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The Application Value of Artificial Intelligence-Assisted Low-Dose 64-Slice Spiral CT Scanning in Lung Cancer Screening and Nodule Follow-Up

Wenjun Liu*

Radiology Department, Qingyang Hospital of Traditional Chinese Medicine, Qingyang 745000, Gansu, China

**Author to whom correspondence should be addressed.*

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Abstract: *Objective*: To explore and observe the application value of artificial intelligence (AI)-assisted 64-slice spiral CT low-dose scanning in lung cancer screening and nodule follow-up. *Methods*: A retrospective analysis was conducted on 390 patients who underwent 64-slice spiral CT low-dose scanning for lung cancer screening at Qingyang Traditional Chinese Medicine Hospital from 2020 to 2024. By recording the morphology and nature of pulmonary nodules (solid, partially solid, ground-glass, and calcified nodules) and measuring nodule size (including volume, longest diameter, maximum short diameter, etc.), the diagnoses of target pulmonary nodules made by AI, senior radiologists, and senior radiologists combined with AI were compared to evaluate the clinical application value of different diagnostic methods. *Results*: A total of 390 subjects participated in the 64-slice spiral CT low-dose scanning for lung cancer screening. Among them, the physician + AI group detected 208 pulmonary nodules, the AI group detected 198 pulmonary nodules with a detection rate of 95.19%, and the physician group detected 194 pulmonary nodules with a detection rate of 93.27%. There was no statistical difference in the detection rate between the AI group and the physician group ($\chi^2 = 0.707$, $P = 0.400$). No statistical differences were observed among different groups in terms of nodule density, nodule location, and the detection of positive nodules ($P > 0.05$). Using the positive nodules identified by the physician + AI group as the screening nodules and the pathological examination results of 6 cases of lung cancer obtained during follow-up as the confirmed results, the physician + AI group demonstrated a sensitivity of 100%, a false-negative rate of 0%, a specificity of 25.10%, a false-positive rate of 74.90%, a positive likelihood ratio of 1.34, a negative likelihood ratio of 0, a concordance rate of 26.90%, a positive predictive value of 3.2%, and a negative predictive value of 100%. *Conclusion*: The screening method of AI-assisted 64-slice spiral CT low-dose scanning can be used to rapidly rule out lung cancer, but positive results require further confirmation through pathological examination and other means.

Keywords: Artificial intelligence; Lung cancer screening; Pulmonary nodules; Low-dose spiral CT; AI-assisted diagnostic system

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1. Introduction

Lung cancer is the leading cause of cancer-related deaths in China, with both its incidence and mortality rates ranking first, imposing a significant burden on society [1]. Current clinical evidence indicates that early diagnosis of lung cancer can substantially improve patient survival rates, reduce treatment risks, and enhance patient prognosis. Early diagnosis and treatment of lung cancer have thus become one of the key public health service tasks outlined in the "Healthy China Initiative" [2]. Low-dose spiral computed tomography (CT) is currently recommended as the primary screening method for lung cancer in guidelines due to its high sensitivity and specificity for lung cancer screening, particularly for stage I lung cancer [3]. However, the guidelines [3] also note that low-dose spiral CT faces the risk of a relatively high false-positive rate in clinical practice. Artificial intelligence (AI), as an emerging interdisciplinary field, has significantly driven innovation in medical models in recent years, demonstrating broad application prospects in enhancing diagnostic accuracy for diseases. Reports suggest that AI technology can reduce the false-positive rate of low-dose spiral CT, optimize workflow, and significantly enhance the efficacy of lung cancer screening [4]. This study aims to explore the value of AI technology in the screening and follow-up of lung cancer and pulmonary nodules, to provide clinical references.

2. Materials and methods

2.1. General information

A retrospective analysis was conducted on 390 patients who underwent low-dose 64-slice spiral CT scanning for lung cancer screening at Qingyang Hospital of Traditional Chinese Medicine from 2020 to 2024. Inclusion criteria: (1) Patients were classified as high-risk for lung cancer or had associated risk factors for lung cancer, with screening criteria referencing the "Chinese Guidelines for Low-Dose CT Screening for Lung Cancer (2023 Edition)" [5]; (2) Complete imaging examination data and corresponding information were available in the medical records; (3) Patients voluntarily participated in this research project and signed informed consent documents. Exclusion criteria: (1) Patients with substandard image data quality; (2) Patients with contraindications to CT examination, such as pregnant women, individuals with severe heart, liver, or renal failure, and critically ill patients.

