Journal of Helminthology

cambridge.org/jhl

Possible case of trichinellosis associated with beaver (*Castor fiber*) meat

A.M. Bronstein[1,2] and A.N. Lukashev[1,3]

[1]Martsinovsky Institute of Medical Parasitology, Tropical and Vector Borne Diseases, Sechenov University, Moscow, Russia; [2]Department of Infectious Diseases and Epidemiology, Pigorov Russian National Research Medical University, Moscow, Russia and [3]Chumakov Federal Scientific Center for Research and Development of Immune-and-Biological Preparations, Moscow, Russia

Short Communication

Cite this article: Bronstein AM, Lukashev AN (2019). Possible case of trichinellosis associated with beaver (*Castor fiber*) meat. *Journal of Helminthology* **93**, 372–374. https://doi.org/10.1017/S0022149X18000342

Received: 13 February 2018
Accepted: 13 March 2018
First published online: 3 May 2018

Author for correspondence:
A. Lukashev, E-mail: alexander_lukashev@hotmail.com

Abstract

Although there have been occasional reports of rare and low-level trichinellae infestation in beavers, no human cases of beaver-associated trichinellosis have been described. This report presents a possible case of human trichinellosis linked to beaver meat. Increasing consumption of beaver meat necessitates raising awareness of this potential source of trichinellosis.

Introduction

Trichinellosis is caused by nematodes of the family Trichinellidae. After ingestion, *Trichinella* larvae grow rapidly. Adults mate and females shed newborn larvae, which enter the blood stream, migrate to striated muscles, assume a spiral shape and are subsequently encapsulated in most trichinellae species (Pozio & Zarlenga, 2013). The severity of infection in humans can range from asymptomatic to fatal, and largely depends on the infective dose.

Currently, nine species and three genotypes are recognized in the genus *Trichinella*. Six species of capsule-forming trichinelles have been found in over 150 mammal species, and three non-capsule forming species have been reported in 14 species of mammals and reptiles and in 13 bird species (Pozio, 2005; Korhonen *et al.*, 2016).

The major sources of human infection are carnivorous and omnivorous mammals that exhibit scavenging habits, such as domestic and feral pigs, bears, dogs and badgers. A total of 65,818 human cases were reported worldwide during 1986–2009 (Murrell & Pozio, 2011). Most cases were caused by *Trichinella spiralis*, which is prevalent globally among domestic pigs (Pozio, 2014). Other important causes of human infection are *Trichinella britovi*, which circulates among wild animals in temperate regions of Eurasia and is the second most common species of *Trichinella*, and *Trichinella nativa*, which circulates in northern and Arctic regions. Human infection in these regions is usually associated with consumption of bear and wild boar meat (Gottstein *et al.*, 2009; Kennedy *et al.*, 2009; Wilson *et al.*, 2015), but the prevalence of the disease is generally low. There are 10–20 cases per year reported in the USA (Kennedy *et al.*, 2009; Wilson *et al.*, 2015), and in Russia the total number of cases decreased from 201 in 2006 (Guzeeva, 2008) to 94 in 2014 and 35 in 2015 (Rospotrebnadzor, 2016). There are also reports of human infection associated with consumption of badger, jackal, raccoon, dog, fox and puma meat (Rostami *et al.*, 2017). In Arctic regions, human infection can be caused by *T. nativa*, which is prevalent among various wild animal species, including the polar bear *Ursus maritimus*, the Arctic fox *Vulpes lagopus* and marine mammals (Pozio, 2013). Crocodiles, monitor lizards and possibly turtles can also be infected by *T. papuae* and *T. zimbabwensis*, and associated human cases have been reported (Gottstein *et al.*, 2009; Lee *et al.*, 2013).

Although trichinellae have also been found in beavers (Rausch *et al.*, 1956; Zimmermann *et al.*, 1962; Seglina *et al.*, 2015), there has been no clear evidence of human infections from beaver meat consumption. This paper reports a possible case of trichinellosis associated with beaver meat consumption.

Results and discussion

A 24-year-old female patient from the Moscow region was admitted to a polyclinic, with fever and mild abdominal pain. She was diagnosed with yersiniosis and treated with antibiotics and antipyretics for seven days (table 1). Following a lack of improvement, she was admitted to the outpatient department of the First Moscow Infection Hospital, with fever (up to 37.8°C), facial (mainly para-orbital) oedema, fatigue, weakness, pain in muscle and joints of limbs, abdominal discomfort and mushy stool. A blood test revealed leukocytosis (11.8×10^9/l) with 17% (2.0×10^9/l) eosinophils. Biochemical markers of liver damage (ALT, AST, bilirubin, alkaline phosphatase) were within normal limits. Testing for creatine phosphokinase and aldolase was not done. Tests for HIV, syphilis, yersiniosis, viral hepatitis and rotaviruses were negative. No

CAMBRIDGE UNIVERSITY PRESS

Table 1. Timeline of the suspected case of trichinellosis associated with consumption of beaver meat in Moscow, Russia.

