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Diagnostic Value and Safety of CT and US-Guided PTNB for Peripheral Pulmonary Lesions: A Meta-Analysis and Clinical Study

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Abstract

Objective: To evaluate the diagnostic value and safety of CT and ultrasound-guided PTNB for peripheral type of occupying lung lesions by meta-analysis and clinical study. **Methods**: 1) The target data of randomized controlled trials of CT and ultrasound-guided PTNB for peripheral type of occupying lung lesions were extracted by computer search of foreign PubMed, Embase, the Cochrane Library, Web of Science databases, since the establishment of the database. Cochrane quality assessment criteria were used for evaluation. Statistical analysis was performed using Review Manager 5.3 software. 2) To retrospectively study the diagnosis rate and complication rate of patients, undergoing CT or ultrasound-guided PTNB in the First Affiliated Hospital of Dali University from January 2015 to December 2020. **Results**: Meta-analysis included 7 papers with a total of 1177 patients including 502 patients in the ultrasound group and 675 patients in the CT group. Meta-analysis results showed that there was no difference in the diagnosis rate of PTNB guided by ultrasound and CT. The incidence of postoperative complications was higher in the CT group than in the ultrasound group. The incidence of postoperative pneumothorax was higher in the CT group than in the ultrasound group, and there was no difference in the incidence of postoperative bleeding. 3) Clinical study results show that the puncture success rate was 100% in both of the ultrasound and CT groups, the pathological diagnosis rate was 85.48% in the ultrasound group and 91.67% in the CT group, and there was no difference in the overall complication rate between the two puncture groups. **Conclusion**: Either ultrasound or CT-guided PTNB is a safe and effective clinical diagnostic method for the diagnosis of peripheral pulmonary occupations.

Keywords

Ultrasound, Computed Tomography, Percutaneous Lung Biopsy, Meta-Analysis, Retrospective Study

1. Introduction

The early stage of lung cancer mostly appears in the form of lung nodules, which are not clinically obvious and have a high underdiagnosis rate, and the extensive local invasiveness and distant metastasis are the reasons for the poor prognosis of lung cancer, therefore, early detection and diagnosis are important for the treatment of the disease [1] [2]. With the widespread use of low-dose computed tomography (LDCT) for lung cancer screening, the detection of peripheral pulmonary lesions (PPL) is increasing, and LDCT in high-risk groups can reduce the mortality rate of lung cancer by 20% [3] [4] [5]. Currently, pathological diagnosis is still the gold standard for lung cancer diagnosis, and more specimens are needed to evaluate targeted therapies based on the latest advances in EGFR, ROS1, gene PD-1 and other current lung cancer targeted therapies and immunotherapy. Surgical biopsy is a reliable method for diagnosing malignant disease and obtaining a sufficient volume of sample tissue, but the method is invasive. Bronchoscopy although a safe diagnostic method, has a rather low diagnostic yield for peri-pulmonary type lesions, with rates ranging from 46% to 88% [6] [7] [8] [9]. Percutaneous transthoracic needle biopsy (PTNB) is now an effective and safe minimally invasive technique for obtaining tissue samples from intrathoracic lesions, with ultrasound and CT being the two commonly used imaging-guided modalities [10]. The method is mainly used for peripheral lung lesions and pleural biopsies as well as central lung lesions, where pathological specimens cannot be obtained by bronchoscopy. Percutaneous lung biopsy provides tissue samples for diagnosis and staging and helps to differentiate primary cancer from distant metastatic or infectious lesions, which is essential for the proper treatment of lung lesions [11]. Percutaneous lung biopsy is also used to obtain tissue samples for genetic and immunological testing for cancer mutations, which can be used to determine radiotherapy regimens for patients undergoing targeted chemotherapy and to personalise treatments [12]. This technique is widely accepted and trusted, and previous studies have shown that percutaneous lung aspiration biopsy has a diagnostic efficacy of 98% for peripheral lung lesions, with a low complication rate, the technique has been accepted and trusted [13] [14].

There are two types of percutaneous lung puncture biopsy techniques, ultrasound and CT guidance, and the most common studies at home and abroad have mainly focused on single imaging-guided puncture, while relatively few studies have compared the two, and the small sample sizes of previous studies have been less convincing. This study will provide more scientific evidence on

the evidence on the early detection, diagnosis and treatment of peri-pulmonary lung cancer, mainly through meta-analysis and combined with clinical case studies.