2.2. Methods

2.2.1. Low-dose 64-slice spiral CT scanning parameters

The study utilized a Siemens 64-slice spiral CT scanner with the following parameters: tube voltage of 120 kVp, tube current of 20–50 mAs; average dose-length product ≤ 100 mGy·cm; effective radiation dose ≤ 1.0 mSv; slice thickness of 1.0–1.5 mm, slice interval ≤ 1 mm; scanning range from the lung apex to the costophrenic angle (including the apical pleura and subdiaphragmatic region); single breath-hold scan at end inspiration; thin-slice reconstruction of raw data after scanning, with AI-assisted analysis of thin-slice reconstruction with a slice thickness ≤ 1.0 mm.

2.2.2. Artificial intelligence-assisted diagnostic system

A deep learning-based lung nodule detection and classification algorithm (AI system model: Shukun Lung Nodule AI-Assisted Diagnostic System V8) was employed. The AI system automatically imported CT images in DICOM format for preprocessing; automatically identified pulmonary nodules using a 3D convolutional neural network, marked their locations, and measured geometric features (longest diameter, maximum short diameter, volume); classified nodule nature based on morphological characteristics and density values; and performed risk assessment in accordance with the Lung-RADS grading criteria.

2.2.3. Research protocol

The study was divided into three groups: the artificial intelligence group (AI group), the senior radiologist interpretation group (radiologist group), and the senior radiologist interpretation combined with artificial intelligence group (radiologist + AI group). Each group diagnosed the imaging data of the 390 included cases. In the AI group, the results automatically measured by the Shukun Lung Nodule AI-Assisted Diagnostic System V8 were used as the basis for diagnosis; in the radiologist group, two senior radiologists with more than 5 years of experience in chest imaging diagnosis independently interpreted the images, and if there was a discrepancy between the two radiologists' imaging diagnoses, a third independent senior radiologist with more than 10 years of experience in chest imaging diagnosis was consulted, and the diagnosis of this radiologist was used as the final result; in the radiologist + AI group, radiologists performed a secondary interpretation based on the nodule detection results and risk assessment provided by the AI system, and the final diagnosis was recorded.

2.3. Observation indicators

The diagnostic criteria for positive nodules referenced the "Chinese Guidelines for Low-Dose CT Screening for Lung Cancer (2023 Edition)" [5], with solid or partially solid nodules measuring ≥ 5 mm in diameter, or non-solid nodules measuring ≥ 8 mm in diameter considered positive. Follow-up and nodule management also referenced the "Chinese Guidelines for Low-Dose CT Screening for Lung Cancer (2023 Edition)" [5], with solid or partially solid nodules measuring 5 mm–14 mm in diameter and non-solid nodules measuring 8 mm–14 mm in diameter undergoing re-examination 6 months after screening.

2.4. Statistical analysis

Statistical analysis was performed using SPSS 24.0 software. Measurement data conforming to a normal distribution were expressed as mean ± standard deviation (SD), and comparisons between groups were made using independent samples t-tests. Count data were expressed as relative numbers, and comparisons between groups were made using the χ^2 test or Fisher's exact test. A p-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of lung nodule detection

A total of 390 subjects participated in the low-dose multi-slice spiral CT lung cancer screening. Among them, the radiologist + AI group detected 208 lung nodules, while the AI group detected 198 nodules, with a detection rate of 95.19%. The radiologist group detected 194 nodules, with a detection rate of 93.27%. There was no statistically significant difference in detection rates between the AI group and the radiologist group ($\chi^2 = 0.707$, $P = 0.400$). No statistically significant differences were observed among the different groups in terms of lung nodule density, nodule location, or detection of positive nodules ($P > 0.05$). See **Table 1**.

Table 1. Comparison of lung nodule detection among different groups

Pulmonary Nodule Characteristics	AI Group	Physician Group	Physician+AI Group	χ^2	P
Nodule Density				2.572	0.632
Solid nodules (n)	189	185	202		
Part-solid nodules (n)	1	2	0		
Non-solid nodules (n)	8	7	6		
Nodule Location				0.100	1.000
Left upper lobe (n)	47	45	48		
Left lower lobe (n)	53	51	55		
Right upper lobe (n)	54	55	58		
Right middle lobe (n)	20	20	22		
Right lower lobe (n)	24	23	25		
Positive nodules (n)	151	149	157	0.098	0.952

3.2. Lung cancer detection

After approximately 12 months of follow-up, 5 patients were confirmed to have lung cancer based on pathological examination results in this study. Patient details are shown in **Table 2**.