Date	Day of the disease	Details
5 Sept. 2017		Consumption of 100–150 g of stewed beaver meat
24 Sept. 2017	1	Onset of symptoms
25 Sept. 2017	2	First admission to outpatient clinic Hyperthermia: 38.2°C Facial (mainly para-orbital) oedema, fatigue, weakness, pain in muscles and joints of limbs, abdominal discomfort, mushy stool Leucocytes 11.4×10^9/l Eosinophils 1.7×10^9/l
1 Oct. 2017	8	Second admission to outpatient clinic Hyperthermia: 37.8°C Facial oedema, weakness, pain in muscles of lower limbs, mushy stool Leucocytes 11.8×10^9/l Eosinophils 2.0×10^9/l
2–11 Oct. 2017	9–18	Treatment: albendazole at 10 mg/kg/day for ten days

pathogenic bacteria were found in stool. Helminth eggs and pathogenic protists were not found during stool microscopy. Lung X-ray, oesophagogastroduodenoscopy, abdominal ultrasound and ECG did not find any pathological changes.

The patient reported a single episode of consumption of about 100–150 grams of stewed beaver meat. According to the patient, her father regularly hunts beavers in the Moscow region for meat. Preference towards beaver meat was justified by its 'ecological cleanness' because 'beavers eat only tree bark.' According to the patient, her father consumed the same meal and had similar symptoms at the same time, but refused to be admitted to the hospital for examination. Her mother never consumed beaver meat and did not have any health problems.

Clinical manifestations and food anamnesis suggested trichinellosis. The patient was positive for IgG antibodies to *Trichinella spiralis* (titer 1 : 600, the cut-off value for this test), using a Trichinella-IgG enzyme-linked immunosorbent assay (ELISA) kit (Vector-Best, Novosibirsk, Russian Federation). Unfortunately, the beaver meat was not available for testing because it was consumed two days before the onset of disease. Muscle biopsy was not carried out because this invasive procedure would not benefit the patient, and relatively mild clinical manifestations suggested a low chance of trichinellae detection.

The patient was treated with albendazole at 10 mg/kg/day for ten days. After ten days of treatment, all symptoms disappeared; leukocyte and eosinophil counts returned to normal four weeks after the start of treatment. According to the patient, her father recovered at the same time without albendazole treatment.

Diagnosis of trichinellosis requires confirmation by either muscle biopsy or a confirmatory Western blot following a screening ELISA. In this case, clinical manifestations were compatible with trichinellosis. A single detection of IgG provided only indirect support. Unfortunately, no additional test, such as a confirmatory Western blot, IgM test or paired serum (seroconversion) was done.

Beavers have not been implicated as a source of human trichinellosis; therefore, this case required an additional analysis. Beavers are amongst the largest rodents and can weigh up to 32 kg. The species *Castor fiber* is common in Europe and North Asia, whereas the species *Castor canadensis* is prevalent in North America. Beaver diet includes tree bark, leaves and other plants (Krojerová-Prokešová *et al.*, 2010), and does not contain an obvious source of trichinellae. However, there is indirect evidence that beavers occasionally consume meat, as rat liver parasites *Capillaria hepatica* and fish/crab parasites *Paragonimus westermani* have been detected in beavers (Craig & Faust, 1958). Trichinellae have been found in beavers (*Castor canadensis*), but the prevalence and larval load were low: one of 29 beavers with a load of 3.0/g in one report (Rausch *et al.*, 1956) and 5.3% positive beavers in another (Zimmermann *et al.*, 1962). The contemporary literature contains only one report from Latvia, describing detection of 5.96 larvae/gram of muscle tissue in just one of 182 beavers tested (Seglina *et al.*, 2015). In Russia, beavers have been mentioned in trichinellosis surveillance reports. In 2006, a total of 201 cases were registered in Russia, and 5% of these cases were associated with beavers (Guzeeva, 2008); however, no supporting evidence for these cases was published. Our patient did not report consuming other game meat. Farm pigs, which were the major source of trichinellosis in the 20th century, are implicated in less than half of cases nowadays (Guzeeva, 2008), and the patient did not acknowledge consumption of privately produced pork.

