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CASE REPORT

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A novel case of food poisoning caused by the consumption of Pacific bluefin tuna infected with *Kudoa hexapunctata*

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Abstract

Consumption of Japanese cuisine, such as sushi and sashimi, is accompanied by the risk of food poisoning through various pathogens. *Kudoa hexapunctata*, detected in both adult and juvenile Pacific bluefin tuna, causes foodborne diseases. Here, we report cases of food poisoning after *Kudoa hexapunctata*-infected PBT consumption.

We suggest that medical history about the fish used in sashimi and sushi preparation is used to assist in making the diagnosis as *Kudoa* infection.

KEYWORDS

food poisoning, gastroenterology, infectious disease, *Kudoa hexapunctata*, tuna

1 | INTRODUCTION

Consumption of Japanese cuisine, such as sushi and sashimi, is accompanied by the risk of food poisoning through various pathogens. *Kudoa hexapunctata*, detected in both adult and juvenile Pacific bluefin tuna, causes foodborne diseases. Here, we report cases of food poisoning after *Kudoa hexapunctata*–infected PBT consumption.

The *Kudoa* genus comprises more than 90 myxosporean parasitic species capable of infecting various marine fish.[1] In Japan, *K septempunctata* was recently associated with food poisoning caused by the consumption of infected raw olive flounder.[2,3] Until recently, infection potential of other members of the genus *Kudoa* in humans was unknown. However, in the past decade, Japanese researchers have reported foodborne diseases after the consumption of *K hexapunctata*–infected adult or juvenile Pacific bluefin tuna (PBT) (*Thunnus orientalis*).[4] Until recently, *K hexapunctata* was classified as an intraspecific variant of *K neothunni*, but it has now been established as a separate species [5,6]; it differs in spore shape, 28S rDNA sequences, and potential to cause myoliquefaction, which is absent in *K hexapunctata*. Although previous in vitro study suggested that *K hexapunctata* causes food poisoning,[4] currently it is not listed as a food poisoning–related pathogen in Japan. Here, we report food poisoning in 10 patients after consumption of juvenile PBT infected with *K hexapunctata*.

2 | CASE REPORT/CASE HISTORY

A 28-year-old man with severe diarrhea and nausea visited our emergency room after consuming food at a restaurant, along with 31 colleagues; as per the survey of the staff at the Izumo Health Center, 10 out of 32 individuals developed acute gastrointestinal symptoms several hours after the meal (attack rate, 31.3%; incubation period ≈ 7 hours; incubation distribution, 2-12 hours) with diarrhea and nausea being the most common symptoms (60.0%), followed by abdominal pain (50.0%) and fever (40.0%); the average number of bowel movements per day was approximately six (range: 4-8), and mean temperature was 37.4°C (range: 37.0-37.8°C).

We suggest that medical history about the fish used in sashimi and sushi preparation is used to assist in making the diagnosis as *Kudoa* infection.

As all the patients had consumed sashimi prepared using juvenile PBT, food poisoning was suspected, and meal leftovers and stool specimens from the patients were submitted to the Shimane Prefectural Institute of Public Health and Environmental Science, Japan. PCR analysis revealed that four of the seven stool (three samples were missing) samples and leftover sashimi samples harbored *Kudoa hexapunctata*. In addition, *Kudoa hexapunctata* was observed microscopically in two samples collected from the leftover (Figure 1). No suspected food poisoning–related pathogens other than *K hexapunctata* were detected in the stool samples. This diagnosis was made as all patients presented with transient diarrhea and vomiting, within a few hours of consuming sashimi containing juvenile PBT.

