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Ultrasound for the Diagnosis and Treatment of Pleural Diseases

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Abstract:Objective: To analyze the application effectiveness of ultrasound in the diagnosis and treatment of pleural diseases.**Methods:** A study was conducted on 80 patients with pleural diseases in our hospital from March 2023 to March 2024. All 80 patients were pathologically confirmed and underwent X-ray/ultrasound examination. Among them, 38 cases underwent syringe aspiration therapy, included in the control group, and 42 cases underwent central venous catheterization therapy, included in the observation group. The clinical efficacy of the two groups was compared.**Results:** The detection rates and specificities of chest wall tumors and pleural effusions were basically consistent between the two examination methods ($P > 0.05$). The ultrasound examination showed significantly higher rates of detection for empyema, pleural adhesions/thickening, pleural effusion, overall detection rate, diagnostic accuracy, and sensitivity compared to X-ray ($P < 0.05$). The treatment success rate in the observation group was significantly higher than that in the control group, and the rates of symptom relief and mortality were significantly lower than those in the control group ($P < 0.05$). **Conclusion:** Ultrasound examination can effectively detect various types of pleural diseases. It is recommended to use central venous catheterization, which shows more significant efficacy.

Keywords: Ultrasound; Pleural Diseases; Diagnosis; Treatment; Central Venous Catheterization

Pleural diseases have a high incidence rate and encompass various types, such as pleural effusion and pleural thickening. Patients with these conditions often experience difficulty breathing due to disease interference. Diagnosis and treatment of these diseases are currently a focus of research. Taking pleural effusion as an example, if its cause is unclear, common diagnostic techniques include cytological examination, biochemical tests, and percutaneous pleural biopsy. However, these methods lack specificity and may lead to misdiagnosis. Imaging techniques allow direct observation of pleural abnormalities, although their efficacy varies between methods. X-rays are widely used and cost-effective, but their diagnostic accuracy is limited due to various influencing factors. Ultrasound examination, on the other hand, provides a more intuitive approach, revealing detailed lesion information with fewer influencing factors. Accurate and timely detection of diseases and appropriate treatment are crucial for improving prognosis. However, there are few reports on the diagnosis and treatment of pleural diseases, and the results are

controversial. This study focuses on patients with pleural diseases, analyzing the diagnostic efficacy of ultrasound and treatment outcomes.

1. Materials and Methods

1.1 General Information

A total of 80 patients with pleural diseases from our hospital between March 2023 and March 2024 were selected for this study. All 80 patients were pathologically confirmed, with the pathological diagnosis results indicating that 5 cases had chest wall tumors, 4 cases had empyema, 8 cases had pleural adhesions/thickening, 8 cases had pleural effusion, and 75 cases had pleural effusion. According to the treatment methods, there were 38 cases in the control group, including 20 males and 18 females, aged 18 to 77 years old, with an average age of (45.65±4.52) years; and 42 cases in the observation group, including 22 males and 20 females, aged 19 to 78 years old, with an average age of (45.72±4.49) years. The general data of the two groups were comparable ($P > 0.05$).

1.2 Methods

1.2.1 Diagnostic Methods

① X-ray Examination: Patients were placed in a supine position, and using a mobile X-ray machine with automatic exposure, careful examination of the chest was conducted to obtain images in both lateral and anteroposterior views. ② Ultrasound Examination: Utilizing an ultrasound diagnostic instrument with convex array probes, including one with a frequency range of 1-5MHz and another with a frequency range of 3-12MHz. The examination was performed with the patient in the lateral decubitus, sitting, and supine positions. Using the convex array probe, the pleural cavity was examined to identify any lesions. Additionally, the intercostal spaces, including the lines of the scapula, midaxillary line, and sternal midline, were carefully examined using a linear needle probe. Following a top-to-bottom approach, the presence of normal A-lines, B-lines, and normal pleural lines was assessed, and the condition of pleural lesions was observed in detail.