2. Meta-Analysis of the Diagnostic Value and Safety of CT and US-Guided PTNB for Peripheral Pulmonary Space-Occupying Lesions

2.1. Literature Search Strategy

The computerized search was conducted for literature published in PubMed, Embase, The Cochrane Library, and Web of Science databases, since the establishment of the database, and the language of the literature was restricted to English. The search terms were ultrasound (US) computed tomography (CT) biopsy peripheral pulmonary lesions and ercutaneous lesions peripheral pulmonary lesions peripheral pulmonary nodules etc. The search terms took the form of mutual combinations of subject words and free words. The boolean logical operators AND, OR, and NOT were used for the combined search and adjusted accordingly to different databases, while all references included in the literature were checked and supplemented by manual search, in order to search all relevant literature as comprehensively as possible.

2.2. Data Extraction

Data extraction requires the participation of at least two researchers who read and screen the included literature according to the established inclusion and exclusion criteria respectively. The researchers then cross-check the screening results with each other. In case of disagreement, a consensus decision is made and the required data are entered into a pre-designed form. The main data extracted included the time of publication of the first author the characteristics of the study population (including number of cases gender age), and the outcome indicators of the intervention.

2.3. Evaluation of the Quality of the Literature

The risk of bias was assessed using the Cochrane Collaboration Network Evaluation of Risk of Bias tool, including randomized methods, allocation concealment, blinding, selective reporting bias, other bias, and completeness of data. A schematic diagram of the methodological quality assessment of the literature and the percentage of each quality assessment item were plotted using RevMan 5.3 software.

2.4. Publication Bias

A funnel plot was drawn using Review Manager 5.3 software and the risk of publication bias was considered to be low when the literature was roughly at the top of the funnel plot, and high when the literature was asymmetrically distributed or mostly at the bottom of the funnel plot.

2.5. Sensitivity Analysis

Included studies were removed one by one, and the change in effect values and heterogeneity before and after removal was observed to assess, whether each study would have an effect on the overall results. A study was considered heterogeneous if the heterogeneity changed after deletion of a study and the combined effect values remained statistically significant. The source of heterogeneity needs to be further analyzed, such as the sample size, the accuracy of the original data included in the study, the correct method of data extraction etc. If the combined effect values and changes in heterogeneity are not significant after item-by-item deletion, then it is said that the results of the study are reliable and robust.

2.6. Statistical Analysis

Meta-analysis was performed using RevMan 5.3 software. Risk Ratio (RR) and its 95% Confidence Interval (95% CI) were used as effect analysis statistics for categorical data, and Mean Deviation (MD) or Standardized Mean Difference (SMD) and its 95% CI were used as effect analysis statistics for quantitative data. Difference (MD) or standardized mean difference (SMD) and its 95% CI were used as effect analysis statistics for quantitative data. Heterogeneity between the results of the included studies was analysed using the Q test (test level set at α = 0.1) and the I^2 value. Higgins JP [15] *et al.* classified heterogeneity into three levels low medium and high, which were expressed as 25%, 50% and 75% of the I^2 value respectively. In the Cochrane systematic evaluation, as long as the I^2 value was not greater than 50%, the heterogeneity was acceptable. If $P > 0.05$ and $I^2 < 50\%$, there was no statistical heterogeneity among the studies, and after excluding the effect of significant clinical heterogeneity, a fixed-effects model was used for analysis, if $P \leq 0.05$ and $I^2 \geq 50\%$, there was statistical heterogeneity among the studies, and a random-effects model was used for analysis. The test level for meta-analysis was set at $\alpha = 0.05$.

3. Results

3.1. Literature Screening Results

A total of 362 documents were detected through the aforementioned search strategy, and 8 relevant documents were obtained by manual search, 280 relevant documents were obtained after manual removal of duplicates by the literature management software, 16 relevant documents were obtained after further reading of the titles and abstracts and excluding irrelevant documents such as case reports. Meta-analyses and reviews, these 16 documents were then read in full text and excluded from the study after further reading of the titles and abstracts, 16 relevant papers were obtained after excluding case reports, meta-analyses, reviews and other irrelevant literature [16]-[21]. The flow chart is shown in **Figure 1**.

