used to represent the hemodynamic condition inside the lesion. The enhancement of lesions after CEUS is closely related to the blood supply and other conditions. Benign and malignant lesions often have different anatomical structures and hemodynamic characteristics, which is an important pathophysiological basis for CEUS evaluation of benign and malignant lesions. The important basis for the diagnosis of benign and malignant lesions is the source of tumor blood supply, which can be diagnosed with the enhancement of lesion contrast. Some scholars have shown that the formation of blood vessels can reflect the whole process of tumor development. Based on neoplastic neovascularization, there is no middle smooth muscle in the blood vessels, only the presence of endothelial cells, and arteriovenous short circuits in the blood vessel bed are commonly produced. The distribution density and maturity of blood vessels can directly reflect the specific enhancement of the tumor. Based on the comprehensive action of many factors, the generation of tumor blood vessels needs a long and complicated process. In the process of generating tumor blood vessels, the growth factor contained in blood vessels plays a key role. This growth factor uses multiple types of pathways to act on the endothelial cells of blood vessels, which is conducive to enhancing the angiogenic activity and increasing the vascular permeability. The specific manifestations of

TABLE 6: Comparison of TIC parameters between benign and malignant peripheral lung lesions in the experimental group by lung biopsy.

Pathological change nature	RT (s)	TTP (s)	WIS (dB/s)	PI (dB)
Benign ( $n = 40$ )	$13.39 \pm 3.96$	$22.42 \pm 7.83$	$1.40 \pm 0.88$	$12.73 \pm 5.72$
Malignant ( $n = 52$ )	$11.34 \pm 1.76$	$18.90 \pm 5.17$	$1.92 \pm 0.59$	$15.40 \pm 2.96$

\*Data are based on the results of an experimental investigation.

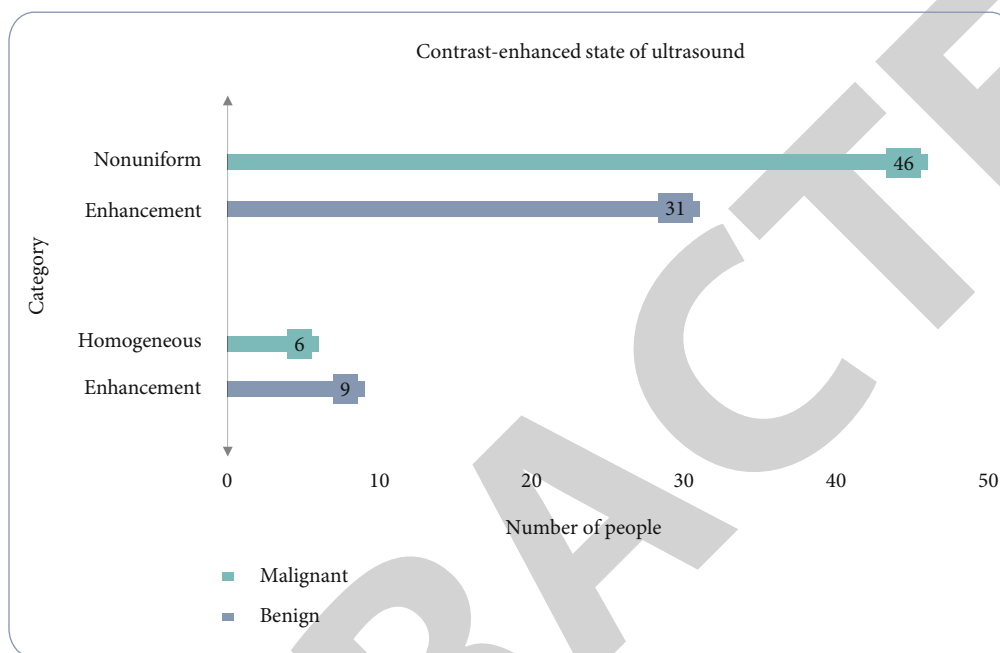


FIGURE 9: Enhancement of contrast-enhanced ultrasound in the experimental group.