1.2.2 Treatment Methods

① Control Group: Syringe aspiration therapy was performed, utilizing a syringe to extract air or fluid by aspiration. ② Observation Group: Central venous catheterization therapy was administered. Patients were positioned supine, and after local anesthesia with 1% lidocaine (Zhejiang Kangde Pharmaceutical; National Medical Products Administration Approval No. H20066381), the second intercostal space at the junction with the sternal midline was identified for catheter placement. Using a puncture needle, any existing gas or fluid was aspirated, and a guidewire was inserted along the needle path. After removing the puncture needle, a dilator was inserted along the guidewire, followed by the central venous catheter. The guidewire was then removed, and the catheter was secured. Patients were semi-recumbent, and the volume of gas or fluid to be withdrawn each time was determined based on the patient's condition. For patients with pneumothorax, glucose was administered, and for those with malignant pleural effusion, cisplatin (Qilu Pharmaceutical; National Medical Products Administration Approval No. H37021362) and dexamethasone (Guangdong Southern Pharmaceutical; National Medical Products Administration Approval No. H44024618) were used as appropriate, with adjustments made to ensure adequate contact between the medication and the pleural cavity.

1.3 Observation Items and Indicators

Evaluation of X-ray and ultrasound detection:Observing the number of cases detected by both methods for chest wall tumors, empyema, pleural adhesions/thickening, pleural effusion, and pleural effusion, and calculating the detection rate. Evaluation of diagnostic efficacy: Based on pathology, calculating the diagnostic accuracy, sensitivity, and specificity of both methods. Evaluation of treatment effectiveness : Observing the number of successful treatments, symptom relief, and deaths in both groups, and calculating the proportions.

1.4 Statistical Methods

Data were analyzed using SPSS 27.0. Data expressed as (%) represented count data. Chi-square test was conducted, with $P < 0.05$ indicating statistical significance of differences.

2. Results

2.1 Comparison of X-ray and Ultrasound Detection Rates

The detection rates of chest wall tumors and pleural effusion were basically the same for both examination methods ($P > 0.05$). However, the ultrasound examination showed significantly higher detection rates

for empyema, pleural adhesions/thickening, pleural effusion, and overall detection rate compared to X-ray ($P < 0.05$). Please refer to **Table 1** for details.

Table 1 X-ray and Ultrasound Detection Results [*n*(%)]

Group	Chest Wall Tumor ($n = 5$)	Empyema ($n = 3$)	Pleural Adhesions/ Thickening ($n = 6$)	Pleural Effusion ($n = 6$)	Pleural Effusion ($n = 60$)	Overall Detection Rate ($n = 80$)
Ultrasound	4(80.00)	3(100.00)	6(100.00)	6(100.00)	60(100.00)	79(98.75)
X-ray	1(20.00)	0(0.00)	6(100.00)	4(66.67)	54(90.0)	65(81.25)
x^2	3.600	6.000	/	2.400	6.316	13.611
P	0.058	0.014	/	0.121	0.012	0.000

2.2 Comparison of Diagnostic Efficacy between Two Methods

Taking pathological diagnosis as the standard, there were 76 positive cases and 4 negative cases. For X-ray examination, there were 63 positive cases and 17 negative cases. For ultrasound examination, there were 74 positive cases and 6 negative cases. The specificity of both methods was basically the same ($P > 0.05$). However, the ultrasound examination showed significantly higher diagnostic accuracy and sensitivity compared to X-ray ($P < 0.05$). Please refer to **Table 2** for details.

Table 2. Comparison of Diagnostic Efficacy between Two Methods [*n*(%)]

Group		Diagnostic Results		Total
		Positive	Negative	
X-ray	Positive	60	3	63
	Negative	16	1	17
Total		76	4	80
Ultrasound	Positive	73	1	74
	Negative	3	3	6
Total		76	4	80

Continuation of **Table 2.** Comparison of Diagnostic Efficacy between Two Methods [*n*(%)]

Group	Cases	Accuracy Rate	Sensitivity	Specificity
Ultrasound	80	95.00(76/80)	96.05(73/76)	75.00(3/4)
X-ray	80	76.25(61/80)	78.95(60/76)	25.00(1/4)
x^2	/	11.425	10.165	2.000
P	/	0.001	0.001	0.157

2.3 Comparison of Treatment Outcomes between Two Groups

The treatment success rate in the observation group was significantly higher than that in the control group, and the rates of symptom relief and mortality were significantly lower than those in the control group ($P < 0.05$). Please refer to **Table 3** for details.

