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Research on the Application of Lung Ground-Glass Nodule Screening Based on Gene Methylation Combined with Spiral CT and AI Recognition System in Teaching Practice

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Abstract: The application of gene methylation combined with spiral CT in the screening of lung ground-glass nodules (GGN) and the integration of AI recognition systems represent cutting-edge advancements in medical technology. This study explores the practical application of these techniques in teaching settings, aiming to enhance students' understanding and proficiency in modern medical imaging and diagnosis. By incorporating these methods into educational curricula, we seek to assess their effectiveness in improving diagnostic accuracy, efficiency, and overall student engagement. The findings of this research have implications for enhancing medical education, particularly in the field of radiology and imaging sciences, ultimately leading to improved patient care and outcomes.

Keywords: Gene methylation; Spiral CT; Lung ground-glass nodule; AI recognition system; Teaching practice

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1. Introduction

Lung cancer is a clinically common malignancy with a high incidence. The diagnosis of lung cancer has always been a hot topic in clinical research. Early symptoms of lung cancer are concealed, so it is extremely important to pay attention to early screening and identification of lung cancer [1,2]. The combination of gene methylation, spiral CT, and AI recognition systems plays a crucial role in the screening of pulmonary ground-glass nodules [3]. Therefore, it is necessary to attach importance to teaching and research on the screening of pulmonary ground-glass nodules. The combination of gene methylation and spiral CT is a common screening method for pulmonary ground-glass nodules. Students can improve their disease diagnosis ability by mastering screening techniques [4,5]. In recent years, with the application of artificial intelligence (AI) technology, early

screening of pulmonary ground-glass nodules has become more accurate, simple, and feasible [6,7]. In teaching and research, it is necessary to integrate AI recognition system teaching and research to enhance the professional level of imaging medical personnel and standardize the screening of pulmonary ground-glass nodules [8].

2. Materials and methods

2.1. General information

Sixty medical students from a hospital between October 2023 and October 2024 were selected for lung ground-glass nodule screening teaching. They were randomly divided into two groups (control group and study group), with 30 students in each group. The control group consisted of 14 males and 16 females, aged between 24–32 years old, with an average age of (28.12 ± 1.01) years old. The study group comprised 13 males and 17 females, aged between 24–30 years old, with an average age of (28.10 ± 1.02) years old. Among the 60 patients, there were 12 males and 48 females, aged between 21–58 years old, with an average age of (35.23 ± 2.45) years old. Comparing the data between the two groups, $P > 0.05$. The study met the requirements of medical ethics. The participants were informed of the study content and expressed their voluntary participation. Inclusion criteria: all were medical imaging students; all had good communication skills; all agreed to participate in the study. Exclusion criteria: poor compliance; failing grades before enrollment (< 60 points); females who were pregnant or breastfeeding.

2.2. Methodology

2.2.1. Control group

(1) Gene methylation teaching: During the teaching process, teachers need to explain theoretical knowledge about gene methylation to students. For example, it belongs to epigenetic modification, which can play an important role in regulating individual growth, development, gene expression patterns, and genome stability without changing the DNA sequence. Moreover, this modification can be inherited during development and cell proliferation. Additionally, teachers should explain to students that different diseases have specific methylation profiles, and there are differences in methylation profiles at different stages of the disease. Detecting methylation at specific sites in specific samples can effectively improve the screening of precancerous lesions. Regarding methylation screening for pulmonary nodules, teachers should explain the auxiliary diagnostic markers, including three key gene methylations: SHOX2, RASSF1A, and PTGER4 genes. These three genes have significant advantages in screening for pulmonary ground-glass nodules, helping to distinguish between benign and malignant nodules.

(2) Spiral CT screening teaching: In CT imaging diagnosis teaching, the imaging manifestations of pulmonary ground-glass nodules are summarized. Teachers should use typical cases to guide students in observing and analyzing the location, morphology, size, density, edges, and internal features of the nodules, and summarize as follows:

(A) Whether the edges of the nodule are smooth and regular. If the nodule is round or oval, it is more likely to be benign; malignant nodules often have irregular shapes, especially for malignant subsolid nodules or mixed ground-glass nodules, which have a higher probability of occurrence. If the nodule shows lobulation, spiculation, vascular convergence sign, and pleural indentation sign, it is more likely to be malignant.

(B) Size of the nodule: As the nodule increases in size, the probability of malignancy increases.

(C) Density: Pulmonary pure ground-glass nodules with uniform density, especially those less than 5 mm, often suggest atypical adenomatous hyperplasia; mixed ground-glass density nodules with uneven density have a higher probability of malignancy as the solid component increases. If the diameter is greater than 5 mm, even a pure ground-glass nodule has the potential to develop into carcinoma in situ. Such pure ground-glass density nodules are defined as intermediate-risk nodules. For individuals who discover such nodules for the first time, it is recommended to have a follow-up examination in three to six months. If there is no change in nodule size, follow-up observation can continue. If the diameter is less than or equal to 5 mm, it is considered a low-risk nodule, and a low-dose spiral CT follow-up examination can be performed once a year.