3 | DISCUSSION

In the present study, PCR analysis of the stool samples of seven patients and leftover sashimi (prepared from juvenile PBT) samples indicated *K hexapunctata* infection. Previous studies have confirmed the presence of *K hexapunctata* in both Japanese bluefin and yellowfin tuna, especially in PBT, with a higher rate of infection in juvenile than in adult fish. The *K hexapunctata* positivity rate in juvenile PBT from Japanese waters is generally high from May to July.[4] More than 70% of clinical diarrhea cases also caused by tuna ingestion occurred between June and September.[4] In the current study, juvenile PBT consumed by the patients were caught in early August, which is proximal to the aforementioned time frame. Therefore, concurrent with the previous reports, we considered the *K hexapunctata* positivity rate in juvenile PBT consumed by the patients to be high.[4] Surveys of the clinical diarrhea due to tuna ingestion in Tokyo indicated a 5- to 7-h incubation period until symptom onset.[4] In vitro studies have reported that the time lag until transepithelial electrical resistance (TER) across the Caco-2 cell monolayer decreases by 80% in cell monolayer permeability assays, which are performed to assess *K hexapunctata* toxicity in vitro. These results correlated with the incubation period reported in an epidemiological survey.[4] Rapid reduction in TER in an assay using the Caco-2 cell line, which has been widely used as an in vitro model for intestinal transport and enterotoxin studies, indicates the loss of human intestinal epithelial monolayer integrity, which is believed to cause diarrhea.[7] The incubation period and primary symptom (diarrhea) observed herein are consistent with those reported previously.[4] *K hexapunctata* does not cause gastrointestinal inflammatory symptoms, unless it is abundantly present in the raw fish consumed.[4] Hence, in the current study, some patients may not have developed gastrointestinal symptoms despite consuming the sashimi. It was also reported that TER of freeze-thawed *K hexapunctata* was not decreased in Caco-2 cell assays, which indicates the possibility to prevent food poisoning caused by *K hexapunctata*. In addition, previous study showed that the *K hexapunctata*–positive rate and number in tuna other than juvenile PBT were low and no *K hexapunctata* was detected in the residual food of clinical diarrhea cases by ingestion of tunas.[4] However, few studies have evaluated the cases of food poisoning that are thought to be caused by *K hexapunctata*. Therefore, it is necessary to investigate the suspected food poisoning cases caused by the ingestion of adult or juvenile PBT.

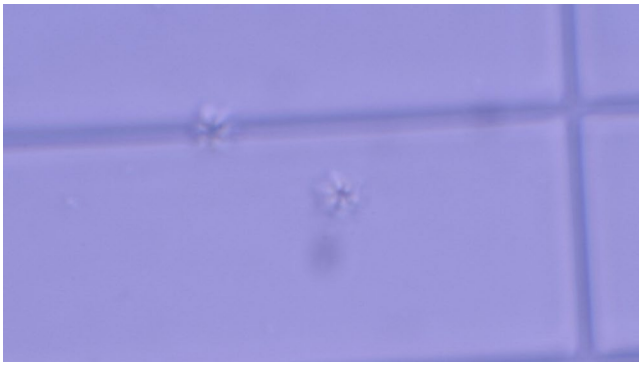

FIGURE 1 *Kudoa hexapunctata* spores. *K hexapunctata* spores harvested from juvenile Pacific bluefin tuna muscles from the sashimi leftovers. Scale bar: 10 μm

Symptoms of the patients were resolved within a few days without specific treatments. However, in case of patients with severe symptoms, supportive care (infusion fluids, antiemetics, and antifebrile treatment) may be required. Currently, Japanese cuisine is the second-most popular cuisine worldwide.[8] Moreover, a patient's history and physical examination usually form the basis of diagnosis for acute gastroenteritis, as culture or blood tests are rarely performed. This increases the chances of underdiagnosis or misdiagnosis of acute gastroenteritis due to parasites, including *K septempunctata*, and the condition is more commonly diagnosed as acute viral gastroenteritis. Acute gastroenteritis due to parasites, including *K septempunctata,* might be associated with autoimmune disease such as Guillain-Barre syndrome caused by Campylobacter; therefore, further experimental and epidemiological studies are required to elucidate the pathogenicity of *K hexapunctata*. Thus, it is important to acquire information about the fish used in sashimi and sushi preparation (raw flounder and adult or juvenile PBT) from the patients for clarifying whether their gastrointestinal symptoms (eg, vomiting and diarrhea) are associated with a *Kudoa* infection.

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CONFLICT OF INTEREST

None declared.

AUTHOR CONTRIBUTIONS

T.T and T.W: almost equally contributed, collected, analyzed, and interpreted data; drafted the article; and critically revised the article.

CONSENT TO PARTICIPATE

Patient consent was obtained prior to this study.

CONSENT FOR PUBLICATION

Patient consent was obtained prior to this study.

DATA AVAILABILITY STATEMENT

Not applicable.

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