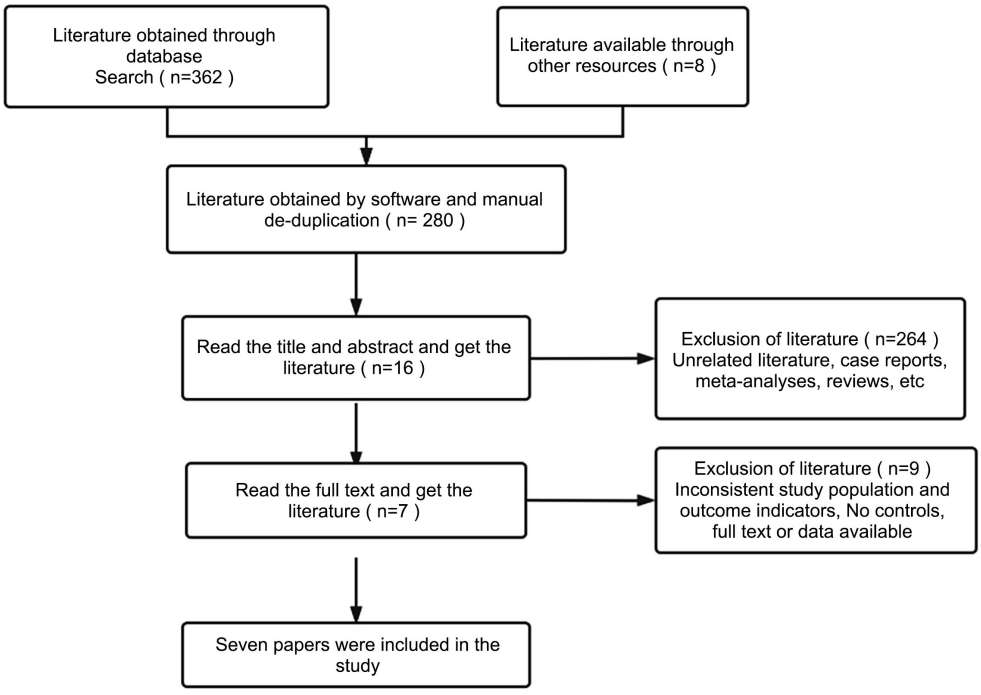

Figure 1. Flow chart of literature screening.

3.2. Basic Characteristics of the Included Literature

Seven randomised controlled trials with a total of 1177 patients were included in this study, including 502 patients in the ultrasound group and 675 patients in the CT group, the basic characteristics are shown in **Table 1**.

3.3. Methodological Assessment of the Included Literature

All included literature was assessed for risk bias according to the quality assessment methods for RCT literature provided in the Cochrane Handbook. See **Figure 2** for + for met, - for not met, and ? for unclear. The results suggest that most of the included literature was at low risk of bias, one literature indicated a high risk of assigning hidden methods and 5 did not explicitly state a specific allocation concealment method. One literature indicated a high risk of allocation concealment and five did not specify the specific allocation concealment method, three failed to specify the blinding method. All included literature had complete data results and no selective publication, 2 may have other biases [17] [18] [19] [20] [21]. The percentage of items included in the methodological assessment of the literature is shown in **Figure 3**.

3.4. Meta-Analysis Results

3.4.1. Forest Plot of Diagnostic Rates

All seven papers gave data on the rate of puncture diagnosis [16]-[21], with the rate of puncture diagnosis calculated for the ultrasound and CT groups, P = 0.02, I^2 = 60%, with some heterogeneity. A random effects model was used for the combined analysis and the meta-analysis showed no statistically significant

difference in puncture diagnosis rates between the two groups (RR = 1.03, 95% CI [0.99, 1.07], Z = 1.33, P = 0.18).See Figure 4 for details.

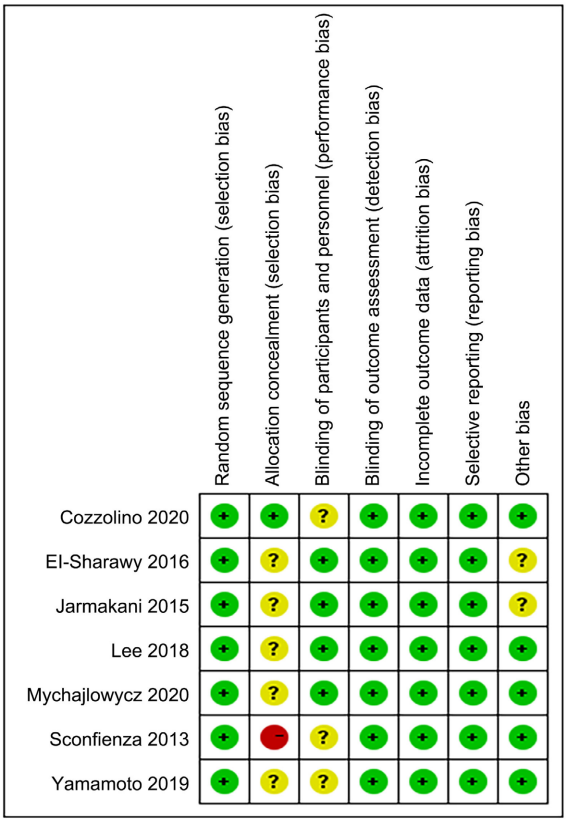

Figure 2. Methodological quality assessment of the included literature.

