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Review Article

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Imported Familial Pulmonary and Cerebral Paragonimiasis in Korea: Cases and Literature Review from a Clinical Grand Round Conference

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ABSTRACT

Paragonimiasis, most commonly caused by *Paragonimus westermani*, is endemic in East and Southeast Asia and commonly transmitted through ingestion of raw or undercooked freshwater crab or crayfish. While pulmonary manifestations predominate, extrapulmonary involvement such as cerebral paragonimiasis can occur. We describe three cases of imported familial pulmonary and extrapulmonary paragonimiasis from Southeast Asia and diagnosed in Korea. A 12-year-old boy presented with dizziness, headache, nausea, and vomiting. Brain magnetic resonance imaging revealed a hemorrhagic mass-like lesion with leptomeningeal enhancement, and chest tomography showed serpiginous tubular opacities with multifocal consolidations. Laboratory evaluation revealed marked eosinophilia (46.2%). Further history revealed habitual consumption of raw crayfish while residing in Cambodia. Serology was positive for *P. westermani* and *Clonorchis sinensis* IgG. Treatment with albendazole and praziquantel resulted in resolution of symptoms and normalization of eosinophil counts. Further evaluation identified similar findings in his parents who were misdiagnosed as tuberculosis and cerebral hemorrhage, and the family was treated with praziquantel. This familial cluster highlights the importance of detailed dietary and travel history in patients with eosinophilia and neurological symptoms. This case was discussed at the Clinical Grand Round of the Korean Society of Infectious Diseases on November 7, 2024.

Keywords: Paragonimiasis; Crayfish; Tuberculosis; Parasite

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INTRODUCTION

Paragonimiasis, caused by lung fluke most commonly by *Paragonimus westermanii*, is a parasitic infection in humans, transmitted by ingesting raw or undercooked crab or crayfish harboring the parasite. The trematode has wide geographic distribution in Asia, Africa, and Americas; *P. westermanii* is most commonly found in East Asia while a wider range of *Paragonimus* such as *P. westermanii* complex, *P. heterotremus,* and *P. srkjabini* are known to be endemic in Southeast and South Asia [1, 2]. The infection primarily involves the lungs and pleura, but extrapulmonary manifestations such as cerebral paragonimiasis may also occur [3].

Here, we describe three cases of imported pulmonary and cerebral paragonimiasis acquired in Southeast Asia and subsequently diagnosed in a Korean family.

CASE PRESENTATION

A 12-year-old boy was referred to the pediatric infectious disease division for evaluation of eosinophilia. He had initially presented to the department of pediatric neurology due to dizziness, headache, and nausea that began three days prior to admission and gradually worsened.

He was born at term with an unremarkable perinatal history and normal growth parameters. His past medical, allergy, and medication histories were noncontributory. The family had resided in rural Cambodia for four years and had returned to Korea two years earlier.

On examination, he was alert and afebrile (36.5°C), and stable vital signs within normal age for his age (blood pressure 99/54 mmHg, heart rate 97 beats/min, and respiratory rate 18 breaths/min). Neurologic examination revealed no focal neurologic deficit. His neurologic symptoms occurred daily, with episodes of dizziness lasting five minutes and waxing-and-waning headaches.

Laboratory findings are shown in **Table 1**. White blood cells (WBCs) count was 11,540×10^3 /mm^3 (neutrophil percentage, 18.5%, lymphocyte percentage, 39.2%, eosinophil percentage, 46.2%), platelet count of 350×10^3/mm^3, erythrocyte sedimentation rate level of 51 mm/hr and C-reactive protein level of 4.6 mg/dL. His initial chest radiograph was unremarkable without any nodule or consolidation. His follow-up brain magnetic resonance imaging (MRI) at our center revealed 2.2 cm-sized hyperintense round lesion with hemorrhage and localized leptomeningeal enhancement on T2 imaging, suggesting localized meningoencephalitis (**Fig. 1A**). Cerebrospinal fluid (CSF) analysis showed clear appearance, red blood cell count 0/μL, WBC count 7 /mm^3, which is for this age, considered mildly elevated, protein 21.1 mg/dL, and glucose 57 mg/dL (serum 92 mg/dL), and negative bacterial culture and meningitis multiplex virus panel.

