Early Detection of Pulmonary Lesion by The Reconstruction of Three-Dimensional (3D) Computed Tomography (CT)

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Citation: Ogura K, Bando H, Kato Y, Kawata T, Kato Y. Early Detection of Pulmonary Lesion by The Reconstruction of Three-Dimensional (3D) Computed Tomography (CT). Asp Biomed Clin Case Rep. 2024 Sept 16;7(3):270-74.

Abstract

This case involves a 59-year-old female with no past medical history. She was a former smoker, consuming 5 cigarettes daily from the age of 20 to 44. In late June 2024, she underwent a health check-up and was advised to have a chest CT scan. As a result, an unexpected lesion was found in the middle to upper area of the left lung, visible in the transverse aspect. The lesion had an irregular shape and measured 25.46 x 11.89 mm. Using the reconstruction method of three-dimensional (3D) computed tomography (CT) by Synapse Vincent, detailed images of the transverse, coronal, and sagittal aspects were obtained. Tumor markers were negative for CRP, CEA, and cytokeratin 19 fragment (CYFRA).

Keywords

Reconstruction, Three-Dimensional (3D) Computed Tomography (CT), Synapse Vincent, Radiological Diagnostic Measurement, Pulmonary Lesion

Introduction

For decades, various developments have been made in radiological diagnostic measurements. Radiologic reconstruction methods have enabled the broad application of three-dimensional (3D) computed tomography (CT) in diagnosing and performing surgery on human organs [1]. Various types of software for 3D-CT have been developed in several countries, including Japan [2]. Among these, novel mechanisms for 3D reconstruction images have been utilized for the pulmonary region in pre- and post-operative simulations [3]. Some of these advanced types have been widely adopted by technicians, radiologists, and thoracic surgeons [4]. Recently, 3D CT images have been used for preoperative planning, surgical training before operations, and intraoperative support during thoracic surgery [5].

Authors and collaborators have reported some impressive clinical cases using 3D CT reconstruction [6]. The research areas included orthopedics, pancreatic imaging using Curved Planar Reconstruction (CPR), and others [7]. By using this high-quality Vincent technique, clinical benefits have been demonstrated. We encountered a female patient with a pulmonary nodule detected by 3D CT, and the general progress and perspectives are described in this article.

Case Report

History and Exam

This case involves a 59-year-old female. She had no significant medical history. In April 2024, she went out to see cherry blossoms with a friend who later tested positive for coronavirus. She developed a sore throat, headache, and back pain the next day and tested positive two days later. After that, she did not experience any further symptoms or signs.

She underwent an annual health check-up in late June 2024. Physical examinations revealed no significant changes in vitals, lungs, heart, abdomen, or neurological tests. Her physique was noted to be 154.6 cm tall, 46.4 kg in weight, with a BMI of 19.4 m^2/Kg. There were no significant changes in her blood chemistry, urinalysis, or electrocardiogram (ECG).

The results of her blood chemistry in July 2024 were as follows: AST 29 U/L, ALT 18 U/L, GGT 25 U/L, BUN 15 mg/dL, Cr 0.59 mg/dL, UA 4.0 mg/dL, LDL 136 mg/dL, HDL 69 mg/dL, TG 85 mg/dL, glucose 91 mg/dL, HbA1c 5.7%, CRP 0.06 mg/dL, CEA 1.9 ng/mL (-5.0), cytokeratin 19 fragment (CYFRA) 1.4 ng/mL (-3.5), RBC 443 x 10^4/μL, WBC 60 x 10^2/μL, Hb 13.0 g/dL, Plt 22.3 x 10^4/μL.

Radiological Exam

In the chest X-ray (**Fig-1A**), slight post-inflammatory old changes were detected in the right apical lung. The doctor in charge of the annual examination recommended further evaluation of the right upper region with a chest CT scan. She underwent a pulmonary CT scan in early July. As a result, an unexpected lesion was found in the middle to upper area of the left lung in the transverse aspect. It had an irregular shape and measured 25.46 x 11.89 mm (**Fig-1B**). Additionally, coronal and sagittal scans of the left lung were performed. The lesion appeared to have an uneven surface, measuring 24.94 x 14.89 mm and 26.06 x 12.07 mm, respectively (**Fig-2A** and **Fig-2B**).