Table 1. Basic characteristics of the included literature.

Author	Year	Type of study	Number of cases (m/f)		Number of diagnoses		Complications of pneumothorax		Bleeding complications	
			Ultrasound group	CT Group	Ultrasound group	CT Group	Ultrasound group	CT Group	Ultrasound group	CT Group
Cozzolino	2020	Randomized control	28/12	28/12	38	39	1	9	2	4
El-Sharawy	2016	Randomized control	35/15	34/16	44	45	2	3	2	3
Jarmakani	2015	Randomized control	32/23	87/43	54	113	1	7	0	0
Lee	2018	Randomized control	78/72	60/40	147	93	10	21	0	0
Mychajlowycz	2020	Randomized control	22/21	54/61	42	114	5	17	1	8
Sconfienza	2013	Randomized control	44/59	71/99	100	164	6	25	1	2
Yamamoto	2019	Randomized control	49/12	54/16	57	59	0	12	2	5

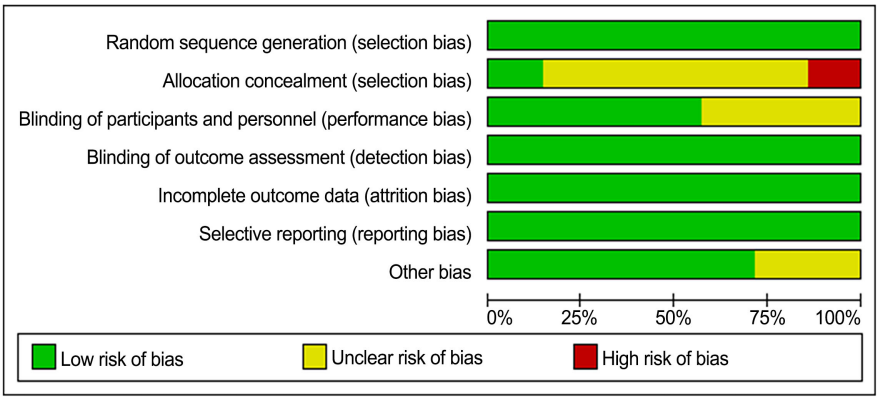

Figure 3. Percentage of items included in the methodological quality assessment of the literature.

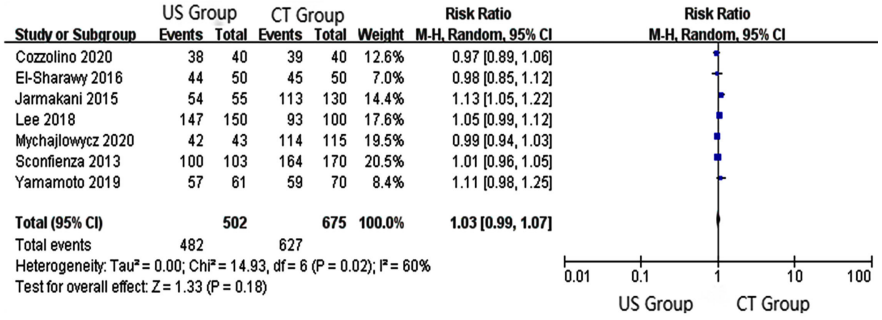

Figure 4. Diagnostic yield of CT and ultrasound-guided PTNB for peripulmonary space-occupying lesions.

3.4.2. Sensitivity Analysis of Diagnostic Rates

Sensitivity analysis was performed on the seven included papers due to the large variation in the included literature. By excluding one literature at a time, it was found that after excluding the Jarmakani group of the studies was significantly less heterogeneous, the results P = 0.22, I^2 = 29%, RR = 1.01, 95% CI [0.98, 1.05], Z = 0.69, P = 0.49, the conclusion was the same as the original results, therefore the meta-analysis of puncture diagnostic rates was more credible. See **Figure 5** for details.