Table 1. Initial laboratory data of patient

Blood test	Result	Normal range
White blood count /mm^3	11,540	4,000–10,800
Neutrophil count, /μL (%)	2,140 (18.5)	39–74
Lymphocyte count, /μL (%)	3,470 (39.2)	19–51
Monocyte count, /μL (%)	390 (3.4)	3.3–10.8
Eosinophil, /μL (%)	5,340 (46.2)	0–7
Hemoglobin, g/dL	14.6	11.2–14.5[a]
Platelet, ×10^3/mm^3	350	150–400
Blood urea nitrogen, mg/dL	11.5	8–18.5
Creatinine, mg/dL	0.56	0.39–0.80
Aspartate aminotransferase, U/L	19	13–34
Alanine aminotransferase, U/L	3	5–46
Erythrocyte sedimentation rate, mm/hr	51	0–15
C-reactive protein, mg/dL	4.6	0–8
Total IgE, kU/L	>5,000	10yr <22

[a]Age-based hemoglobin range.

Given the eosinophilia and MRI findings, parasitic infection was suspected. Chest computer tomography (CT) revealed serpiginous tubular opacities and multifocal consolidations in both lungs, predominantly in the right upper lobe (**Fig. 1B**). Abdominal-pelvic CT was unremarkable. Enzyme-linked immunosorbent assay (ELISA) panel of both serum and CSF including toxocariasis, *Trichinella*, cysticercosis, sparganum, *P. westermani, Clonorchis sinensis, and Entamoeba histolytica* IgG was done as well as stool ova and egg test (**Table 2**). Upon the impression of parasitic infection, albendazole and praziquantel were both initiated empirically.

Table 2. Additional laboratory results including parasitic serology

Test name	Result (titer)	Cut off
Serum ELISA test		
Toxocariasis Ab IgG	Negative (0.04)	>1.0
Trichinella IgG	Negative (0.03)	0.06
Cysticercosis Ab IgG	Negative (0.041)	0.252
Sparganum Ab IgG	Negative (0.041)	0.242
Paragonimus westermani Ab IgG	Positive (2.105)	0.248
Clonorchis sinensis Ab IgG	Positive (0.433)	0.25
Direct *P. westermani* smear (sputum)	Negative	NA
Stool ova/egg	Negative	NA

ELISA, enzyme-linked immunosorbent assay; NA, not applicable.

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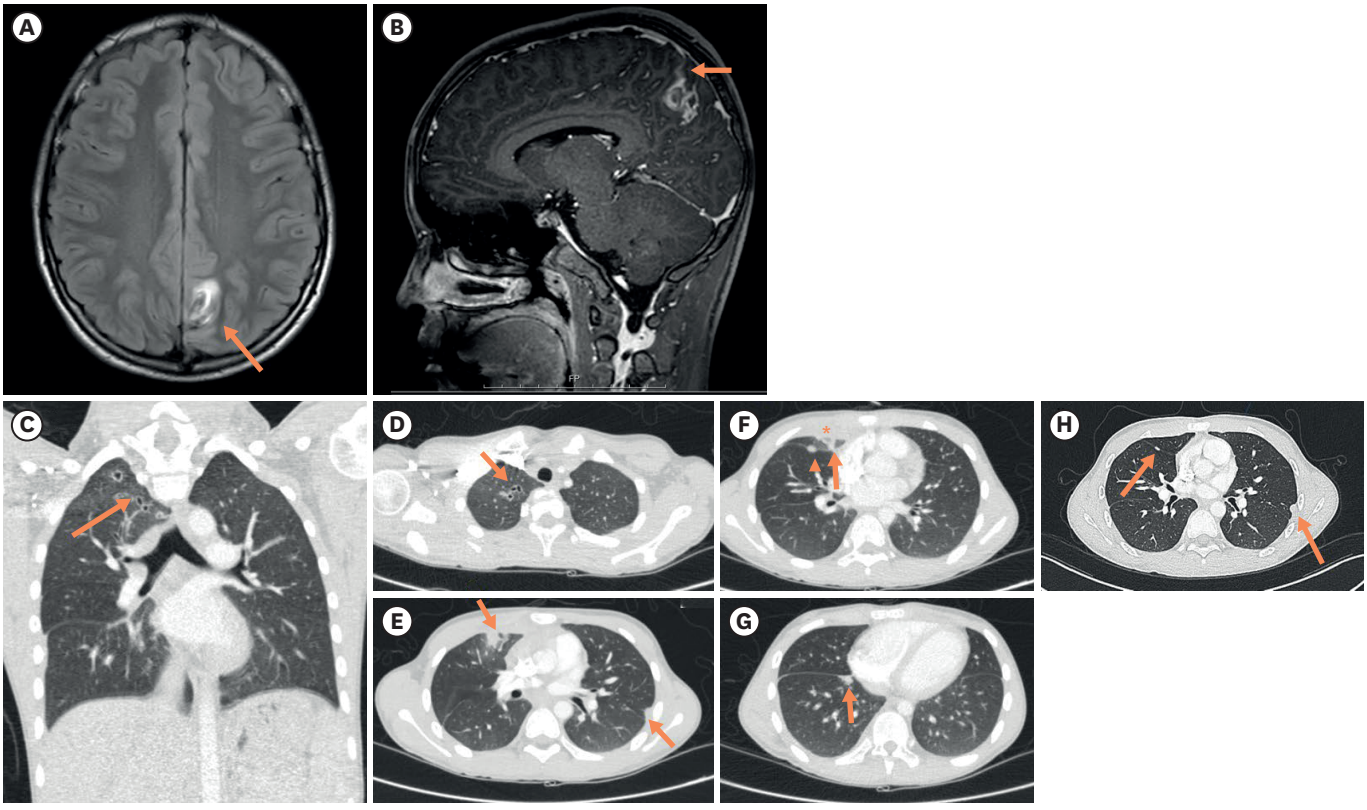

