The prevalence of *Linguatula serrata* nymphs in mesenteric and mediastinal lymph nodes in one-humped camels (*Camelus dromedarius*) slaughtered in Rafsanjan slaughterhouse, Iran

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Abstract *Linguatula serrata* is a well-known zoonotic parasite belonging to the order of *Pentastomida* which infects both human and animals. Human can be infected by both the nymph stage, causing a disease condition called nasopharyngeal linguatulosis or halzoun syndrome and the egg, a condition called visceral linguatulosis. The aim of this study was to evaluate the prevalence of nymphal stages of *L. serrata* in mesenteric and mediastinal lymph nodes of one-humped camels slaughtered in Rafsanjan slaughterhouse, Kerman province, south-eastern Iran. For this purpose, mesenteric and mediastinal lymph nodes of 132 one-humped camels of different sex and age groups in different seasons were examined. Overall, 27 one-humped camels (20.5 %) were infected by *L. serrata* nymphs. The infection rate increased with age ($P < 0.05$). No significant difference by sex groups or seasons was observed ($P > 0.05$). The high prevalence of infection in one-humped camels is of major concern to public health, owing to the zoonotic nature of the parasite and the potential risk of infection to humans and other animals.

Keywords *Linguatula serrata* · Lymph nodes · One-humped camels · Rafsanjan · Iran

Introduction

Linguatula serrata, is a tongue shaped parasite, lightly convex dorsally and flattened ventrally (Soulsby 1982). It is a cosmopolitan zoonotic parasite, belonging to the order of *Pentastomida* (Shekarforoush et al. 2004). Adults of *L. serrata* inhabit in the respiratory system (nasal sinuses and nasopharynx) of carnivorous especially dogs as definitive host (Alcala-vanto et al. 2007). It's eggs containing fully developed larvae are discharged into the environment by nasal secretion of carnivores. Herbivores such as cattle, goats, camels and sheep as intermediate hosts digest the eggs. Parasite's nymphal stages develop in various organs, particularly mesenteric and mediastinal lymph nodes of these animals (Berger and Marr 2006).

Humans can be infected by both adult stages, resulting in nasopharyngeal linguatulosis (halzoun syndrome) and the eggs causing a disease, called visceral linguatulosis. Ingestion of *L. serrata* nymphs with infected raw liver or lymph nodes of intermediate hosts can cause halzoun or marrara (maraca) syndrome in humans. Halzoun syndrome is often characterized by inflammation of the upper respiratory tract, swelling of the sub-maxillary and cervical lymph nodes and occasionally abscess formation in the eyes or ears (Yagi et al. 1996). The visceral form occurs by eating the eggs in contaminated water vegetables, or fruits (Yao et al. 2008; Tappe and Büttner 2009). This parasitic infection has also been reported in humans in Iran (Yeganeh Moghadam et al. 2001; Siavashi et al. 2002; Anaraki Mohammadi et al. 2008).

Several studies have been carried out regarding the prevalence rate of *L. serrata* infection in animals including

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dogs (Tavassoli et al. 2000; Meshgi and Asgarian 2003; Oryan et al. 2008), sheep (Esmail-Nia et al. 2000; Shekarforoush et al. 2004; Tavassoli et al. 2007; Ravindran et al. 2008; Nourollahi-Fard et al. 2011), goats (Razavi et al. 2004; Nourollahi-Fard et al. 2010b) and camels (Wahba et al. 1997; Tajik et al. 2007; Shakerian et al. 2008; Haddadzadeh et al. 2009).

The high prevalence of infection in ruminants is of concern owing to the zoonotic nature of the parasite and the potential risk of infection to humans and other animals.

So far no report of *L. serrata* infection has been carried out in camels of Rafsanjan, therefore the objective of this study was to determine the prevalence rate of *L. serrata* nymphs in mesenteric and mediastinal lymph nodes of one-humped camels slaughtered at Rafsanjan slaughterhouse.

Materials and methods

This study was conducted in Rafsanjan district. Rafsanjan is located in Kerman province, southeast of Iran. Kerman province has a moderate climate and the average annual rainfall is 135 mm, because it is located close to the Lut desert. Upon enquiry about the farming of the camels, most of the owners declared that they were raised in an open farming area.

Overall, 132 slaughtered camels including 61 males and 71 females were examined randomly for nymphal stages of

L. serrata from March 2010 to March 2011 at Rafsanjan slaughterhouse.

The animals were classified in four age groups (<2, 2–4, 4–6 and >6 years old), and the age ranges were determined by using the eruption of permanent incisor teeth criteria as described elsewhere (Currasson 1947). Immediately after slaughtering, 4–6 samples from mesenteric and 2–3 samples from mediastinal lymph nodes, from each camel, were collected in plastic containers with the corresponding characteristic numbers and transferred to Medical School promptly for further examination.

Examination of the lymph nodes of the camels was performed in two steps. First, 50–100 g samples were sliced in small pieces and observed under stereomicroscope for observation of the nymphal stage. In the second step, the minced tissues were treated in 200 ml of digestion solution containing 5 g pepsin enzyme (7178, Merck) and 25 ml hydrochloric acid (374, Merck) in 1 L water and incubated at 37 °C for 24 h. Then, the suspensions were transferred to petri dishes and examined for *L. serrata* nymph (Shakerian et al. 2008).

Statistical analysis

Data were subjected to analysis using SPSS 17.0 software (SPSS Inc, Chicago, IL, USA). χ^2 -test was used to compare the relative frequency of infection among different groups by lymph nodes, age, sex and seasons. $P \leq 0.05$ was considered as statistical difference.