2.2.2. Research group

Based on the control group, AI recognition system teaching will be conducted. During the teaching process, students are required to have a good grasp of the principles and operational usage of the system. Additionally, by combining imaging technology, low-dose spiral CT scans of the chest will be quickly performed for screening patients. Suspected ground-glass lung nodules will be precisely located, and a quantitative analysis of nodule composition will be conducted. The nature of nodules, such as solid nodules, ground-glass nodules, and part-solid nodules, will be distinguished based on artificial intelligence technology and labeled with colored frames. Furthermore, the AI recognition system can provide real-time descriptions of imaging features including the number, diameter, nature, volume, and CT value of suspicious lesions. It can accurately locate the structural relationship between lung tissue and nodule tissue, thereby enhancing diagnostic accuracy.

2.3. Observation indices

(1) Comparison of the detection rate of pulmonary ground-glass nodules between the two groups of students, calculated as the number of detected pulmonary ground-glass nodules divided by the total number of cases, multiplied by 100%.

(2) Analysis of teaching satisfaction between the two groups. Satisfaction evaluation includes teaching content, screening accuracy, and screening convenience. The full score is 100 points, where 0–59 points represent dissatisfaction, 60–79 points represent basic satisfaction, and 80–100 points represent satisfaction. The satisfaction rate is calculated as 1 minus the dissatisfaction rate.

2.4. Statistical analysis

Statistical analysis was performed using SPSS 22.0. Count data are expressed as n(%), and the chi-square test (χ^2) was used for comparison. A P-value less than 0.05 was considered statistically significant.

3. Results

3.1. Detection of pulmonary ground-glass nodules in two groups of students

The detection rate of pulmonary ground-glass nodules was higher in the study group than in the control group, with $P < 0.05$. See **Table 1** for details.

Table 1. Detection of pulmonary ground-glass nodules in two groups of students (%)

Group	Number of cases	Number of detected cases	Detection rate
Control group	60	32	53.33
Study group	60	45	75.00
χ^2 value	-	-	6.125
P value	-	-	0.013

3.2. Analysis of teaching satisfaction between two groups

The teaching satisfaction of the research group was higher than that of the control group, with a *P*-value less than 0.05. See **Table 2** for details.

Table 2. Analysis of teaching satisfaction between two groups (%)

Group	Number of cases	Satisfied	Average	Dissatisfied	Total satisfaction
Control group	30	9 (30.00)	12 (40.00)	9 (30.00)	21 (70.00)
Research group	30	12 (40.00)	16 (53.33)	2 (6.67)	28 (93.33)
χ^2 Value	-	-	-	-	5.455
P Value	-	-	-	-	0.020

4. Discussion

Screening for pulmonary ground-glass nodules plays a crucial role in ensuring people's health. It enables timely detection of high-risk nodules, allowing for early and effective intervention strategies to prevent disease progression and reduce the occurrence of lung cancer [9,10]. Currently, the teaching of pulmonary ground-glass nodule screening mainly focuses on the combination of gene methylation and spiral CT imaging techniques. Students can assess diseases based on imaging features and gene methylation content, which demonstrates significant screening value [11,12]. However, due to the complexity of these techniques, students often have inadequate understanding of screening methods and principles, affecting the accuracy of screening results for pulmonary ground-glass nodules.

The application of Artificial Intelligence (AI) technology has played a significant role in the screening process of lung ground-glass nodules. Incorporating the use of AI recognition systems in student teaching enables students to quickly and accurately identify and extract CT image features during clinical practice, assisting doctors in rapidly diagnosing and locating lesions, and improving the accuracy of students' disease screening results [13,14]. The results of this study showed that the detection rate of lung ground-glass nodules was higher in the study group than in the control group, $P < 0.05$; the teaching satisfaction of the study group was higher than that of the control group, $P < 0.05$. It suggests that the screening of lung ground-glass nodules based on gene methylation combined with spiral CT and the AI recognition system has high practical value in teaching. The AI recognition system can enhance students' ability to identify lesions in teaching. The system utilizes automatic registration technology to comprehensively observe the growth cycle of nodules and effectively identify the risk of disease progression, which has a high value in teaching and research [15].

5. Conclusion

In summary, traditional screening methods for pulmonary ground-glass nodules mainly rely on technologies such as gene methylation and spiral CT, which have good screening value. However, with medical research advancements, it has been found that the combination of gene methylation and spiral CT, aided by artificial intelligence systems, can provide more accurate results for disease screening and diagnosis. In clinical teaching practice, it is important to emphasize the in-depth study of AI recognition systems to make future screening for pulmonary ground-glass nodules more standardized and comprehensive.

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Disclosure statement

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