Clinical Progress

After the chest CT, a recent novel method of reconstruction was performed. The reconstructed images of the left upper lung showed the coronal and sagittal planes, respectively (**Fig-3A** and **Fig-3B**). They revealed an irregular shape with an uneven surface. Additionally, the lesion was detected in the transverse plane and with a 150-degree rotation of the coronal plane, respectively (**Fig-4A** and **Fig-4B**).

Regarding the CT findings, a case discussion was held with a physician, surgeon, and specialist radiologist to ensure a satisfactory evaluation. A definitive diagnosis could not be made at the time, and recent post-inflammatory changes were considered. Consequently, administering antibiotics for a few weeks was proposed to potentially improve the abnormal lesion by reducing local inflammation. The patient was prescribed levofloxacin for 2 weeks and
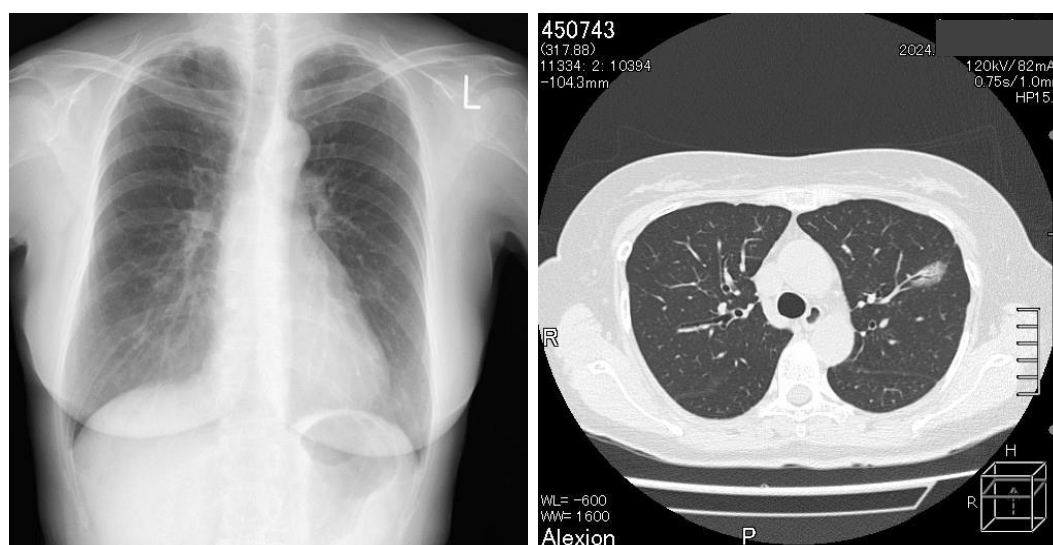
Fig-1: Findings of the lung by X-ray and CT scan

A: No remarkable lesion in left upper lung by plain X-ray

B: Irregular lesion detected with blood vessels by transvers scan. The size is measured as 25.46 x 11.89 mm
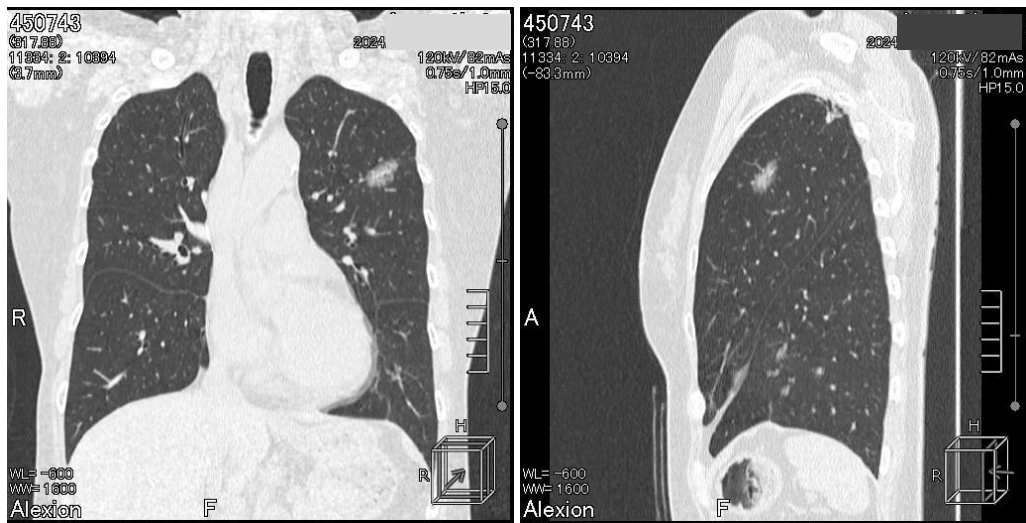
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Fig-2 Findings of the lung by CT scan

