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Review Article

Larvae of *Taenia taeniaformis* in the Liver of a Laboratory Rat (*Rattus norvegicus*)

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Abstract

We report the occurrence of the tapeworm cyst, the metacestodelarval stage of *Taenia taeniaformis* in a laboratory rat (*Rattus norvegicus*).The macroscopic and histopathological features of the parasite are described as well as the serology and parasitology. The epidemiology of *Taenia taeniaformis* is discussed, particularly as it relates to the possibility of altered research results in studies conducted in *T. taeniaformis*-infected rats (immune-modulation) as well as the slightzoonotic potential that this metacestode presents.

INTRODUCTION

Adult *Taenia taeniaformis* occurs in the small intestine of wild and domestic cats throughout the world[1].The rodent serves as the intermediate host for the cat tapeworm *Taenia taeniaformis*. Rodents become infected by ingesting feed or bedding contaminated with cat faecal material.Following ingestion of the infectious egg, the larva migrates through the intestinal wall of the rodent and develops into cysticerci or cysts (the intermediate metacestode form) in the rodent liver or peritoneum[1].The life cycle is completed when the cat (the definitive host) ingests the infected rodent. The metacestodes are common in the liver of mice, rats, black rats, cotton rats, voles andother wild rodents [1]. The infection in the rodent is considered harmless, but the metacestode has slight zoonotic potential and the presence of the metacestode cyst in laboratory animals will potentially affect research results [2].In addition, Letonja and coworkers (1987) have reported that *T. taeniaformis* infection in mice may induce partial suppression of the host's immune system [3].

Taenia taeniaformis is found throughout the world including India [4], Japan [5] and Mexico [6]. *Taenia taeniaformis* metacestode cysts have been reported in the livers of wild rats (*Rattus norvegicus*) in the west Indies [7], Korea [8], Serbia [9], in wild mice in India [10], in synanthropic rodents in Egypt [11], in rodents and shrews in Taiwan [12], in rats in Colombia [13] and insmall mammals in Malaysia [14]. The helminth community structures of two urban rat populations in Malaysia were investigated andthree cestodesand one acanthocephalanwere recovered [15]. In addition, *T. taeniaformis* was noted in rodents in Kuala Lumpur [16]. *Taenia taeniaformis* infected voles were noted in Switzerland [17] and *T.taeniaformis* infected musk rats were observed in Belgium [18] and the Netherlands [19]. *Taenia taenia formis* was alsonoted in the wood mouse in Southern England [20]. *Taenia taeniaformis* has been reportedin the common and water vole in Western Australia [21].

T. taeniaformis has been reported in the intestines of stray cats in Iran [22] and in the intestinal contents of cats on the Antillian Islands [23]. Furthermore *T. taeniaformis* has been reported in stray catsat an incidence of 75.8% in Qatar, a highly arid region [24]. *Taenia taeniaformis* is present in the faecal samples of feral cats in Korea [25] and has been noted in the carcasses of Eurasian lynx in Estonia [26]. *Taenia taeniaformis* has been reported in semi-stray dogsin Jordan [27] and Rossin and coworkers (2004) were ableto experimentally reproduce the adult stage of *Taenia taeniaformis*in domestic dogs[28].The adult worm measures 15 to 60 cm in length and is 5 to 6mm in width and the scolex possess two crowns with hooks [1].

The objective of this study was to identify the parasitic cyst found in the liver of a laboratory rat and to highlight the epidemiology of Taenia taeniaformis, particularly as it relates to the possibility of altered research results in studies conducted in T. taeniaformis-infected rats (immune-modulation) as well as the slight zoonotic potential that this metacestode presents.

MATERIALS AND METHODS

The white female Albino Wistar rat (aged six months) was submitted toCerberus Sciences, a rodent health monitoringcompany.The rat was housed in an animal facility at the University of Adelaide. The submitted live rat was inspected

by veterinary surgeons and then underwent necropsy.At necropsy, histopathology, serologyandparasitology samples were harvested.

The rat was euthanized with an overdose of carbon dioxide in a CO_2 chamber and a necropsy was performed.Upon discovery of a macroscopic lesion at necropsy, tissue samples of the liver were fixed in 10% neutral buffered formalin for histopathological examination.