3.4.3. Overall Complication Forest Map

All seven papers reported in detail on the complications studied [18] [19] [20] [21], mainly including data on the occurrence of haemorrhage and pneumothorax, none mentioned serious complications such as air embolism and death. The overall complication rate after puncture was used as a calculation, P = 0.48, I^2 = 0% and there was no heterogeneity in the included literature. A fixed effects model was used for the combined analysis and the results of the meta-analysis showed a statistically significant difference suggesting a total complication rate between the two groups (RR = 0.37, 95% CI [0.25, 0.53], Z = 5.36, P < 0.00001), indicating that the CT group had a higher postoperative complication rate than the ultrasound group. See **Figure 6** for details.

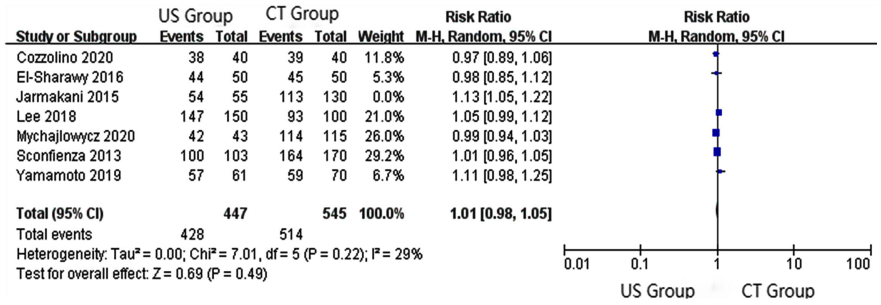

Figure 5. Diagnostic rates after excluding data from the Jarmakani group.

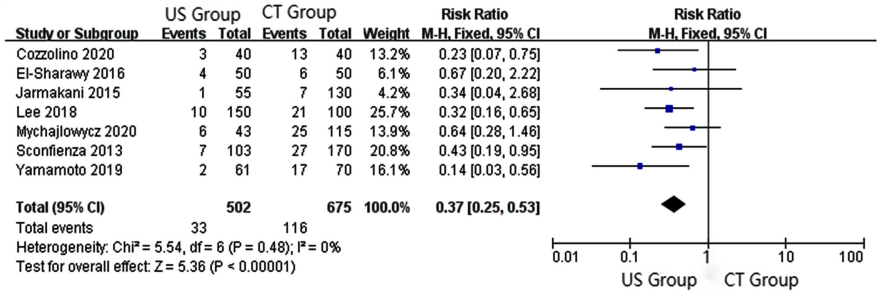

Figure 6. Total complication rate.

3.4.4. Forest Chart of Pneumothorax Complications

Pneumothorax was reported in all seven included papers [19] [20] [21], and most pneumothoraxes were self-resorbing, with only a minority of patients requiring postoperative closed chest drainage, the incidence of pneumothorax was used as a calculation, P = 0.33, I^2 = 14% and there was no heterogeneity in the included literature. A fixed-effects model was used for the combined analysis and the results of the meta-analysis showed a statistically significant difference suggesting the incidence of pneumothorax between the two groups (RR = 0.34, 95% CI [0.22, 0.52], Z = 5.04, P < 0.00001), indicating that the incidence of postoperative pneumothorax was higher in the CT group than in the ultrasound group. See **Figure 7** for details.

3.4.5. Forest Chart of Bleeding Complications

Bleeding was not reported in only two of the seven included papers [20] [21], while the rest experienced bleeding, using the incidence of bleeding as the calculation index, P = 0.98, I^2 = 0%, there was no heterogeneity in the included papers. A fixed-effects model was used for the combined analysis, and meta-analysis showed no statistically significant difference in the incidence of bleeding between the two groups (RR = 0.50, 95% CI [0.22, 1.14], Z = 1.65, P = 0.10), and the incidence of bleeding after puncture was similar in both groups. See **Figure 8** for details.

3.4.6. Publication Bias Analysis

As shown, no significant bias was observed after funnel plot analysis of the included studies. See **Figure 9** for details.

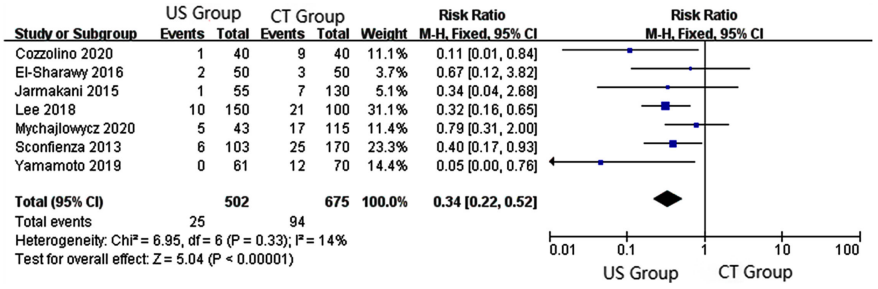

Figure 7. Incidence of pneumothorax.