A: Irregular lesion in left upper region by coronal scan. The size is measured as 24.94 x 14.89 mm

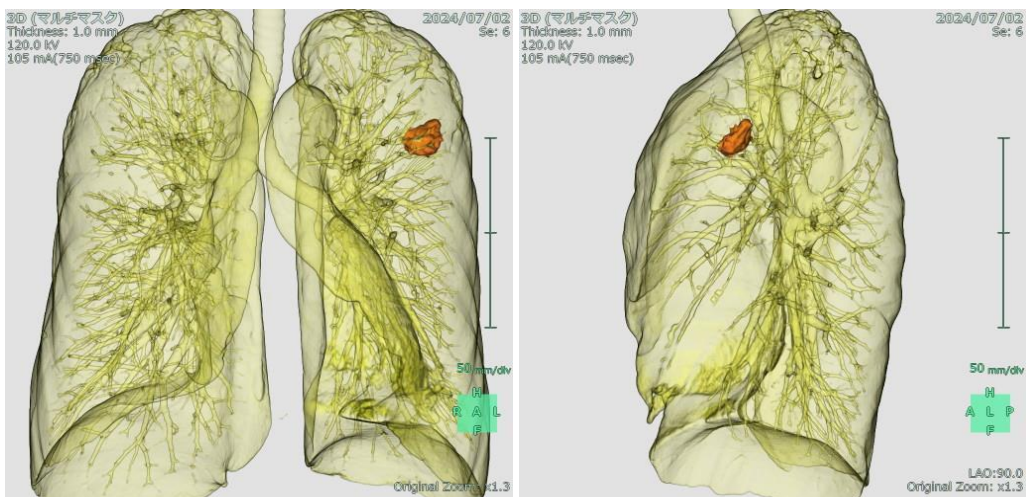B: Irregular lesion with blood vessels by sagittal scan. The size is measured as 26.06 x 12.07 mm

Fig-3: Reconstruction image of SOL in left upper lung

A: Irregular shaped SOL detected in coronal plane

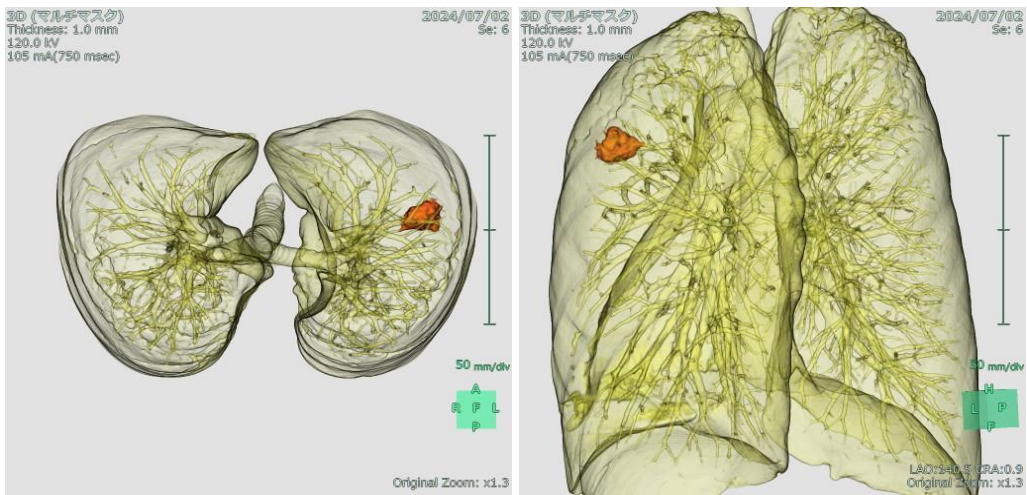B: Irregular shaped SOL detected in sagittal plane