The parasitology tests includeda cellophane tape test for ectoparasites (mites, fleas, lice, mallophages). The cellophane tape samples were then placed on a glass slide and examined by light microscope.

Further parasitological tests included the faecal flotation which was performed on faeces flushed through the entire small and large intestinal system using a syringe and 10ml of 10% neutral buffered formalin (Confix Green, Australian Biostain, Australia).Briefly, the faecal contents were mixed with 10% neutral buffered formalin and 2.5 ml of this solution was added to 2.5 ml ofa saturated $NaNO_3$solution (specific gravity above 1.18).A cover slip was placed on the meniscal surface of the solution and left in place for 20 min.The cover slip was placed on a glass slide and examined microscopically.

Parasite eggs and protozoa were also examined by adding a drop ofiodine solution (Oxoid, Australia)onto two, separate, small sections of cecum and duodenum (with adherent faeces) which were placed on a glass slide, covered with cover slips, sealed with clear nail varnish and examined under the light microscope.

RESULTS

Macroscopic pathology

At necropsy, a raised, yellow, cyst measuring 3mm in diameter filed with fluid and fluctuating white material was noted on the capsular surface of the underside of the left liver lobe (Figure 1).

Histopathology

Upon histopathological examination a thick fibrous connective tissue capsular wall (Figure 2) was observed which contained a moderate to severe lymphocyte, plasma cell and eosinophil cell infiltrate.The cyst contained a single metacestode(i.e.with calcareous bodies (Figure 3), cuticle and muscle strands typical of *Taenia taeniaformis*.

Parasitology

Tape test and faecal flotation were negative. Wet mounts of the caecum revealed *Trichomonas* spp. and *Entamoeba muris* spp. present at moderate numbers.

Serology

ELISA testing on the serum was negative for rat coronavirus, parvovirus (rNS1), pneumonia virus of mice and *Mycoplasma pulmonis* (ELISA kits obtained from Bioresearch, US).

DISCUSSION AND CONCLUSION

Taenia taeniaformis has been transmitted to humans [29] however this is quite rare.The close association of rats in

Figure 1 A raised, yellow, cyst measuring 3mm in diameter filed with fluid and fluctuating white material was noted on the capsular surface of the underside of the let liver lobe.

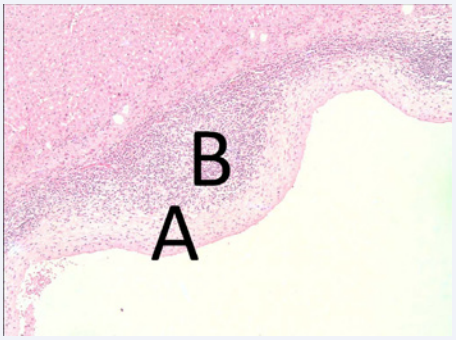

Figure 2 A thick fibrous connective tissue capsular wall (A) was observed which contained a moderate to severe lymphocyte, plasma cell and eosinophil cell infiltrate (B).

areas such as Kuala Lampur potentially contaminating the environment, water and food sources remains a public health hazard [16]. A child with an unusual *Taenia taeniaformis* (from a cat) infection has been reported in Sri Lanka [30]. The zoonotic potential of this parasite is only of concern if laboratory workers were to consume the laboratory rat including the liver with the cyst. Alternately, humans would need to eat the ova in/from the faeces of the definitive host (cat) in order to develop cysticercosis or tapeworms within the intestine.The rat in this case study was infected with eggs from cat faeces and the most likely sources are food, water, bedding, and other materials introduced into the animal cage. Inlaboratory animal facilities food and bedding are autoclaved or gamma-irradiated for the purpose of killing rodent pathogens. This process is usually highly effective, however complete sterilization cannot be guaranteed. The water used is tap water, usually with additional treatments including one or more of autoclaving, filtration, UV treatment, chlorination or acidification. Once again this process is usually effective or highly effective, but complete sterilization cannot be guaranteed.

