INTRODUCTION

Although pork remains the predominant source of trichinellosis throughout the world, other meats occasionally have been implicated as well [1]. In recent years, the *Trichinella* spp. host range has been widening, and new species and genotypes have emerged [1]. A wider host spectrum is especially evident in non-encapsulated species, such as *Trichinella pseudospiralis*, infecting birds [2]. Furthermore, it has been shown that *Trichinella papuae* and *Trichinella zimbabwensis* can infect reptiles, the species living in equatorial regions [2]. It has also been established that the life cycle of *Trichinella spiralis* can be reproduced in reptiles when maintained at higher temperatures [3].

Human trichinellosis transmission via consumption of reptile meat is rare worldwide. In Korea, however, 2 such outbreaks, possibly via consumption of soft-shelled turtle meat, have occurred in 2 successive years. In 17 August 2014, 6 patients were admitted to Wonju Severance Christian Hospital complaining of myalgia, fever, and headache. Eosinophilia was the indication of the initial laboratory results, and they were eventually diagnosed as trichinellosis by ELISA. All of the patients worked at the same company and had eaten raw soft-shelled turtle meat at a company dinner 10 days prior to their admission. They were treated with albendazole for 2 weeks, upon which all of their symptoms disappeared. This is the 8th report on human trichinellosis in Korea, and the second implicating raw soft-shelled turtle meat.

CASE RECORD

A 42-year-old woman residing in Wonju, Gangwon-do was admitted to the Department of Internal Medicine, Wonju Severance Christian Hospital on 17 August with 5 of her colleagues, all complaining of myalgia, headache, and fever. Prior to the onset of their symptoms (7 days before their admission), they had been healthy. Along with the aforementioned symptoms, some of them also complained of periorbital edema, diarrhea, skin rash, and pruritus. Eosinophilia was observed in all of their blood (1,225-10,760/µl), and biochemical examinations showed that creatinine phosphokinase (CPK) and lactic dehydrogenase (LDH) were elevated in some of the patients (Table 1). They worked at the same company, and had all consumed raw soft-shelled turtle meat at a company dinner on 1 August (Fig. 1). On 6 September, at the Department of Parasitology and Tropical Medicine, Seoul National
University College of Medicine, ELISA was performed under the suspicion of trichinellosis. For use in the formulation of a crude antigen, T. spiralis larvae were recovered from laboratory-maintained mice. The sera collected from the 5th Korean outbreak were used as a positive control, and the other ELISA procedures were the same as those in a previous Clonorchis sinensis ELISA [7]. Three of the present serum samples showed positivity against T. spiralis larval antigen (Table 2). An additional ELISA was performed on 24 September, which confirmed the positivity of the remaining 3 sera. Since all the 6 patients had eaten the turtle meat at the same time and they had no experience of wild boar meat in raw, the turtle meat was strongly suspected as the source of infection. They were treated with albendazole (800 mg/day) for 14 days, and their symptoms were gradually resolved. At the follow-up visit 3 months later, all of them were healthy without any clinical signs of trichinellosis. This is the 8th report on human trichinellosis in Korea and the second one implicating raw soft-shelled turtle meat.

**Table 1.** Laboratory findings of patients in the present case

| No. | Sex | Age | WBC  | EOS (%) | CK  | LDH  | AST  | ALT  |
|-----|-----|-----|------|---------|-----|------|------|------|
| 1   | M   | 40  | 23,190 | 46.4  | 7,332 | 874  | 101  | 115  |
| 2   | M   | 28  | 9,010  | 13.6  | 456  | 292  | 21   | 18   |
| 3   | M   | 31  | 10,320 | 20    | 261  | 454  | 32   | 45   |
| 4   | M   | 32  | 16,110 | 28.5  | 164  | 349  | 21   | 28   |
| 5   | M   | 43  | 13,350 | 20.5  | 488  | 303  | 25   | 20   |
| 6   | F   | 42  | 9,810  | 25.6  | 77   | 277  | 36   | 35   |

WBC, white blood cell/mm$^3$; EOS, eosinophil; CK, creatine kinase; LDH, lactic dehydrogenase; AST, aspartate amino-transferase; ALT, alanine transaminase.