Table 2. Sociodemographic and imaging characteristics of lung cancer patients

	Case 1	Case 2	Case 3	Case 4	Case 5
Age (years)	65	68	49	65	55
Gender	Male	Male	Male	Male	Male
Type of Pulmonary Nodule	Space-occupying	Solid	Space-occupying	Space-occupying	Space-occupying
Nodule Size (mm)	25 × 21	12 × 11	22 × 24	25 × 23	24 × 28
Image Number	170	211	246	135	234
Nodule Location	Right lower lobe	Left upper lobe	Left upper lobe	Left upper lobe	Right lower lobe

3.3. Evaluation of screening efficacy

Taking the positive nodules determined by the radiologist + AI group as the screened nodules and the pathological examination results obtained from follow-up as the definitive outcomes, the screening efficacy of the radiologist + AI group is shown in **Table 3**. The sensitivity of the radiologist + AI group was calculated to be 100%, with a false-negative rate of 0%, specificity of 25.10%, false-positive rate of 74.90%, positive likelihood ratio of 1.34, negative likelihood ratio of 0, accuracy of 26.90%, positive predictive value of 3.2%, and negative predictive value of 100%.

Table 3. Screening efficacy of the radiologist + AI group

Positive Nodules	Follow-up Diagnosis of Lung Cancer		Total
	Yes	No	
Yes	5	152	157
No	0	51	51
Total	5	203	208

4. Discussion

Relevant epidemiological investigations indicate that lung cancer remains the malignancy with the highest incidence and mortality rates in China. Concurrently, there is an increasing trend in the number of newly diagnosed lung cancer cases from pulmonary nodules each year [6]. Due to the lack of typical symptoms in the early stages of lung cancer, many patients present at advanced stages when seeking medical attention, often resulting in a poor prognosis. Therefore, early detection, diagnosis, and treatment of lung cancer are crucial measures for improving the prognosis of lung cancer patients. In recent years, guidelines [3,5] have recommended low-dose CT scanning as the preferred method for early screening of high-risk populations and lung cancer, significantly reducing lung cancer mortality and demonstrating high clinical value. As a cutting-edge technology in the healthcare field, AI exhibits immense potential in assisting disease detection and diagnosis, reducing the workload of clinicians, and minimizing the impact of subjective experience on disease diagnosis, thereby further promoting the standardization and normalization of pulmonary nodule screening.

The results of this study show that the physician-AI group achieved a sensitivity of 100% and a false-negative rate of 0%, indicating that this screening protocol has excellent lung cancer detection capabilities and poses no risk of missed diagnoses. This is consistent with previous reports highlighting the high detection rate of AI-assisted low-dose CT screening for early-stage lung cancer [7]. Particularly, it demonstrates reliable identification capabilities for solid nodules with a diameter of ≥ 5 mm or non-solid nodules with a diameter of ≥ 8 mm, making it a preferred option for exclusionary screening to prevent missed diagnoses in high-risk populations. However, the specificity was low and the false-positive rate was high in the physician-AI group in this study, which can be attributed to the inherent limitations of low-dose CT scanning. Low-dose CT is highly sensitive to subtle structural abnormalities but struggles to differentiate between benign and malignant lesions [8]. Additionally, the resolution limitations of low-dose CT hinder accurate determination of nodule nature, particularly leading to misinterpretation of inflammatory or fibrotic lesions [9]. Furthermore, the presence of benign pulmonary lesions in high-risk individuals may further increase the risk of false positives. Previous studies [10] have also pointed out that the age and underlying diseases of individuals undergoing low-dose CT screening can affect diagnostic specificity. Moreover, variations in the threshold for positive determination can also lead to fluctuations in the false-positive rate. In this study, the criteria for positive nodules were relatively strict (solid nodules ≥ 5 mm were considered positive), potentially including numerous benign small nodules and further elevating the false-positive rate. There was no significant difference in the detection rates between the AI group and the physician group, but the total number of pulmonary nodules detected in the physician-AI group was higher than that in either individual group, suggesting that combined diagnosis can enhance nodule detection rates through complementarity. However, this study still has the following limitations: with only five confirmed cases of lung cancer, the small sample size may affect the final diagnostic efficacy. Additionally, the study did not compare the efficacy of different AI algorithms, which requires further research and validation in the future.

5. Conclusion

In conclusion, AI-assisted low-dose multi-slice spiral CT scanning is suitable as an initial exclusionary screening tool for high-risk populations. However, the issue of its relatively high false-positive rate still needs to be addressed through AI algorithm optimization and clinical stratification management to further achieve precision medicine in clinical practice.

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Disclosure statement

The author declares no conflict of interest.

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