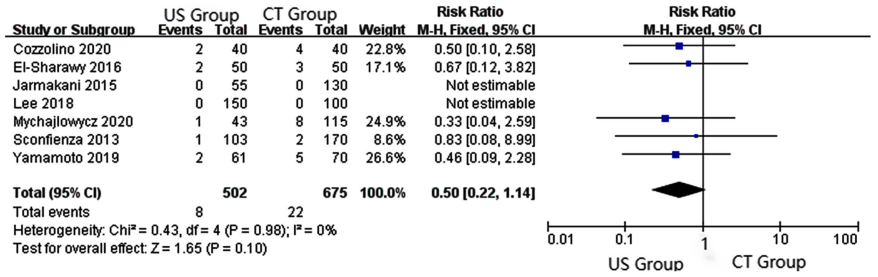

Figure 8. Incidence of haemorrhage.

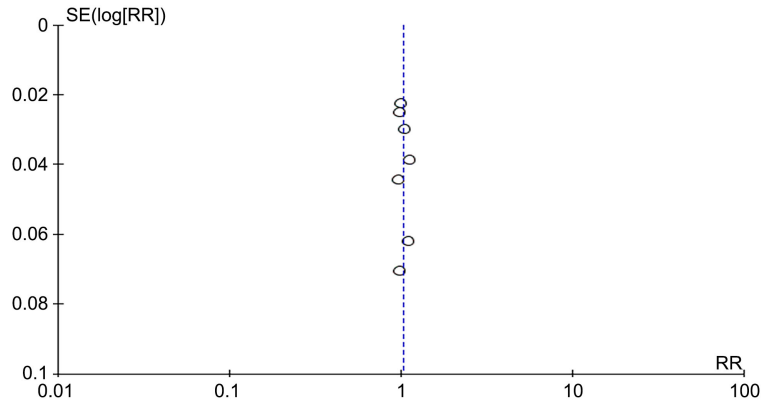

Figure 9. Funnel plot of puncture diagnostic rates.

4. Clinical Study on the Diagnostic Value and Safety of CT and US-Guided PTNB for Peripheral Pulmonary Space-Occupying Lesions

4.1. Research Content and Research Methodology

We retrospectively analyzed the general data, post-puncture complications, and pathological data of puncture materials of 110 patients to understand the diagnostic value and complications of ultrasound and CT-guided PTNB for peripheral type of occupying lung lesions.

4.2. Statistical Methods

All data were collated and analysed by the statistical software SPSS 26.0. The measurement data, expressed as mean ± standard deviation ($\overline{X} \pm S$), and count data were mainly expressed as composition ratio, count data were mainly based

on the magnitude of theoretical numbers. Pearson chi-square test, continuity-corrected chi-square test and fisher's exact probability method test were used. All tests were performed at $\alpha = 0.05$, and differences were considered statistically significant at $P < 0.05$.

5. Results

5.1. Puncture Success Rate and Complications

In both groups, percutaneous lung puncture was successful and the material was retrieved with a 100% puncture success rate.

Among the 110 patients, the overall complication rate in the ultrasound-guided group was 4.8%, including 3 (4.8%) cases of pneumothorax and no bleeding, the overall incidence in the CT-guided group was 16.7%, including 5 (10.4%) cases of pneumothorax and 3 (6.3%) cases of bleeding, none of the patients had serious complications, and the compressed lung area of all pneumothorax patients was less than 10%, and most of the bleeding was a small amount of blood in the sputum, no special treatment was required, and the symptoms basically improved after bed rest and oxygenation. None of the patients suffered from respiratory distress or death due to air embolism. There was no statistically significant difference between the two puncture groups in terms of overall complication rate ($\chi^2 = 2.994$, $P = 0.084 > 0.05$), incidence of pneumothorax ($\chi^2 = 0.558$, $P = 0.455 > 0.05$) and incidence of bleeding ($\chi^2 = 1.976$, $P = 0.160 > 0.05$). See Table 2.

5.2. Characteristics of Mass Distribution and Puncture Pathology Findings in the Study Population

In this study, the maximum diameter of the lung masses in the ultrasound-guided group was 5.14 ± 1.78 cm, with 28 right lung lesions and 34 left lung lesions. The maximum diameter of the lung mass in the group receiving CT guidance was 4.69 ± 1.84 cm, with 22 left lung lesions and 34 right lung lesions, there was no statistically significant difference between the diameter of the lesion ($P = 0.790 > 0.05$) and the location of the lesion ($P = 0.621 > 0.05$).

