Introduction

Pleural effusion may be result from various stimuli; infections, neoplasms, trauma, drugs, collagen vascular disease, etc, or it can be “idiopathic” for reasons that were not clear. As another feature of chest image, pulmonary infiltration is considered a context-dependent, non-specific and imprecise descriptive term when used in radiology reports, which referred to substance or cell type that occurs within or spreads as through the interstices of the lung. In clinic, it has been described that organizing pneumonia (OP), including drug-induced lung injury (DLI), is one of the most frequent etiologies of “wandering pneumonia” (or migrating pneumonia). However, “wandering pleural effusion accompanied by pulmonary infiltration” is rarely reported.

We herein present a case of migrating pleural effusion with pulmonary infiltration on chest CT. We describe this unusual case because it is a unique pulmonary abnormality associated with *paragonimus* infection.

Case presentation

A 48 years old male from SiChuan Province of China was presented with right chest pain for half months. He denied fever, productive cough, palpitation, anorexia and weight loss. There were reduced breath sounds in the right infrascapular region. No cackles or rhonchi were present. The chest computed tomography (CT) scan showed right pleural effusion with lung consolidation and a ground-glass opacity (GGO), which corresponded to his right chest pain (Figure 1(a)–(d)). At that time, routine blood investigation revealed eosinophilia of $3.31 \times 10^9/L$, which accounted for 39.3%. 10 days after starting antibiotics (Ticarcillin/Clavulanate Acid and moxifloxacin) treatment, follow-up chest CT revealed right pleural effusion with lung consolidation had disappeared (Figure 1(e)–(h)). After another 2 months, chest CT was revealed novel left pleural effusion, and some patchy opacities and nodules in the left upper lung field (Figure 1(i)–(l)). The series of radiographic
findings could be referred to as “wandering pleural effusion with pneumonia.”

Laboratory tests showed leukocyte of 9.61 \times 10^9/L, eosinophilia (3.57 \times 10^9/L), thrombocyte of 188 \times 10^9/L, hemoglobin of 151 g/L, C-reactive protein level of 2.75 mg/dL, creatinine of 68.9 μmol/L, lactate dehydrogenase (LDH) of 156 U/L, ALT of 15.3 U/L, total IgE of >500 IU/mL, Fer of 170.82 mg/L, and negative serology for HIV. Blood were also negative for fungi antigen, ANA, ANCA, CCP, RF, NT-proBNP, D-D dimmer, and tumor markers. Routine stool examination was normal. And the patient was given ultrasound scans of the abdomen organs, which presented no significant abnormalities.

Then, diagnostic ultrasound-guided thoracentesis was performed, which yielded yellow fluid. Analysis of the pleural fluid showed exudates with 76.80 g/L of proteins, 1.01 mmol/L of glucose, 965.3 U/L of LDH, 17.4 U/L of ADA, 14.7 U/L of amylase. A cell fractionation of pleural effusion revealed 19% neutrophils, 62% eosinophils, and 14% lymphocytes. No microorganism was isolated from the pleural fluid and blood by artificial culture. Also, no malignant cells were detected upon the pleural effusion cytology. A second test of pleural fluid was abnormal for eosinophils, similar with the previous result.

Since the cytological examination presented infrequent cells with no definite diagnosis, the patient was given a Video-assisted Thoracoscopic Surgery (VATS) pleural biopsy. Thoracoscopic examination revealed diffuse miniature nodules on left pleura (Figure 2(a)–(c)). Definite pathology was reported as eosinophil infiltration (Figure 2(d)). Thereby, the patient provided a clue, which was that he had a history of intake of raw crabs 6 months ago at KaiJiang distinct of SiChuan Province, one of the endemic areas of paragonimiasis (online Supplement 1). Also, there was an epidemiological context in his family relatives.

Under the suspicion of parasite infection, the patient’s serum was detected by multiple-dot ELISA with specific antibodies against variety of parasite antigens including Paragonimus, Toxoplasma, Filaria, Taenia solium cysticercus, Schistosoma ect, and positive result of Paragonimus was found. Due to the unknown status of Paragonimus, genetic sequencing was performed on the blood through NGS (Illumina Hiseq4000). Sequence of Paragonimus was
not visualized by the Integrative Genomics Viewer (IGV).

So on the background of epidemiology, intake history of raw crabs, with eosinophilia on investigation, eosinophil infiltration seen in pleural biopsy, serological result of *Paragonimus*, diagnosis was defined as eosinophilic pleurisy and pneumonia, eosinophilia, Paragonimiasis.