Beaver meat is consumed in many countries where beavers occur. In particular, in the USA and Canada beavers are a part of the diet of the indigenous population, and are among the most common game animals (Rinella, 2011). It is therefore surprising that they have not been implicated as a source of trichinellosis in the USA, although other game meat was the source of roughly half of the cases (Kennedy *et al.*, 2009; Wilson *et al.*, 2015). In Russia, beaver meat is also traditionally consumed for food. In the 20th century its popularity declined but in recent years it has been increasing. There is potential for an increase in the role of beavers (and other game animals) as a source of trichinellosis because beaver meat is commonly available as raw meat, sausage and stewed meat, and is marketed as organic, which raises the risk of under-cooking. Beaver hunting is often carried out without due licensing. Beaver farming is developing, too, but the extent of this industry is unknown, and meat is processed privately without appropriate control measures. At present, it is difficult to project the significance of beaver-borne trichinellosis for public health. A high level of trichinellae infection and a subsequent severe infection seems unlikely, and the moderate severity of the reported case can be ascribed in part to low infection levels reported in beavers. However, it is possible to imagine a scenario of poor farming practices leading to a beaver-borne trichinellosis outbreak. In any case, it is important to raise public awareness regarding beavers as a source of trichinellosis and to promote safe cooking habits among consumers of exotic meat.

Financial support. This study did not receive any financial support.

Conflict of interest. Authors declare that they do not have a conflict of interest.

References

Craig CF and Faust EC (1958) *Clinical parasitology*. 6th edn. Philadelphia, Lea & Febiger.

Gottstein B, Pozio E and Nöckler K (2009) Epidemiology, diagnosis, treatment, and control of trichinellosis. *Clinical Microbiology Reviews* **22**, 127–145.

Guzeeva TM (2008) The incidence of parasitic diseases in the Russian Federation and tasks under service reorganization. *Meditsinskaia Parazitolgiia* **1**, 3–11 (in Russian).

https://doi.org/10.1017/S0022149X18000342 Published online by Cambridge University Press

Kennedy ED, Hall RL, Montgomery SP, Pyburn DG, Jones JL and Centers for Disease, Control nd Prevention (2009) Trichinellosis surveillance - United States, 2002–2007. *MMWR Surveillance Summaries* **58**, 1–7.

Korhonen PK, Pozio E, La Rosa G *et al.* (2016) Phylogenomic and biogeographic reconstruction of the *Trichinella* complex. *Nature Communications* **7**, 10513. doi: 10.1038/ncomms10513

Krojerová-Prokešová J, Barančeková M, Hamšíková L and Vorel A (2010) Feeding habits of reintroduced Eurasian beaver: spatial and seasonal variation in the use of food resources. *Journal of Zoology* **281**, 183–193.

Lee SR, Yoo SH, Kim HS, Lee SH and Seo M (2013) Trichinosis caused by ingestion of raw soft-shelled turtle meat in Korea. *Korean Journal of Parasitology* **51**, 219–221.

Murrell KD and Pozio E (2011) Worldwide occurrence and impact of human trichinellosis, 1986–2009. *Emerging Infectious Diseases* **17**, 2194–2202.

Pozio E (2005) The broad spectrum of *Trichinella* hosts: from cold- to warm-blooded animals. *Veterinary Parasitology* **132**, 3–11.

Pozio E (2013) The opportunistic nature of *Trichinella*—exploitation of new geographies and habitats. *Veterinary Parasitology* **194**, 128–132.

Pozio E (2014) Searching for *Trichinella*: not all pigs are created equal. *Trends in Parasitology* **30**, 4–11.

Pozio E and Zarlenga DS (2013) New pieces of the *Trichinella* puzzle. *International Journal for Parasitology* **43**, 983–997.

Rausch R, Babero BB, Rausch RV and Schiller EL (1956) Studies on the helminth fauna of Alaska. XXVII. The occurrence of larvae of *Trichinella spiralis* in Alaskan mammals. *The Journal of Parasitology* **42**, 259–271.

Rinella S (2011) America's top five wild-game meats. *American Hunter*. Available at https://www.americanhunter.org/articles/2011/5/31/americas-top-five-wild-game-meats/ (accessed 15 March 2018).

Rospotrebnadzor (2016) Incidence of infectious diseases in Russian Federation in January–December, 2015. Available at rospotrebnadzor.ru/activities/statistical-material/statistic_details.php?ELEMENT_ID=5525 (accessed 10 March 2018).

Rostami A, Gamble HR, Dupouy-Camet J, Khazan H and Bruschi F (2017) Meat sources of infection for outbreaks of human trichinellosis. *Food Microbiology* **64**, 65–71.

Seglina Z, Bakasejevs E, Deksne G, Spungis V and Kurjusina M (2015) New finding of *Trichinella britovi* in a European beaver (*Castor fiber*) in Latvia. *Parasitology Research* **114**, 3171–3173.

Wilson NO, Hall RL, Montgomery SP and Jones JL (2015) Trichinellosis surveillance - United States, 2008–2012. *MMWR Surveillance Summaries* **64**, 1–8.

Zimmermann WJ, Hubbard ED, Schwarte LH and Biester HE (1962) *Trichinella spiralis* in Iowa wildlife during the years 1953 to 1961. *The Journal of Parasitology* **48**, 429–432.