Figure 1. Radiologic findings of pleuropulmonary and cerebral paragonimiasis in a 12-year-old male presenting with severe headache. (A) Axial T2-weighted FLAIR brain MRI shows a hyperintense lesion with internal hemorrhage in the left parietal lobe (arrow). (B) Contrast-enhanced sagittal T1-weighted MRI demonstrates adjacent localized leptomeningeal enhancement (arrow], suggestive of localized meningoencephalitis. (C, D) Chest CT in lung window reveals a serpiginous tubular structure in the right upper lobe apex, consistent with a worm migration tract, seen on both coronal (C) and axial (D) images. (E) Multiple subpleural consolidations are noted in the right middle and left lower lobes (arrows). (F) Diffuse pleural thickening in the right anterior thorax (*) with a subpleural nodule at the right minor fissure (arrowhead) and linear opacities in the right upper lobe anterior segment (arrow). (G) Additional subpleural nodule along the right major fissure (arrow). (H) Follow-up chest CT obtained 8 months later demonstrates interval improvement of previous pulmonary lesions, with residual subpleural consolidation in the left upper lobe (arrow) and decreased subpleural nodule along the right minor fissure (arrow).
FLAIR, fluid-attenuated inversion recovery; MRI, magnetic resonance imaging; CT, computed tomography.

Upon re-evaluation, the family disclosed critical information; they frequently purchased local crayfish in the market near the Mekong river and the mother cooked seasoned crayfish or "ganjang gejang" in Cambodia. Further evaluation revealed familial clustering according to timeline as illustrated in **Figure 2**.

- Father: He had experienced a chronic cough and sputum production for several years, which progressed to dyspnea. After returning to Korea, he was diagnosed with left pleural effusion and underwent chest tube insertion (**Fig. 3A**). Both interferon-gamma release assay and sputum culture for *Mycobacterium tuberculosis* were negative. Nevertheless, presumptive tuberculosis (TB) was treated empirically with anti-tuberculosis therapy for six months. Retrospective review of his laboratory data revealed an absolute eosinophil count as high as 2,400/μL during follow-up.
- Mother: Approximately one year before her son's symptom onset, she developed seizures and was diagnosed with epilepsy secondary to a cerebral hemorrhage, for which levetiracetam was prescribed. When the medication was tapered off, her seizure relapsed. However, seizures recurred one year later due to worsening hemorrhagic lesions. Retrospective review of her initial brain MRI demonstrated findings compatible with cerebral paragonimiasis (**Fig. 3B**). In addition, review of her prior chest CT—originally performed as part of her husband's postexposure tuberculosis screening—revealed subtle pulmonary nodules (**Fig. 3C**).
- Younger siblings: Asymptomatic; only the youngest daughter had not consumed the raw crayfish.