Fig-4: Reconstruction image of SOL in left upper lung

A: Irregular shaped SOL detected in transvers plane

B: Irregular shaped SOL detected in 150-degree rotation

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underwent a second chest CT scan in early August. The results showed no changes in the lesion compared to the findings one month prior. The patient was then referred to the specific pulmonary disease department at a large general hospital in the prefecture for the possible diagnosis of adenocarcinoma of the left lung.

Ethical Considerations

The patient complied with the standard ethical guidelines of the Declaration of Helsinki [8]. Additionally, certain commentary was found regarding information regulation. The principle is outlined in the ethical rules governing research and practice. Several clinical issues involving humans have been studied. There are valuable guidelines from the Japanese government, originating from the Ministry of Health, Labor and Welfare, and the Ministry of Education, Culture, Sports, Science, and Technology. The authors established an ethical committee for this case at Kanaiso Hospital, Tokushima, Japan. This committee included several hospital personnel, such as the hospital director, doctors, head nurse, pharmacist, nutritionist, and a legal professional. The members thoroughly discussed the current protocol. Informed consent was obtained from the patient in written form.

Discussion

In this report, a 59-year-old female was found to have a lesion in the left lung via pulmonary CT scan, accompanied by reconstruction techniques. Several possibilities can be considered for the background of this case. Regarding her past history, she smoked about 5 cigarettes a day from the age of 20 to 44 (until 2009). Her husband had been a heavy smoker, consuming about 20 cigarettes a day until 2009 when he was diagnosed with lung cancer at the age of 45. He quit smoking immediately but lived only about 1.5 years after that. She had been exposed to second-hand smoke from her husband's cigarettes at home for over 20 years. Thus, she is an ex-smoker, having quit smoking 15 years ago.

Regarding the findings in the left lung, the lesion had an uneven surface with radiologically inhomogeneous density. Figure 2b showed the lesion associated with a linear shadow indicating a small bronchiole. Although not observed in the figure, blood

vessels around the bronchi may exist and could enter the lesion. The reconstruction image was satisfactorily presented using Synapse Vincent's computerized AI. The case also showed a positive SARS-CoV-2 antigen test about one month before the health check-up [9]. As a result of our clinical meeting, follow-up with antibiotics for a few weeks was recommended. In this situation, clinical management seemed to be adequate.

One beneficial aspect of 3D CT imaging is that it is a non-invasive measure that can analyze the reconstruction of pulmonary anatomy and help understand the spatial relationships of complex structures [10]. In a relatively short period, 3D CT imaging can accumulate large datasets of 1,000-5,000 cases [11]. Furthermore, it can analyze the relationship between pulmonary volume and segmental anatomy [12]. Thus, it can provide novel and detailed information about lung lesions for various studies [13].

Regarding 3D CT software, various kinds of technical software are available worldwide [14, 15]. When 3D images were constructed for a pulmonary lesion using Synapse Vincent, 97.8% of the images of 316 related branches of the pulmonary artery were consistent with the intraoperative findings, showing a high coincidence ratio with the obtained data [3].

Some limitations may be present in the current article. This was a single case of pulmonary disease where 3D CT reconstruction was clinically useful. Various actual reconstructions have been observed so far, and we will continue to improve the technique level of these radiological diagnostic developments.

In summary, a 59-year-old female patient presented with a detected lesion using 3D CT techniques. We hope that this article may become a useful reference in the field of pulmonary disease and radiology.

Conflict of Interest

The authors have read and approved the final version of the manuscript. The authors have no conflicts of interest to declare.

Funding

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