TABLE 7: Contrast-enhanced time of benign and malignant lesions of gallbladder.

	Malignant lesions	Benign lesions	$t$ value	$p$ value
Initial increase time	$14.05 \pm 3.33$	$17.46 \pm 3.92$	-3.070	0.004
Peak time	$22.05 \pm 5.93$	$24.25 \pm 5.79$	-1.238	0.223
Fade time	$34.80 \pm 9.04$	$53.50 \pm 16.38$	-4.555	0.000
Beginning-Dafeng	$8.00 \pm 3.78$	$6.79 \pm 2.81$	1.214	0.232
Peak-recession	$12.75 \pm 5.42$	$29.25 \pm 17.71$	-4.007	0.000
Increase-decrease	$20.75 \pm 7.21$	$36.04 \pm 16.59$	-3.826	0.000

the amount of contrast agent retained inside the tumor and the number of blood vessels on the TIC time-strength curve indicate the specific enhancement of contrast agent. If the lesions around the lung are malignant, there will be more neovascularization inside the tumor, and the growth of neovascularization is disordered, with dilation and tortuosity as the main manifestations. The contrast agent filled a lot in the new blood vessel, and the enhancement was obvious.

In this study, CEUS was used to detect the lesions around the lung, and time-intensity curves were analyzed

from the acquisition of dynamic images, and relevant quantitative parameters were finally obtained. The specific trend of the time-intensity curve reflects the changes of the specific perfusion of contrast agent in the lesion with the development of time. Due to different blood flow distribution, the characteristics of blood perfusion in peripheral lung lesions are also different. Through regular changes on the time-intensity curve, the characteristics of perfusion in various types of lesions can be summarized, so as to provide valuable quantitative parameter information for the evaluation of benign and malignant peripheral lung lesions. The specific condition of blood supply per unit area determines the early phase transition of the time-intensity curve. The microcirculation structure inside the tumor determines the late changes of the time-strength curve.

**4.2.2. Evaluation and Discussion of Benign and Malignant Lesions.** The method of quantitative contrast-enhanced ultrasound combined with lung biopsy to evaluate peripheral lung lesions has been widely accepted by the medical community. But the ultimate success rate of lung biopsy is determined by the identification of active tissue within the lesion. CEUS can reflect the actual situation of microvascular perfusion and blood supply in the lesions. On the one hand, it can realize the effective differentiation of the nature of lesions; on the other hand, the implementation of CEUS

TABLE 8: Comparison of contrast-enhanced ultrasound features between benign and malignant lesions of gallbladder.

	Morphological characteristics	Malignant	Benign	$\chi^2$ value	$p$ value	
Enhancement level (early stage)	High enhancement	16	15	1.6	0.205	
	Equal enhancement	4	9			
	(late)	Low enhancement	17	7	13.7	0.000
		Equal enhancement	3	17		
Enhanced mode	Uneven	12	5	7.1	0.008	
	Evenly	8	19			
Gallbladder wall integrity	Discontinuous	14	4	12.8	0.000	
	Continuous	6	20			

TABLE 9: Comparison of quantitative parameters of contrast-enhanced ultrasound tic curve between benign and malignant groups.

Grouping	AT	RT	TTP	IMAX	RS
Benign group	$9.9 \pm 4.3$	$10.1 \pm 4.2$	$20.1 \pm 7.4$	$24.3 \pm 5.9$	$3.1 \pm 1.6$
Malignant group	$12.9 \pm 5.2$	$12.4 \pm 5.0$	$24.6 \pm 9.3$	$23.9 \pm 5.3$	$2.4 \pm 1.3$
$t$	2.203	1.775	1.918	0.238	1.717
$p$	0.032	0.082	0.061	0.813	0.093

TABLE 10: Comparison of time and time difference between contrast medium reaching lung lesions and adjacent lung tissues.