Due to family's wholesome piece of information, the family was tested and the parents, our patient, and the first younger sibling's parasitic ELISA tests were positive for *P. westermani* as well as *C. sinensis*. The patient completed

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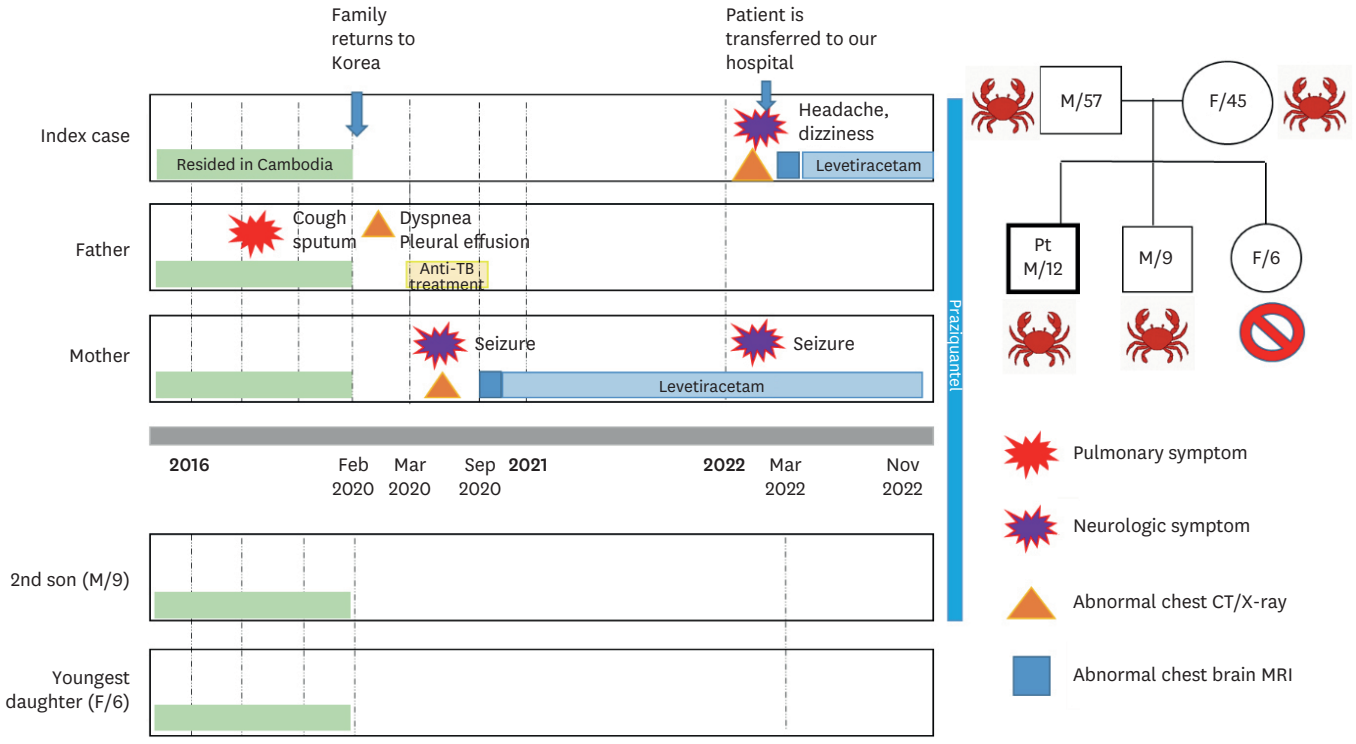

Figure 2. Timeline of family members' symptoms and signs during the diagnostic process.
CT, computed tomography; MRI, magnetic resonance imaging.

Table 3. Participants of the clinical grand round discussion

Role	Name	Affiliation
Moderator	Tae Hyong Kim	Soonchunhyang University, Seoul Hospital
Case presenter	Ji Young Lee	Yonsei University College of Medicine, Severance Children's Hospital
Audience	Junsik Choi	Yonsei University College of Medicine, Gangnam Severance Hospital

a three-day course of praziquantel with resolution of neurological symptoms and normalization of eosinophilia. Nine months later, follow-up chest CT of the patient demonstrated near-complete resolution of pulmonary lesions (**Fig. 1H**). Although a follow-up brain imaging was not conducted, our patient did not exhibit neurologic symptoms nor signs and was able to taper off levetiracetam in three months. Finally, the entire family received praziquantel therapy, and the mother's seizures resolved, allowing discontinuation of antiepileptic medication.

MINUTES OF THE CLINICAL GRAND ROUNDS ON NOVEMBER 7, 2024

This case was discussed at the Clinical Grand Round of the Korean Society of the Infectious Diseases conference in 2024. The discussion began with the moderator's inquiry about the case and appointed an audience for further discussion. **Table 3** shows the participants of the discussion.