Fichet-Calvet and coworkers (2003) presentedevidence that the prevalence of *Taenia taeniaformis* in *Mircotis arvalis*

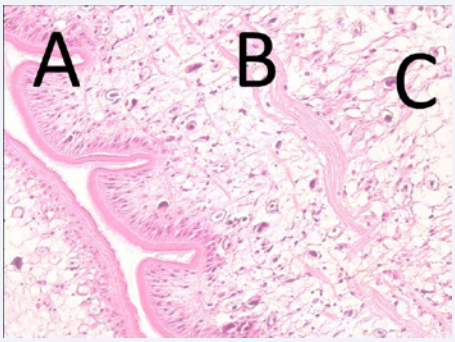

Figure 3 The cyst contained a single metacestode with cuticle (A),muscle strands (B) andcalcareous bodies (C).

(common vole) may be dependent on population density [31]. These workers noted that the prevalence increased in spring and that this may correlate with an increase in host density in spring. Since this case was submitted to Cerberus Sciences in 2011, when large numbers of feral mice were present (due to plentiful rains in South Australia), it is possible that the prevalence of *T. taeniaformis* was also related to an increase in the host density and thus it was more likely that the parasite could be transmitted to laboratory animal species due to contamination of the food or bedding (despite the fact that food and bedding are autoclaved before entry into this laboratory animal facility).In contrast, Singleton and coworkers (1993) reported the presence of *Taenia taeniaformis* in wild mice in south eastern Australia and stated that the infections differed significantly with time, but appeared to show no apparent association with host density [32]. Owen (1976) reported the presence of *T. taeniaformis* in wild rodents within the vicinity of a SPF unit containing laboratory rodents indicating that contamination of feed and bedding with feline *T.taeniaformis*-infected faeces with consequent infection of laboratory rodents is a possibility [33], however, pest control strategies in contemporary modern vivaria have improved considerably since this time.

The histopathology of the cyst or Strobilocercus fasciolaris metacestode cyst found in the laboratory rat in this study is similar to that reported in the livers of white mice [34] and includes the presence of plasma cells, macrophages, eosinophils and fibroblasts.Two of five male Sprague-Dawley rats with hepatic tapeworm cysts (*Cysticercus fasciolaris*, the larval stage of *Taenia taeniaformis*) develop large multinodular fibrosarcomas which envelope thetapeworm cysts and extend through peritoneal and pleural cavity [35] .The development of sarcomas in rats induced by *Taenia* sp. is thought to be attributable to the chronic inflammatory reaction of the capsule.Tapeworm cysts in liver of Wistar ratsinducehepatic sarcoma and gastroenteropathy in stomach and intestine [36], although these phenomenon are considered to be rare.The gastropathy is characterised by gastric mucosal hyperplasia, dilation of gastric glands with secretion, intestinal mucosal cell hyperplasia and proliferation of duodenal submucosal glands [36] and may be T cell driven [37]. Lagapa et al, 2008 [38] speculate that the intestinal hyperplasia is likely to be related to the associated gastropathy; although the mechanisms are undefined [38] and Konno and coworkers (1999) [39] state that the gastropathy results in hyperplasia of the gastric mucosa and hypergastrinaemia and an increase in intragastric pH.

Praziquantel has been developed to treat cestode infections (including *T. taeniaformis*) in cats [40]. Different UV lamps have been shown to have an inhibitory effect on Taeniid eggs, including those of *T. taeniaformis* [41].

The negative serology results (negative for rat coronavirus, parvovirus (rNS1), pneumonia virus of mice and *Mycoplasma pulmonis*) are not unexpected in a laboratory rat and the presence of *Trichomas* spp. and *Entamoeba muris* protozoa in the caecal contents of this laboratory rat is extremely common [42].

This case remains important due to the possibility of altered research results in studies conducted in *T. taeniaformis*-infected laboratory rats as well as the very small zoonotic potential that this metacestode presents.

In conclusion, this study demonstrates that it is possible for laboratory rats to become infected with *T. taeniaformis* and that this has implications for the possibility of altered research results in studies conducted in T. taeniaformis-infected laboratory rats as well as a small zoonotic potential.

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