Contrast agent arrival time	Benign group	Malignant group	$t$	$p$
AT1	$8.8 \pm 3.4$	$9.8 \pm 5.1$	0.851	0.399
AT2	$10.6 \pm 4.1$	$13.7 \pm 5.8$	2.171	0.035
$\Delta AT$	$1.8 \pm 1.4$	$3.9 \pm 1.6$	4.734	<0.001

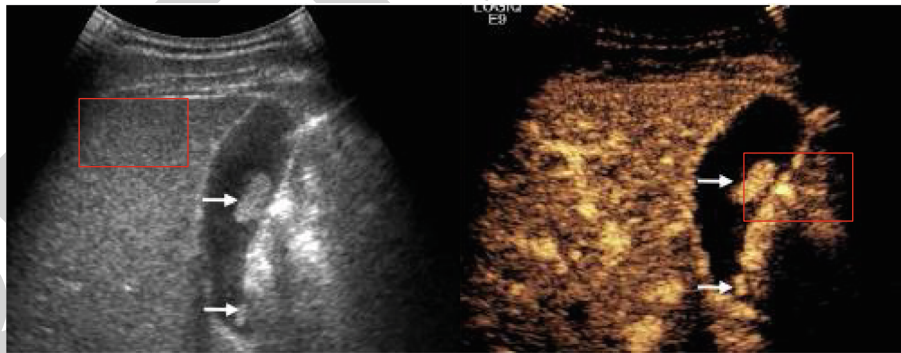


FIGURE 10: Comparison of color blood flow signals of benign and malignant lesions between the control group and the experimental group.

before lung biopsy can promote the continuous improvement of the success rate of lung biopsy.

As lung tissues filled with gas are normal, strong echo is the image manifestation of normal lungs. When local lesions occur in lungs, low or very low echo is the main ultrasonic manifestation of lungs to increase the acoustic impedance difference between lungs and surrounding tissues. If a small amount of gas is present inside the lesion, mixed echogenicity is the sonographic manifestation. The results of this study show that there is little difference between the echogenicity of lesions in benign and malignant African lesions, which is consistent with the previous results obtained by scholars. The lungs contain two blood

supply systems, the bronchus and the pulmonary artery. Based on hemodynamic factors, when CEUS is used, the pulmonary artery blood supply increases relatively early compared to the location of the bronchial artery blood supply. Some scholars' studies have shown that most of the blood supply of malignant pulmonary lesions comes from bronchial artery and its branches, while the blood supply of benign pulmonary lesions mainly comes from pulmonary artery. The TIC results in this study showed that compared with benign peripheral lung lesions, the RT of malignant lesions was significantly smaller, but its WIS and PI were significantly larger. The reason for this phenomenon is that the bronchial artery stage is usually



the beginning stage of malignant pulmonary lesions, and the pulmonary artery stage is the intensification stage of pneumonia lesions. Compared with benign lesions, although malignant pulmonary lesions began to strengthen relatively late, arteriovenous fistulas and malignant pulmonary lesions were present, and new blood vessels also had winding and disordered arrangement, which made the contrast agent rapidly spread and reached its peak after entering the pulmonary lesion. Therefore, compared with benign lesions, TIC of malignant pulmonary lesions rises faster and has a relatively high peak value, that is, RT value is small, and WIS and PI value is larger than benign lesions, which is consistent with the previous conclusion. In addition, uneven enhancement was the main manifestation of lesions in the experimental group, with 77.50% benign lesions and 88.46% malignant lesions. The main reason for this difference was the different distribution of microvessels in the lesions. Malignant pulmonary disease will breed new blood vessels inside, increasing the overall density and distribution of microvessels. When the supply of nutrients cannot meet the needs of the lungs, necrosis may occur inside, which is reflected in the uneven enhancement of the quantitative parameters of contrast-enhanced ultrasound. In benign pulmonary disease, due to changes in blood flow dynamics, vascular permeability will be improved to a certain extent, resulting in tissue necrosis, which is also reflected in uneven enhancement of CEUS quantitative parameters.