1. What is the most needed diagnostic test or information in the next step?

Tae Hyong Kim: To summarize the presentation so far, this patient has eosinophilia, and pulmonary infiltrate on the chest CT as well as focal brain lesion. All the choices are somewhat needed in the diagnosis of this patient, but what is most needed information at this point? I would like ask Professor Junsik Choi from pediatric infectious diseases.

Junsik Choi: Given the eosinophilia and brain lesion, food consumption history as well as animal exposure history would be priorities. Parasitic infection is possible, but without confirmation I would hesitate to start treatment empirically. Drug allergy history seems less relevant here. Parents' TB history would have been already asked, but still important. I do not suspect

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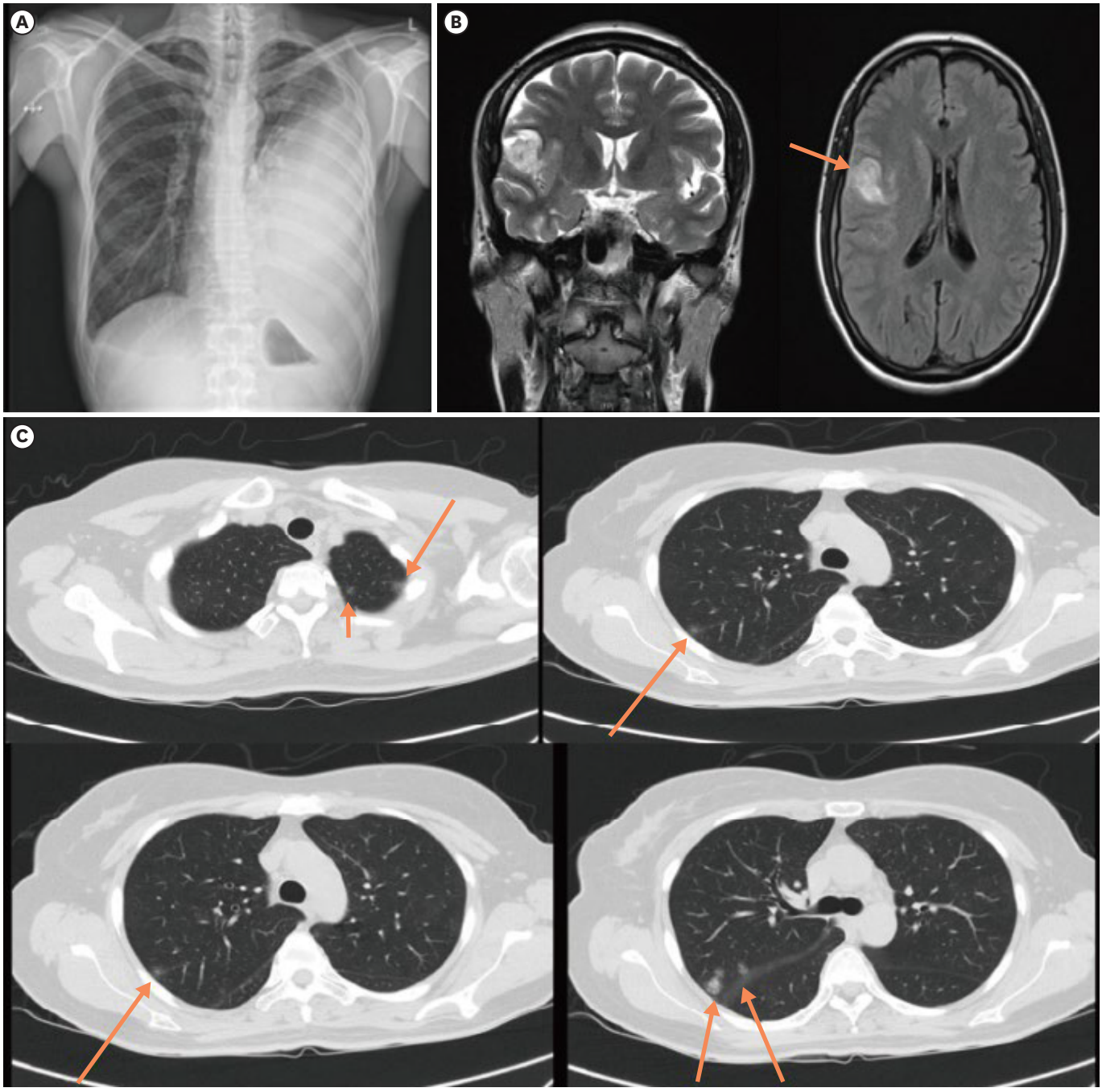

