Canine hepatic calodiosis with cirrhosis

P. Sumathi · S. Hemalatha · K. Nagarajan · M. Vidhya · C. Sreekumar

Abstract The nematode parasite Calodium hepaticum (Capillaria hepatica) has a global distribution and is commonly reported in rodents (definitive host), dogs, cats and wild animals. Humans especially children are more susceptible to the parasitic infection. This paper documents an incidental finding of hepatic calodiosis with cirrhosis in a stray dog and discusses the zoonotic implications. A non descript dog was brought for necropsy examination to the Department of Veterinary Pathology, Madras Veterinary College, Tamil Nadu, India. Liver appeared dark brown, mottled with multifocal random variably sized, grey white flat firm areas. Histopathologically, liver tissue revealed multiple random encysted large collection of eggs surrounded by mild inflammation with a few lymphocytes, macrophages and fine fibrosis. The eggs had characteristic barrel shape, bipolar ends, bilayered wall, cross striations between the walls, and yolk. Periodic acid Schiff stain demonstrated the glycolic wall of ova. Marked portal to portal fibrosis was demonstrated by Masson’s trichrome (for collagen) and by Warthin-Starry (for reticulin) stains. The stage of parasitic infection was diagnosed as intermediate to chronic due to fibrosis. A need to study the prevalence of the disease in rodents, human and animals is emphasized. Improper burial of carcasses of rodents and dogs may contribute to spread of infection. Pets and stray animals may transmit infection to human and pose health risk.

Keywords Hepatic calodiosis · Capillaria hepatica · Cirrhosis · Dog

Introduction

Dogs as pets has been studied commonly in human animal interaction research and documented to provide social support, enhanced immunity, reduced stress and anxiety among adults and children in society (Kertes et al. 2018). However, stray and pet dogs pose a substantial risk in transmission of various zoonotic diseases caused by bacterial and viral infectious agents of which more common are rabies and leptospirosis. Parasitic zoonoses due to Echinococcus granulosus and Toxocara canis are widely reported (Eckert and Deplazes 2004; Chen et al. 2018). The nematode parasite Calodium hepaticum, earlier known as Capillaria hepatica, has a global distribution and is commonly reported in rodents (definitive host) especially wild rats and mice (Fuehrer et al. 2011) and to a lesser extent in dogs, cats, primates, and humans (Fuehrer 2014). Hepatic capillariosis was reported in non-human primates (Graczyk et al. 1999; Pereira et al. 2016) porcupines (Hamir and Rupprecht 2000) rabbits (Mowat et al. 2009) and horses (Ochi et al. 2017). Canine hepatic capillariosis was reported in India (Patil et al. 2017) and worldwide (Landolfi et al. 2003; Palma et al. 2009; Ajayi et al. 2010; de Oliveira et al. 2021). Adult humans also suffer from the infection which is manifested as non-specific symptoms such as persistent fever, hepatomegaly, eosinophilia and sometimes...
lead to death in humans (Fuehrer et al. 2011). Pica among children has been reported as a risk factor for the infection between one to 5 years old (Aghdam et al. 2015).

*Calodium hepaticum* has a direct lifecycle and is the only nematode that parasitizes in adult form in liver of primary host (rodents) and other secondary hosts (other mammals) (Demirer et al. 2018). Unembryonated ova are present in liver of primary host in genuine infection. Genuine infection is a true infection with localisation of unembryonated eggs in liver that are not eliminated in feces, which occurs only after the death of the animal (Nabi et al. 2007; de Oliveira et al. 2021). Spurious (untrue) infection, wherein hepatic form does not occur and unembryonated eggs are shed in faeces and cause serious zoonotic threat to humans and animal handlers (Demirer et al. 2018). Eggs contaminate the soil, water or food, it takes 4 to 5 weeks for the eggs to embryonate in environment. Rodents or other mammalian hosts ingest the infective embryonated eggs that hatch in the cecum, and the larvae penetrate the intestinal mucosa and enter the portal vein. Larvae reach the liver, where they mature within 3 weeks. The adult worms live for short periods but deposit large numbers of unembryonated eggs in the liver. These eggs do not develop and are not passed in feces but remain viable in the liver until the animal dies. Cannibalism and carcass decomposition release eggs into the environment (Farhang-Azad 1977). When the infected animal is eaten by a carnivorous animal (predator), unembryonated eggs are then discharged and passed out in the feces.

This paper reports an incidental finding of *C. hepaticum* eggs with cirrhosis in liver of a stray dog. Since hepatic calodiosis is less commonly reported in India and as it is of zoonotic importance, this paper emphasizes the need for a detailed clinical investigation in hepatopathology for early diagnosis, the zoonotic implications and precautions to be considered.