Some scholars' research results show that the probability of lung biopsy sampling failing to achieve the diagnosis of lesions is between 5% and 15%. And as the area of the lesion expands, the probability of pulmonary tissue necrosis will also increase. Therefore, the key to improve the diagnostic accuracy of pulmonary lesions lies in the effective development and guidance of the active biological tissues inside the lesions. The experimental study in this paper analyzed the application value of CEUS quantitative parameters combined with lung biopsy in the assessment of peripheral pulmonary benign and malignant. It was found that compared with the control group, the probability of final diagnosis of ocean phase in the experimental group was significantly higher, with an increase of about 11%. This indicates that CEUS can be used to clarify the internal blood supply status of the lesion, effectively guide the location and path of lung biopsy, prevent the deviation of sampling location of lung biopsy, and promote the continuous improvement of the diagnostic accuracy of pulmonary disease. Conventional ultrasonic testing cannot reflect the status of microcirculation perfusion and cannot correctly determine the extent of tissue necrosis. The size of the lesion and the extent of tissue necrosis directly affect the accuracy of lung biopsy diagnosis. In the present study, there were 5 cases of nonqualitative lung biopsy in the experimental group and 10 cases in the control group. Therefore, we can conclude that CEUS quantitative parameters combined with lung biopsy can effectively distinguish the activity of lung lesions and the location of necrosis and promote the effective improvement of the positive rate of lung biopsy.

To sum up, the application of CEUS in the diagnosis of peripheral pulmonary diseases and quantitative analysis can realize the rapid acquisition of effective information of peripheral pulmonary diseases, especially in the guidance of lung biopsy. Its application deepens the medical research on peripheral pulmonary diseases. Contrastive ultrasound can clearly show the slow flow rate of blood in small blood vessels, which can effectively make up for the color Doppler technology. The main characteristic of this technology is to display the distribution of small blood vessels clearly. At the early stage, the perfusion characteristics of ultrasound contrast agent provide a reference for the evaluation of benign and malignant peripheral pulmonary lesions. Through CEUS, the time-intensity curve analysis is carried out to obtain sufficient quantitative information. However, due to the small number of samples studied in this paper, it may not be possible to fully excavate the available information, so it is necessary to expand the sample size and carry out more in-depth research in future research experiments.

## 5. Conclusion

Influenced by many factors such as living habits, the incidence of lung diseases, especially malignant diseases, is increasing year by year. In order to achieve effective treatment of pulmonary diseases, it is necessary to accurately assess the benign and malignant properties of peripheral pulmonary lesions. Based on contrastive analysis experiments, the author explored the role of CEUS quantitative parameters combined with lung biopsy in the evaluation of benign and malignant peripheral pulmonary lesions. Through the study, the author finally reached the following conclusions:

- (1) In this study, CEUS was used to detect the lesions around the lung, and time-intensity curves were analyzed from the acquisition of dynamic images, and finally, relevant quantitative parameters were obtained. These quantitative parameters provided an important reference for the evaluation of benign and malignant lesions
- (2) The combination of quantitative parameters of CEUS with lung biopsy can effectively distinguish the activity of lung lesions and the location of necrosis and promote the effective improvement of the positive rate of lung biopsy, which indicates that this diagnosis method is scientific and effective in the assessment of peripheral pulmonary benign and malignant

## Data Availability

This article does not cover data research. No data were used to support this study.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

## Acknowledgments

This study is supported by the Fundamental Research Funds of Heilongjiang Provincial Universities in 2020 (2020-KYYWF-0017).