A total of 53 cases of ultrasound-guided PTNB were diagnosed, with a clear diagnosis rate of 85.48%, including 34 cases of malignant lesions, including 16 cases of adenocarcinoma of the lung, 13 cases of squamous lung cancer, 1 case of small cell lung cancer, 1 case of other types of lung cancer, 2 cases of metastatic cancer and 1 case of T-lymphoblastic lymphoma, 19 cases of benign lesions, including 7 cases of mechanized pneumonia, 7 cases of tuberculosis, 3 cases of pneumonia, 1 case of neurofibroma and 1 case of inflammatory, a total of 44 cases of CT-guided PTNB were diagnosed, with a clear diagnosis rate of 91.67%, including 30 cases of malignant lesions, including 19 cases of adenocarcinoma of the lung, 4 cases of squamous lung cancer, 4 cases of small cell lung cancer, 1 case of other types of lung cancer and 2 cases of metastatic cancer, 14 cases of benign lesions, including 3 cases of mechanized pneumonia, 6 cases of tubercu-

losis, 3 cases of pneumonia, 1 case of neurofibroma and 1 case of adenoma. There was no statistically significant difference in the rate of puncture pathology diagnosis between these two groups ($\chi^2 = 0.992$, P = 0.319 > 0.05).

Thirteen of the 110 patients still did not receive a definitive pathological diagnosis after PTNB examination, nine in the ultrasound group and four in the CT group, these patients were subsequently perfected with bronchial transcranial examination and pathological specimens were taken, and one case of adenocarcinoma of the lung and four cases of squamous carcinoma of the lung were diagnosed by pathology. See Table 3 for details.

Table 2. Incidence of complications with the two guidance methods.

	Ultrasound group	CT Group	*c*2	P-value
Total complications	3 (4.8)	8 (16.7)	2.994	0.084
Pneumothorax	3 (4.8)	5 (10.4)	0.558	0.455
Bleeding	0	3 (6.3)	1.976	0.160

Table 3. Specific puncture and pathology results.

Features	Ultrasound group (n = 62)	CT group (n = 48)
Longest diameter of lesion (cm)	5.14 ± 1.78	4.69 ± 1.84
Lesion location		
Left lung	28 (45.2)	22 (45.8)
Right lung	36 (54.8)	34 (54.2)
Pathological diagnosis of lesions		
Malignant lesions		
Adenocarcinoma	16 (25.8)	19 (39.6)
Squamous carcinoma	13 (20.1)	4 (8.3)
Small cell carcinoma	1 (1.6)	4 (8.3)
Other types of cancer	1 (1.6)	1 (2.1)
Metastatic cancer	2 (3.2)	2 (4.2)
T-lymphoblastic lymphoma	1 (1.6)	0 (0.0)
Benign lesions		
Mechanized pneumonia	7 (11.3)	3 (6.3)
Tuberculosis	7 (11.3)	6 (12.5)
Pneumonia	3 (4.8)	3 (6.3)
Neurofibroma	1 (1.6)	0 (0.0)
Pulmonary fungal infections	0 (0.0)	1 (2.1)
Inflammatory pseudotumour	1 (1.6)	0 (0.0)
Adenoma	0 (0.0)	1 (2.1)
Unspecified nature	9 (14.5)	4 (8.3)

6. Discussion

Seven studies were included in this study, which compared the diagnostic value and safety of the two imaging-guided modalities, this meta-analysis study showed that all included studies had 100% puncture success, and the difference between the two diagnostic rates [RR = 1.03, 95% CI [0.99, 1.07], P = 0.18] was not statistically significant, indicating that ultrasound and CT-guided PTNB are effective and feasible for peripheral pulmonary space-occupying lesions are both effective and feasible. In terms of safety, meta-analysis showed no statistically significant difference in complication rates for bleeding (RR = 0.50, 95% CI [0.22, 1.14], P = 0.10), overall complication rates (RR = 0.37, 95% CI [0.25, 0.53], P < 0.00001), pneumothorax complications (RR = 0.34, 95% CI [0.22, 0.52], P < 0.00001) were statistically significant, and although the overall postoperative complication rate was higher in the CT group than in the ultrasound group, particularly for pneumothorax, both had a high safety profile for use in the diagnosis of peripheral type of occupying lung lesions.