Table 3. Comparison of Treatment Outcomes between Two Groups [*n*(%)]

Group	Cases	Treatment Success Rate	Symptom Relief Rate	Mortality Rate
Observation Group	42	41(97.62)	1(2.38)	0(0.00)
Control Group	38	26(68.42)	8(21.05)	4(10.53)
x^2	/	12.497	6.966	4.654
P	/	0.000	0.008	0.031

3. Discussion

Patients often experience severe chest pain, described as stabbing or cutting, affecting their respiratory function after developing pleural diseases. The use

of imaging techniques can effectively detect this condition. X-ray examination, widely used due to its broad applicability, reveals characteristic features such as the presence of gas in the pleural cavity, transparency, relative uniformity, and absence of pulmonary markings. However, in severe cases, X-ray may lead to missed diagnoses, impacting clinical treatment. CT technology, on the other hand, can observe gas shadows in the pleural cavity and abnormal manifestations in lung tissue, including small cysts beneath the pleura.

The research findings indicate that the detection rates and specificity of chest wall tumors and pleural effusion were essentially the same between the two examination methods ($P > 0.05$). However, ultrasound examination showed significantly higher detection rates, diagnostic accuracy, and sensitivity for empyema, pleural adhesions/thickening, pleural effusion, and overall detection rate compared to X-ray ($P < 0.05$). This suggests that ultrasound technology offers higher diagnostic efficacy compared to X-ray. Regarding pleural effusion, three main types exist: anechoic, mixed echo with septations, and mixed echo without septations. The presence of septations may be influenced by factors such as the duration of the disease and the causes of effusion.Patients with tuberculous pleurisy may experience interference from iatrogenic operations like puncture. In the late stage of other inflammatory pleural effusions, pleural adhesions/thickening typically occur. Analyzing its sonographic features reveals dark areas with a thickness of 0.5-2 cm, visible septations, poor transparency, and localized thickening. Differential diagnosis of pleural thickening should be made, considering symptoms like pyothorax. For pleural effusion, sonograms typically show dark areas with round or oval shapes, enhanced or thickened pleura, clear and relatively regular margins, and blurry echoes. Pleural lesions commonly manifest as pleural effusion, especially in the early stages or in a progressive state. Masses can be found on the pleural wall, showing heterogeneous and solid features, sometimes single or multiple, with varying shapes, stationary positions, unaffected by lung tissue movement during deep breathing.

When clinically treating this condition, the usual approach involves first removing any gas present in the pleural cavity, followed by draining the fluid and then selecting appropriate medication. Previously, clinicians often used syringes to aspirate the gas and fluid, which, although effective to some extent, required repeated tube insertion, potentially causing damage and leading to infection. Utilizing central venous catheterization eliminates the need for repeated tube insertion, providing protection for patients and helping alleviate their suffering. Additionally, it ensures thorough removal of both gas and fluid from the pleural cavity. Subsequent administration of appropriate medication can enhance overall efficacy. In cases of malignant pleural effusion, treatment decisions should be based on pathological characteristics, actual fluid volume, predicted fluid accumulation, and patient tolerance levels.The observation group showed significantly higher treatment success rates and significantly lower symptom relief rates and mortality rates compared to the control group ($P < 0.05$). This suggests that central venous catheterization significantly improves efficacy compared to syringe aspiration. It indicates that utilizing ultrasound technology can effectively detect pleural diseases. Once the diagnosis is confirmed, central venous catheterization can be performed to drain fluid and gas from the pleural cavity, thereby enhancing treatment efficacy.

In summary, ultrasound examination is effective in detecting various types of pleural diseases. It is recommended to use central venous catheterization, as it offers more significant therapeutic efficacy.

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