**Case history**

A nondescript stray dog which was found dead on the road, was brought for necropsy examination to the Department of Veterinary Pathology, Madras Veterinary College, Tamil Nadu, India during October 2021. The condition of the carcass was fair with simple fracture of right femur from the hip joint, dark brown mottled liver that showed multifocal random variably sized, measuring about <1–2 mm diameter, grey white flat firm areas on the surface and extending into the parenchyma (Fig. 1). Lungs appeared dark red due to congestion and haemorrhage. Kidneys were pale with cortical pitting upon removal of capsule. Stomach and intestine had yellow fluid contents.

![Fig. 1 Dog—Liver showing multifocal random grey white firm areas](image1)

Representative tissue samples were collected in 10% neutral buffered formalin. Formalinized tissues were trimmed and routinely processed for histopathological examination. Paraffin embedded tissues were cut to 4–5 μm thickness and stained with haematoxylin and eosin, Periodic acid Schiff (PAS), Warthin–Starry and Masson’s trichrome methods (Suvarna et al. 2019).

**Results and discussion**

A stray dog found dead with fracture of femur, presumably due to hit by a vehicle. When the dog was necropsied, liver revealed multifocal random small grey white firm foci. Histopathological examination of the foci (855.62 μm to 940.60 μm diameter) revealed multiple random large collection of numerous eggs surrounded by mild inflammatory reaction consisting of a few lymphocytes, macrophages and fine fibrosis (Fig. 2). The eggs were numerous and of...
various sizes, approximately measuring 59.39 × 30.46 μm with characteristic barrel shape, bipolar ends, bilayered wall, cross striations between the walls, condensed or disintegrated yolk. The glycolic wall of the oocysts was distinct pink with PAS (Fig. 3) and brown black with Warthin–Starry stain. Our morphological findings were consistent with earlier reports (Patil et al. 2017; Demirer et al. 2018; de Oliveira et al. 2021). However, no granulomatous or calcified lesions, as reported (Yadav et al. 2016; Ochi et al. 2017; Demirer et al. 2018) previously was observed. Marked portal to portal fibrosis was demonstrated for collagen by Masson’s trichrome (Fig. 4) and for reticulin by Warthin–Starry stains. Li et al. (2010) had discussed that the inflammatory reaction persist until the worm eggs become encysted or calcified followed by septal fibrosis due to activation of Kupffer cells. Septal fibrosis was evident in intermediate stage of infection and persisted through chronic stage in an experimental infection of C. hepatica in rats (Andrade and Andrade 2004). No adult worm was observed in serial sections in the liver of dog studied. In the life cycle of C. hepaticum, sexually mature female adult worms live for about 40–60 days, lays eggs in liver portal space and then degenerate. Once reproductive function is fulfilled the adult parasite dies and gradually degenerate (Demirer et al. 2018). Hence, the stage of parasitic infection was diagnosed as intermediate to chronic as there was absence of adult worm, presence of encysted ova, minimal inflammation and marked portal fibrosis. The dog could have become infected only by the embryonated eggs released from the decomposed liver on ingestion. The dog may not be infected by predation of the infected rodent, as the eggs of the worm from the prey (rodent) are retained in the liver and may lead to a spurious infection.

This parasitic infection goes undiagnosed due to non-specific clinical manifestations in humans and animals. Hepatic biopsy and incidental histopathological findings in liver after death were the commonly reported diagnostic methods although other clinical investigations like ultrasound, serological methods are helpful and mostly followed in humans (Ochi et al. 2017). This parasitic infection must be considered as a disease to be ruled out whenever symptoms or lesions of hepatic abnormalities are encountered.

A seasonal occurrence of hepatic calodiosis in a puppy was reported (Demirer et al. 2018) in spring months in Turkey and warm and moist conditions created favorable conditions for the development of C. hepatica and lead to release of eggs from the decayed host liver (Demirer et al. 2018). The stray dog reported could have contracted the infection through contaminated soil or feed with embryonated eggs of C. hepaticum as liver form is recorded. If the carcass had not been removed for disposal, decomposition of carcass may have lead to dissemination of infection. Calodium hepaticum parasitic infection in dogs may pose an increased risk to human health, as the dissemination of eggs from intestine through excrements on streets serve as a source of infection for other animals and humans (Quadros et al. 2016; Demirer et al. 2018).

Sporadic cases of hepatic capillariasis were reported in humans in India and the reports were mostly among children between 1 and 5 years with serious liver abnormalities (Nabi et al. 2007; Yadav et al. 2016) due to soil-hand-mouth habit (Misra et al. 2008). Epidemiological studies on prevalence of this parasitic infection is scarce among human and animals. Humans are intercalary or accidental host similar to dogs, hence adequate personal protection while handling of animals/dead or decomposed carcass,
safe disposal, avoiding contact with contaminated soil or feces, uncooked meat and proper disinfection of hands of person/fomites/premises is to be adopted.