Figure 3. Family members' medical history and imaging findings.
(A) Father's chest radiograph at the time of empyema diagnosis shows left-sided pleural effusion with lung collapse and an air–fluid level. (B) Coronal T2-weighted FLAIR brain MRI demonstrates a hyperintense lesion with internal hemorrhage in the right frontal lobe, and axial contrast-enhanced T1-weighted MRI shows adjacent localized leptomeningeal enhancement (arrow), suggestive of localized meningoencephalitis. (C) Mother's initial axial chest CT scan during post-tuberculosis exposure screening reveals multiple subpleural ground-glass opacities and nodular consolidations (arrow), findings compatible with pulmonary paragonimiasis.
FLAIR, fluid-attenuated inversion recovery; MRI, magnetic resonance imaging; CT, computed tomography.

immunocompromised in this patient, so the serum aspergillus galactomannan test and anti-HIV antibody would be unnecessary. Therefore, my choice would be animal contact history or parents' TB history.

Tae Hyong Kim: In pediatric infectious diseases, how common is TB in children compared to adults? Because if it were an adult case, TB would have been a common choice.

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Junsik Choi: Children under the age of five are at higher risk of extrapulmonary TB such as TB meningitis and osteomyelitis, which is why BCG is included in the national immunization program. But in school-aged children and adolescents, pulmonary infiltrates are more often due to *Mycoplasma*. Sometimes these cases are initially isolated for suspected TB but are later confirmed as *Mycoplasma* pneumonia.

Tae Hyong Kim: Thank you for your valuable opinion and perspective. Dr. Lee, would you have considered *Mycoplasma* as a possible option for differential diagnosis?

Ji Young Lee: *Mycoplasma* pneumonia would have been one of the differential diagnoses, but typically presents with lobar consolidation on chest X-ray. This patient's x-ray was nearly normal and chest CT had nodular infiltrates which is not typical of *Mycoplasma*.

Because the child had pleuropulmonary involvement, TB needed to be ruled out therefore parents' TB history would be most important information. Children live with their parents, so family history is crucial. History taking is always more important than diagnostic test. Parents later reported that when they had returned from Cambodia where they lived for three years and father developed empyema, and was treated with six months of anti-TB therapy. A year after his diagnosis, mother was diagnosed with epilepsy, due to focal seizure. Subsequent year, she was admitted to the hospital due to brain hemorrhage, and her brain MRI revealed similar finding as the patient. The entire family had been unwell since the return to Korea.

2. What is the diagnosis of this patient?

Tae Hyong Kim: Additional information we have is that the family is ill, and because the answer to the first question was TB history does not mean that the diagnosis of this family is TB. The majority of the audience voted for toxocariasis and paragonimiasis, narrowing the impression down to parasitic infection.

Ji Young Lee: Without revealing the answer right away, additional critical hint will be given. As history taking cannot be overemphasized, raw food consumption as Professor Choi mentioned is the key. This family habitually ate "ganjang gejang"or raw crab marinated in soybean sauce, from local market nearby the river in Cambodia. The 9-year-old brother and 6-year-old sister lived with the patient, but the younger sister, who did not eat raw crab, remained healthy. Serologic testing showed positive *P. westermani* antibodies in all affected family members, except the youngest. Direct smear and stool ova tests were negative, but the family was treated with praziquantel and showed marked clinical and radiologic improvement. In conclusion, the final diagnosis was paragonimiasis.

DISCUSSION

Paragonimiasis is a foodborne parasitic infection, caused by ingestion of raw or undercooked crabs or crayfish infested with *Paragonimus* genus, most commonly *P. westermanii*. While *P. westermanii* is endemic to Korea, China, and parts of Southeast Asia, other species such as *P. heterotremus, and P. skrjabini* are distributed in Southeast Asia. Although most epidemiological studies from Southeast Asia have been conducted in Thailand and Vietnam, we were unable to identify the etiologic pathogen in our cases due to limited data from Cambodia [2]. Nevertheless, the diagnosis of paragonimiasis was established based on clinical and radiologic findings.