Although percutaneous lung aspiration biopsy is recognized as a well-established and safe, minimally invasive diagnostic technique, it is still not immune to damage and complications can occur to a greater or lesser extent, although serious complications are rare. Common complications of percutaneous lung aspiration biopsy include pneumothorax and haemorrhage, while needle tract dissemination of malignancy, pleural reaction, embolism and even death are relatively uncommon.

Pneumothorax was one of the common complications of percutaneous lung puncture biopsy, but all were small amounts of pneumothorax and none required closed chest drainage treatment, ultrasound was performed in four cases with a complication rate of 4.8%, which was similar to that reported in the literature [22]. In the current study, the mean diameter of the lesions in the CT group (4.69 ± 1.84 cm) was smaller than that in the ultrasound group (5.14 ± 1.78 cm), and the complications of pneumothorax were higher in the CT group than in the ultrasound group, which is in line with the findings of Yeow *et al.* [23]. Although the difference in overall pneumothoracic complications between the two was not statistically significant, the aforementioned meta-analysis showed that the complications in the CT group were significantly higher than those in the ultrasound group, so it is better to choose the appropriate guidance method according to the lesion in clinical operation to reduce pneumothoracic complications as much as possible.

Bleeding was another common complication in this study, second only to the incidence of pneumothorax, in this study, three patients (6.3%) in the CT group had bleeding, with no significant hemothorax or intrapulmonary haematoma present, while no bleeding occurred in the ultrasound group, which is similar to previous reports [24] [25]. The reason for less bleeding in the ultrasound group may be that the method allows for knowledge of the lesion and surrounding blood supply, and real-time dynamic observation, rational planning of the

needle route, and avoidance of rich blood supply areas as much as possible during puncture. In addition, for lesions with a rich blood supply or vascularity, it is essential to assess the patient's bleeding tendency by improving coagulation before the procedure.

In this study, a total of 110 patients underwent percutaneous lung puncture biopsy and pathology revealed a total of 64 patients (58.2%) with malignant lesions, early detection and diagnosis of lung occupations are essential to improve the prognosis of lung cancer patients [26]. The early detection and diagnosis of lung occlusions is essential to improve the prognosis of patients with lung cancer. In addition 39.4% of patients in the benign lesion group in this study were tuberculosis, which is similar to the study by Guo *et al.* [27]. According to the Global Tuberculosis Report 2020 published by the World Health Organization, China has the second highest burden of tuberculosis with about 889,000 new cases of tuberculosis and 14% of patients, who are resistant to tuberculosis drugs in 2019, out of about 10 million new cases of tuberculosis worldwide [28]. The number of new cases of tuberculosis in China is about 880,000 and the proportion of patients with drug-resistant tuberculosis is 14, making it one of the countries with the highest burden of tuberculosis, tuberculosis is a major threat to human health and has become a global public health problem, so early diagnosis is important. The present results also confirm that ultrasound or CT-guided percutaneous puncture biopsy is one of the methods used to diagnose tuberculosis.

The mean diameter of the lesions in the ultrasound group in this study was 5.14 ± 1.78 cm, which was greater than the mean diameter of the lesions in the CT group (4.69 ± 1.84 cm). It has been noted that lesion diameter size has a significant impact on the diagnostic rate, with lesions larger than 5 cm in diameter having a 29% probability of liquefied necrotic areas in peripheral type lung occupancies, resulting in a lower pathological diagnosis rate [29]. CT can distinguish areas of liquefaction and necrosis based on the CT value of the lesion, avoiding the need for puncture in these areas, which ultrasound lacks [30]. Ultrasound lacks this advantage. For small lesions, the smaller the lesion, the more difficult it is to insert the needle accurately, the weak movements or erratic breath-holding during biopsy affects the accurate localisation of the lesion, and it is more likely that the sample will be obtained from the peripheral area of the lesion rather than from the lesion itself [31]. However, there is a small group of people who believe that the size of the lesion does not seem to affect the diagnostic yield of ultrasound-guided biopsy, because the operation allows the needle tip to be displayed in real time on colour doppler images, large vascular structures can be easily displayed to avoid injury, ultrasound allows real-time monitoring of the accompanying.

Lesion movement is with breathing [32]. Therefore, before performing the procedure, the size of the lesion needs to be assessed and the appropriate guidance modality selected to improve the pathological diagnosis. In summary, PTNB guided by either ultrasound or CT is a safe and effective clinical diagnos-

tic method for the diagnosis of peripheral pulmonary occupations. Depending on the actual condition of the patient and the lesion, choosing the appropriate guidance modality will not only improve the pathological diagnosis rate, but also reduce the occurrence of complications.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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