Then he received a treatment with praziquantel of 25 mg/kg three times daily for 5 days in an institute of tropical medicine in Beijing, China. Given the migrating features of paragonimiasis in his lung and pleura, another additional praziquantel treatment was performed 1 month later. And he had no discomfort since such therapy. Six months later, a novel chest CT scan of this patient showed no pleural effusion and infiltration in neither of pleural cavities and lungs. The patient is still being followed up.

**Discussion**

Paragonimiasis is a food-borne parasitic zoonosis resulting from various species of lung fluke, which is endemic in many regions of Asia, Africa, and South America. Fresh water snails, crabs, and crayfish are the first and second intermediate hosts, respectively. Humans are infected with this parasite dominantly by eating uncooked or undercooked crustaceans. According to a retrospective research in Japan, the middle- and old-aged Japanese with wild boar meat or freshwater crab intakes are the main groups infected with paragonimiasis. In China, *P. westerman* and *P. skrjabini* are the primary epidemic types for *paragonimus* infection. Our patient had a definite ingestion history of raw crabs in KaiJiang distinct of SiChuan Province, an endemic area of *P. skrjabini*. Also, there was an epidemiological context in his relatives. So, it is suggested that he was probably infected with *P. skrjabini*, although those infected cases of this *paragonimus* genus in China are non-pulmonary.

Clinically, Paragonimiasis can be categorized into pulmonary, extrapulmonary, and pleuropulmonary forms. Or we may classify it into acute and chronic forms and ectopic paragonimiasis. Symptomatically, the common manifested symptoms are pain or chest distress, dyspnea, rusty brown or blood-stained sputum or recurrent hemoptysis. Chronic infection presents with fever, anemia, weakness, and weight loss. Our patient presented with chest pain only.

In chest radiography of pleuropulmonary paragonimiasis, patchy airspace consolidation with or without cystic changes, cysts, nodules, adjacent bronchiectasis, peripheral linear opacities, with or without hydropneumothorax, pleural effusion and pleural thickening were frequently showed. The difference may be based upon the paragonimiasis species, different stages of infection and surrounding tissues reaction. Sign of subpleural linear opacities or a tubular structure connecting to a cyst was referred to be suggestive of worm migration tracks. CT, especially high-resolution CT, can present more details on the worm cyst and migration track. In our case, the patient’s CT showed several ill defined subpleural ground-glass nodules and two subpleural linear opacities connecting pleura and peripheral consolidation, which is a quite important clue to diagnosis of pleuropulmonary paragonimiasis. While paragonimiasis with unilateral or bilateral pleural effusion had been reported, our case is a rare report of paragonimiasis involving wandering pleural effusion and pneumonia.
Pulmonary paragonimiasis is commonly misdiagnosed as pulmonary infection, pulmonary tuberculosis or lung cancer. In our patient, the consolidative lung lesions was initially taken to be a sign of bacterial infection. The diagnosis was delayed as a result of the temporary improvement on CT scan. Ultimately, eosinophilia with “wandering” pleural effusion and pneumonia, normal immunologic function, and asymptomatic features were important clues that warned us to look for this unusual cause.

Laboratory diagnosis of Paragonimiasis is done by identification of eggs in the sputum/feces/pleural effusion or by serology. In areas where Paragonimiasis are endemic, the diagnosis of this parasitic disease generally depends on patient's intakes history, demonstration of eggs in sputum, bronchial acquisitions, or feces, laboratory data, and immunodiagnostic tests. An accurate diagnosis of paragonimus infection should be made on the discovery of parasite eggs, but the detection rate of eggs is very low for now, possibly for the reason of low-density infections. For P. skrjabini complex, few can sexually mature in human lung, thus it is almost impossible to find the eggs in patients. At present, ELISA is considered as one of the most reliable and widely used diagnostic role for paragonimiasis. Also, Immunoblot test, as another feasible detecting technology to diagnose paragonimiasis, reportedly have a sensitivity and specificity of 96% and 99%, respectively. In the present case, paragonimiasis was diagnosed by subsequent serological test, in accordance with many cases that presented only eosinophilic infiltration without eggs.

Conclusion
As to unknown wandering pleural effusion and infiltration, physicians should attentively analyze the chest radiogram, consider the possibility of paragonimiasis in endemic areas, and concern about patient’s ingestion history, while performing immunological tests and histological examination.

Declaration of conflicting interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics approval
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Supplemental material
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