This case highlights how Korean expatriates who maintained traditional dietary habit abroad, can acquire parasitic infections that mimic other diseases such as tuberculosis, upon returning to Korea. Therefore, this imported paragonimiasis warrants clinical attention, and a thorough history taking—including travel history and dietary habits of all members of the family—is crucial for accurate diagnosis and prompt treatment.

Clinical manifestations of paragonimiasis are often nonspecific, and diagnosis can be delayed, particularly in children whose dietary histories are difficult to obtain. Common symptoms include insidious onset of fever, cough, chest pain. Pulmonary disease is often mild, and may be overlooked. Extra-pulmonary involvement occurs when flukes migrate beyond the lungs, most commonly to the brain, causing paralysis, seizures, and motor, cognitive impairment. As summarized in **Table 4**, recent pediatric cases reported in East Asia typically involve pulmonary and cerebral disease, with occasional rare presentations such as abdominal subcutaneous [4]. Adults, by contrast, have demonstrated a wide spectrum of presentations, including fulminant myocarditis [5], peritoneal paragonimiasis mimicking diverticulitis or abdominal abscess [6], subcutaneous abscess in lower

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Table 4. Summary of recently reported pediatric paragonimiasis cases in East Asia

Year [reference]	Age/sex	Country	Source	Clinical symptom and sign (n, %)	Initial presumptive diagnosis	Outcome
2011 [30]	9/F	Korea	Raw crabs	Hemoptysis, fever, cavitary lesion on CXR	Pulmonary tuberculosis	Cured
2012 [7]	12/F	Korea	Raw crabs	Dysarthria, facial palsy, clumsiness of right hand, progressed to seizures	Ruptured vascular malformation	Cured
2013 [31]	89 cases of cerebral paragonimiasis (68 children)	China	Raw crayfish	Headache, nausea, vomiting, speech disorders, limb movement	Cerebral hemorrhage, tumor, cerebrovascular disease	Cured
2015 [27]	18 children (range: 4–19 years old) 72.0% male	China	Raw crayfish	Cough, hemoptysis, paralysis, seizure	Pulmonary tuberculosis, stroke	6 patients with mild motor dysfunction 1 impaired memory
2017 [6]	16/M	Korea	Raw crabs	Abdominal, flank pain	Peritonitis	Cured
2018 [28]	6/F	Korea	Raw crabs	Chronic abdominal pain and erythematous rash; pleural effusion	*Mycoplasma pneumoniae* infection	Cured
2023 [32]	45 children (range: 18 months–16 years old) 69.0% male	China	Untreated water (16, 35.5%), onsuming raw freshwater crab (25, 55.6%), consuming raw meat (10, 22.2%)	Thoracopulmonary type (14, 31.1%), extrapulmonary (6, 13.3%), complex (25, 55.6%)	Tuberculosis, tumor, viral encephalitis	Cured except 1 patient (cerebral paragonimiasis)

CXR, chest x-ray.

back mimicking acute pyelonephritis or ureter stone [7], and hepatic involvement [8]. Therefore, physicians should be aware of possibility of diverse symptoms due to paragonimiasis.

Peripheral eosinophilia is a common but nonspecific laboratory finding parasitic infection. Eosinophilia, defined by >500 eosinophils per μL or >7% of leukocytes are eosinophils, warrants evaluation for allergic, parasitic, and hematologic causes [9]. Eosinophilia has low positive predictive value in diagnosing helminth infections ranging from 14.0–18.9% [10, 11]. In a large study including 14,298 travelers with suspected infections, eosinophilia was present in 4.8% and only 18.9% had helminth infections. Higher eosinophil counts correlated with parasitic infection, with a mean of 1,545 eosinophils/μL [11]. In our case, marked eosinophilia (5,340 cells/μL] was present in the child, and elevated counts were also retrospectively noted in his parents (3,700 and 2,400 cells/μL). Earlier recognition of eosinophilia in the parents could have prompted timely diagnosis and prevented diagnostic delay in the index patient.

Additionally, eosinophilia may also mislead diagnosis when overlapping with other diseases. For example, a 48-old-year-old Japanese woman with cerebral paragonimiasis was initially misdiagnosed as eosinophilic granulomatosis with polyangiitis, who had multiple nodular pulmonary lesions accompanied by hemorrhagic mass lesion motor cortex [12]. Another case report of misdiagnosed pulmonary paragonomiasis in Japanese adult as chronic eosinophilic pneumonia was described [13]. Therefore, when eosinophilia is accompanied by relevant dietary or exposure history, further testing such as serology and direct observation of ovum is crucial.