This paper documents an incidental finding of hepatic calodiosis with cirrhosis in a stray dog. A need to study the prevalence of the disease in rodents, human and animals in India and attempts for early diagnosis is emphasized.

Improper burial of carcasses of rodents and dogs may contribute to spread of infection. Pets and stray animals may transmit the infection to human in spurious form of the infection and pose health risk.

Acknowledgements The authors thank the Department of Veterinary Pathology, Madras Veterinary College and Tamil Nadu Veterinary & Animal Sciences University for providing the necessary facilities and funding for carrying out the work.

Funding The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Declarations

Conflict of interest The authors declare no conflict of interest with regard to manuscript.

Ethical approval The manuscript describes an incidental finding of a parasite in a necropsied dog that does not require ethical approval.

References

Aghdam MK, Karimi A, Amanati A, Ghoroubi J, Khodami M, Shamsian BS, Shamsizadeh A, Far SZ (2015) Capillaria hepatica, a case report and review of the literatures. Pediatr Infect Dis J 3:e19398
Aijay OL, Omotainse SO, Antia RE, Antia FA, Akande FA, Olaniyi MO, Kehinde OO (2010) Hepatic histopathological changes in a dog with natural Capillaria hepatica infection in Nigeria. Niger J Parasitol 31(1)
Andrade SBD, Andrade ZA (2004) Experimental hepatic fibrosis due to Capillaria hepatica in man—an overview of hepatic capillariosis and spurious infections. Parasitol Res 109:969–979
Graczyk TK, Lowenstein LJ, Cranfield MR (1999) Capillaria hepatica (Nematoda) infections in human-habituated mountain gorillas (Gorilla gorilla beringei) of the Parc National de Volcans, Rwanda. J Parasitol 85:1168–1170
Hamir AN, Rupprecht CE (2000) Hepatic capillariosis (Capillaria hepatica) in porcupines (Erethizon dorsatum) in Pennsylvania. J Vet Diagn Invest 12:463–465
Johannes Eckert J, Deplazes P (2004) Biological, epidemiological, and clinical aspects of echinococcosis, a zoonosis of increasing concern. Clin Microbiol Rev 17:107–135
Kertes DA, Hall N, Bhatt SS (2018) Children’s relationship with their pet dogs and OXTR genotype predict child–pet interaction in an experimental setting. Front Psychol 9:1472
Landolfi JA, Karim BO, Poynton SL, Mankowski JL (2003) Hepatic Calodium hepaticum (Nematoda) infection in a zoo colony of black-tailed prairie dogs (Cynomys ludovicianus). J Zoo Wildl Med 34:371–374
Li CD, Yang HL, Wang Y (2010) Capillaria hepatica in China. World J Gastroenterol 16:698–702
Misra M, Pacaud D, Petryk A, Collett-Solberg PF, Kappy M (2008) Vitamin D deficiency in children and its management: review of current knowledge and recommendations. Pediatrics 122:398–417
Mowat V, Turton J, Stewart J, Lui KC, Pilling AM (2009) Histopathological features of Capillaria hepatica infection in laboratory rabbits. Toxicol Pathol 37:661–666
Nabi F, Palaha HK, Sekhsaria D, Chiatale A (2007) Capillaria hepatica infestation. Indian Pediatr 44:781
Ochi A, Hifumi T, Ueno T, Katayama Y (2017) Capillaria hepatica (Calodium hepaticum) infection in a horse: a case report. BMC Vet Res 13:1–3
Palma HE, Brasso PC, de Amaral AS, Silva AP, Silva CI (2009) Calodium hepaticum parasitism in two dogs. Ciencia Rural 39(9):2642–2645
Patil RJ, Dhaygude VS, Gavhane DS, Bharkad GP, Moregaonkar SD, Gadhave PD (2017) A case of hepatic capillariosis in a dog. Indian J Vet Pathol (online) 41:306–307
Pereira A, Martins A, Brancal H, Vilhena H, Silva P, Pimenta P, Diz-Lopes D, Neves N, Coimbra M, Alves AC, Cardoso L (2016) Parasitic zoonoses associated with dogs and cats: a survey of Portuguese pet owners’ awareness and deworming practices. Parasites Vectors 9:1–9
Quadros RMD, Weiss PHE, Miletti LC, Moura ABD (2016) Occurrence of Calodium hepaticum (Bancroft, 1893) Moravec, 1982 eggs in feces of dogs and cats in Lages, Santa Catarina, Brazil. Rev Inst Med Trop Sao Paulo 58:6
Suvarna KS, Layton C, Bancroft JD (eds) (2019) Bancroft’s theory and practice of histological techniques E-Book. Elsevier Health Sciences, Amsterdam
Yadav SC, Sathe PA, Ghodke RK (2016) Hepatic capillariosis: A rare parasitic infection. Indian J Pathol Microbiol 59:124

Publisher’s Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.