**Table 2.** ELISA results in sera of 6 patients$^a$

| No. | ELISA IgG (3 week)$^b$ | ELISA IgG (5 week)$^c$ |
|-----|-----------------------|-----------------------|
| 1   | 0.458 (positive)      | 0.678 (positive)      |
| 2   | 0.177 (negative)      | 0.442 (positive)      |
| 3   | 0.053 (negative)      | 0.553 (positive)      |
| 4   | 0.382 (positive)      | 0.565 (positive)      |
| 5   | 0.559 (positive)      | 0.192 (negative)      |
| 6   | 0.254 (borderline)    | 0.733 (positive)      |

$^a$ELISA was done in the Department of Parasitology, Seoul National University College of Medicine.

$^b$Reference for positive and negative: 0.316, 0.034.

$^c$Reference for positive and negative: 0.836, 0.087.

**DISCUSSION**

The results of the present study strongly suggest that trichinellosis had been spread in Korea by consumption of soft-shelled turtle meat. This fact has added weight given that soft-shelled turtle meat has been used medicinally for many decades in Korea [8] and that some Koreans still believe that soft-shelled turtle meat helps hemopoiesis. Thus, possible mechanisms by which soft-shelled turtles harbor Trichinella sp. larvae should be explored.

Among various species of soft-shelled turtle, only Trionyx sinensis has been distributed in Korean waters [9]. Korean soft-shelled turtles usually eat aquatic animals such as fish, crabs, and frogs. Many of them, as were those in the present case, are raised in aquatic farms [8]. In order to trace the route of infection, contact with the farm owner was attempted, though the effort proved unsuccessful due to the sudden closure of the farm. Ruling out infection by formulated feeds, we speculated that it might have been transmitted through the consumption of other animals, or less likely, by cannibalism. Cannibalism among farmed crocodiles, for example, has been implicated as playing a central role in transmission of T. papuae infection [10]. In any case, it is known that without proper management of domestic animals, Trichinella infection can be transmitted from the sylvatic to the domestic environment [11]. In Korea, a systematic survey on the relation between Trichinella infection and soft-shelled turtles is urgently needed.

Indeed, despite the 8 trichinellosis outbreaks (including the present one) that have occurred in Korea, efforts to arrange for and complete epidemiological surveys of relevant wild life are still lacking. A serological surveillance was performed on pig breeding farms, showing them to be trichinellosis free, though the animals were investigated under controlled housing condi-
In the spread of trichinellosis, globalization might play a role. *T. papuae*, which has been proved, along with *T. zimbabwensis*, to infect mammals and reptiles, was suspected as the causative species in the 2008 Taiwan outbreak among people who had eaten raw soft-shelled turtle meat [5]. If established as the source of infection in the case, *T. papuae* known to be distributed in Thailand and Malaysia [26,27] could have been spread to Taiwan synanthropically in rats traveling with humans [28]. In the case of encapsulated species, larvae can survive in decaying muscles over long periods of time: 3 months for *T. nativa* and *T. britovi* in rat carcasses, for example [29]. In frozen carnivore muscle, *T. nativa* larvae can survive, in fact, for years [30]. The non-encapsulated species, *T. papuae* and *T. pseudospiralis*, meanwhile, can retain their infectivity up to 9 days at 20-24°C, and up to 40 days at 5°C [29]. Hence, in addition to widely disseminating information on the trichinellosis risk incurred in the consumption of raw soft-shelled turtle meat, significant investment in veterinary public health services should be made to prevent foodborne trichinellosis in Korea.

**CONFLICT OF INTEREST**

We have no conflict of interest related to this report.

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