Diagnosis relies on serology for *Paragonimus* IgG, which has high sensitivity (86–98%) and specificity (90–95%) in endemic regions [14, 15]. Its correlation rate with clinical evidence was 81.8%, which was higher than other helminthic infections such as clonorchiasis and cysticercosis, and showed cross-reactivity upto 20.5% mainly between *Paragonimus* and *Clonorchis* genus [16, 17]. As our patient had positive IgG for *P. westermanii* as well as *C. sinensis*, differential diagnosis was made clinically, as cross-reactivity with other trematode or cestodes is commonly reported [18, 19]. Additionally, although the patient exhibited seropositivity for *P. westermanii*, cross-reactivity with other species within the *Paragonimus* genus such as *P. heterotremus* and *P. pseudoheterotremus* has been previously reported therefore etiologic diagnosis of *P. westermanii* infection cannot be made [20]. The gold standard remains identification of eggs in sputum, stool, or tissue; however, this is challenging especially in children due to poor sputum expectoration, and negative results cannot exclude disease.

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As for the treatment, praziquantel for three days is the recommended first-line therapy in both adults and children [21]. However, treatment failure rates up to 64.0% have been reported, requiring additional therapy with triclabendazole [22, 23]. Factors associated with failure include prolonged duration of respiratory symptoms, higher *P. westermani* IgG titers, and multiple pulmonary lesions [23]. In our index patient, combined praziquantel and albendazole were administered empirically for suspected parasitic infection, with good clinical and radiological response, and no need for second-line therapy. Albendazole may be added in endemic areas where possible co-infection with other parasites is suspected.

Although conservative treatment with corticosteroids and anti-epileptic drug remains the mainstay treatment for cerebral paragonimiasis, surgical treatment is not routinely required but should be considered when complications such as hydrocephalus or pseudoaneurysm occur [21, 24, 25]. In a Chinese cohort of 14 pediatric patients with cerebral paragonimiasis, four underwent neurosurgical resection, and none of them developed neurological sequelae postoperatively. Although the indication for surgery was not clearly described, the size of the lesion and the severity of neurological symptoms likely influenced the decision to proceed with resection [26]. In another retrospective series involving 10 patients with hemorrhagic cerebral paragonimiasis, four underwent surgical resection. The highest risk of stroke was observed within one month after the onset of neurological symptoms, underscoring the importance of early clinical suspicion and prompt diagnosis in patients presenting with unexplained cerebral hemorrhage or cerebrovascular malformations [27]. Our patient responded well without additional interventions and successfully discontinued antiepileptic medication after three months.

Clinical outcome of paragonimiasis if treated promptly is favorable; however, literature review demonstrates varying range of complications such as neurologic deficits in patients with cerebral involvement. A retrospective case series of 27 cerebral paragonimiasis in China including adults and children revealed fine motor dysfunction, motor and sensory impairment, personality change, and impaired memory [25]. This necessitates the need for early diagnosis and treatment especially in children in order to prevent long-term complications. Continued public health education targeting dietary habits and improved food safety should be warranted.

In conclusion, this case highlights pulmonary and cerebral paragonimiasis masquerading as tuberculosis and hemorrhagic brain mass, resulting in delayed recognition. The family cluster underscores the importance of detailed dietary and travel history in evaluating eosinophilia and unexplained neurological or pulmonary lesions. Misdiagnosis as tuberculosis in the father and delayed recognition of cerebral hemorrhage in the mother illustrate diagnostic pitfalls. When similar symptoms are present in a family, investigation including thorough history taking is required, in which raw crayfish consumption served as a critical clue. Recent reports of a familial case of paragonimiasis are rare, and our report emphasizes the importance of history taking and holistic care of the family [28, 29].

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Ethics statement
Written informed consent was obtained from the patient for the publication of this case report and the accompanying images. A copy of the written consent form is available for review upon request. This study was approved by the Institutional Review Board of Yonsei Medical University (IRB No. 2025-0515-001].

Conflict of Interest
No conflict of interest.

Author Contributions

Conceptualization: JYL, JGA; Data curation: JYL,JGA,HY, ML; Formal analysis: JYL, JYB, HY, ML Methodology: JYB, JGA. Writing - original draft: LJY. Writing - review & editing: JYL HY, ML, HK, SHK, JSL, JK, JGA.

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