## References

- [1] A. Biswas, H. J. Mehta, and P. S. Sriram, "Diagnostic yield of the virtual bronchoscopic navigation system guided sampling of peripheral lung lesions using ultrathin bronchoscope and protected bronchial brush," *Turkish Thoracic Journal/türk Toraks Dergisi*, vol. 20, no. 1, pp. 6–11, 2019.
- [2] A. L. Wangüemert Pérez, H. González Expósito, and L. Pascual Fernández, "Valoracion de la sedacion con midazolam en las punciones pulmonares perifericas dirigidas por ecografia toracica," *Archivos de Bronconeumología*, vol. 54, no. 6, pp. 342–343, 2018.
- [3] M. Kamimura, Y. Takeda, K. Furihata et al., "Bronchoscopic examination with body-surface ultrasound guidance for diagnosing peripheral lung lesions," *Annals of Cancer Research & Therapy*, vol. 26, no. 1, pp. 11–16, 2018.
- [4] M. Soliman, F. Neemuchwala, A. Sankar et al., "Multiple cavitary lung lesions in an adolescent: case report of a rare presentation of nodular lymphocyte predominant Hodgkin lymphoma," *Journal of Pediatric Hematology/Oncology*, vol. 40, no. 7, pp. e454–e457, 2018.
- [5] S. B. Mena, M. Torky, C. C. Clemente et al., "P2.05-15 radial endobronchial ultrasound-guided transbronchial biopsy in peripheral lung lesions. What can cryobiopsy contribute?," *Journal of Thoracic Oncology*, vol. 14, no. 10, p. S753, 2019.
- [6] J. S. Eom, J. H. Mok, I. Kim et al., "Radial probe endobronchial ultrasound using a guide sheath for peripheral lung lesions in beginners," *BMC Pulmonary Medicine*, vol. 18, no. 1, p. 137, 2018.
- [7] Srinivasa K G, Sowmya BJ, A. Shikhar, R. Utkarsha, and A. Singh, "Data analytics assisted Internet of Things towards building intelligent healthcare monitoring systems: Iot for healthcare," *Journal of Organizational and End User Computing*, vol. 30, no. 4, pp. 83–103, 2018.
- [8] T. S. Panchabhai, S. B. Roy, N. Madan et al., "Electromagnetic navigational bronchoscopy for diagnosing peripheral lung lesions in lung transplant recipients: a single-center experience," *Journal of Thoracic Disease*, vol. 10, no. 8, pp. 5108–5114, 2018.
- [9] M. Elhoseny and K. Shankar, "Optimal bilateral filter and convolutional neural network based denoising method of medical image measurements," *Measurement*, vol. 143, pp. 125–135, 2019.
- [10] A. Majid, A. Palkar, and F. Kheir, "Convex probe EBUS-guided fiducial placement for malignant central lung lesions," *Journal of Bronchology & Interventional Pulmonology*, vol. 25, no. 4, p. 1, 2018.
- [11] S. Nasu, N. Okamoto, H. Suzuki et al., "Comparison of the utilities of cryobiopsy and forceps biopsy for peripheral lung cancer," *Anticancer Research*, vol. 39, no. 10, pp. 5683–5688, 2019.
- [12] S. Lachkar, F. Guisier, M. Roger et al., "Assessment of per-endoscopic placement of fiducial gold markers for small peripheral lung nodules <20 mm before stereotactic radiation therapy," *Chest*, vol. 153, no. 2, pp. 387–394, 2018.
- [13] Z. Lv and L. Qiao, "Analysis of healthcare big data," *Future Generation Computer Systems*, vol. 109, pp. 103–110, 2020.
- [14] K. Harris, D. J. Rohrbach, K. Attwood, J. Qiu, and U. Sunar, "Optical imaging of tissue obtained by transbronchial biopsies of peripheral lung lesions," *Journal of Thoracic Disease*, vol. 9, no. 5, pp. 1386–1392, 2017.
- [15] L. Borjigin, T. Shimazu, Y. Katayama et al., "Immunogenic properties and mycoplasmal pneumonia of swine (MPS) lung lesions in large white pigs selected for higher peripheral blood immune capacity," *Animal Ence Journal*, vol. 87, no. 5, pp. 638–645, 2016.