Results

Twenty-seven out of 132 camels (20.5 %) were infected with *L. serrata* nymphs. The number of collected nymphs from each infected lymph node varied from 1 to 30. The infection rate of mesenteric and mediastinal lymph nodes were 26.5 and 14.1 %, respectively. The frequency of infection increased with age $P < 0.05$ (Table 1). However, there was no significant difference between sex and infection rate among the camels. The prevalence of *L. serrata* infection in different seasons is presented in Table 1, although no significant difference was observed ($P > 0.05$).

Discussion

As intermediate hosts, camels, like other ruminants, play an important role in the life cycle of *L. serrata*. The prevalence rate of linguatulosis in dogs has been determined in different part of Iran such as Shiraz (76.2 %) by Oryan et al. (2008), Shahre-Kord (65.5 %) by Meshgi and

Table 1 The prevalence of *Linguatula serrata* nymphs in camels slaughtered in Rafsanjan slaughter house by age, sex, seasons and lymph nodes, Iran

Parameter	Infected no	Non-infected no	Total no
Age (years)			
<2	3 (2.3 %)	35 (26.5 %)	38 (28.8 %)
2–4	8 (6.1 %)	37 (28 %)	45 (34 %)
4–6	13 (9.8 %)	29 (22 %)	42 (31.8 %)
>6	3 (2.3 %)	4 (3 %)	7 (5.4 %)
Sex			
Male	12 (9.1 %)	49 (37.1 %)	61 (46.2 %)
Female	15 (11.4 %)	56 (42.4 %)	71 (53.8 %)
Seasons			
Spring	7 (5.4 %)	28 (21.2 %)	35 (26.5 %)
Summer	6 (4.5 %)	23 (17.4 %)	29 (22 %)
Autumn	8 (6.1 %)	29 (21.9 %)	37 (28 %)
Winter	6 (4.5 %)	25 (19 %)	31 (23.5 %)
Lymph nodes			
Mesenteric or mediastinal	27 (20.5)	105 (79.5 %)	132 (100 %)
Total	27 (20.5)	105 (79.5 %)	132 (100 %)

Asgarian (2003) and Fars province (76.5 %) by Oryan et al. (1997). Close contact between dogs and the intermediate host plays an important role in transmission of *L. serrata* in this area. Many studies have been carried out on prevalence of *L. serrata* in various domestic ruminants in Iran and other parts of the world showing that *L. serrata* nymphs obtained from different visceral organs such as liver, lung and spleen (Tajik et al. 2008; Tavassoli et al. 2007; Nourollahi-Fard et al. 2010a; Razavi et al. 2004). But in most studies mesenteric and mediastinal lymph nodes were evaluated because they are the principal place of infection with parasite. Therefore, possibility of infection in mesenteric and mediastinal is higher than other viscera (Shakerian et al. 2008). Another study with slaughtered camels showed that mesenteric lymph nodes, the lungs and the liver were infected with *L. serrata* nymphs, (75, 29.7 and 30.4 %, respectively) of animals (Tajik et al. 2007). Shakerian et al. (2008) reported that mesenteric lymph nodes (21 %) and liver (4.5 %) were infected with the infective stage of these parasites in Najaf-Abad, Iran (2008). According to the life cycle of *L. serrata*, mesenteric lymph nodes, located in the way of portal circulation before the other organs, hence the infection rate of these nodes is higher than other organs. In this study, 26.5 and 14.1 % of the camels had *L. serrata* nymphs in mesenteric and mediastinal lymph nodes, respectively.

Several studies have been conducted to determine the prevalence of linguatulosis in ruminants in Iran and other countries. The prevalence rate was 44 % in cattle in Urmia slaughterhouse, Iran (Tajik et al. 2007), 29.9 % in goats in Shiraz, Iran (Razavi et al. 2004), 49.1 % in goats slaughtered in Kerman, Iran (Nourollahi-Fard et al. 2010b). Several studies regarding the prevalence of *L. serrata* nymphs in camels were carried out in Iran including Mashhad (75 and 18.3 % in two separate studies) (Tajik et al. 2007; Fard et al. 2012) and Najaf-Abad (35 and 21 %, in two separate studies) (Pourjafar et al. 2007; Shakerian et al. 2008) and 19 % in cattle of India (Ravindran et al. 2008).

The prevalence of the infection in camels may be influenced by many factors such as the geographic and climatic changes which affect the survival of the parasite eggs. Apparently, high prevalence rate of infection in Kerman province may be due to the suitable climatic conditions for the parasite to maintain the survival of its egg in vegetables, fruits, and water resources. The prevalence rate (20.5 %) of infection in lymph nodes should be considered as a risk factor for human being infection.

In several studies, seasonal variation of *L. serrata* infection in small ruminants of Iran was reported (Hamdast-joo 2001; Nematollahi et al. 2005). In our survey no significant difference between prevalence rates of infection in different seasons of the year was observed.

The results of our study showed a significant association of age and infection rate of camels ($P < 0.05$) that was consistent with other studies on sheep and camel in Iran (Shekarforoush et al. 2004; Shakerian et al. 2008). On the other hand no significant difference was observed in the infection rate in both sexes which was in agreement with other study (Shakerian et al. 2008). Due to the nature of such studies particularly in camels, the sample size seems to be enough as compared to the other studies (Haddadzadeh et al. 2010; Oryan et al. 2011).

Conclusion

Because of the veterinary and human medical importance of linguatulosis, further investigations in other herbivores, carnivores and also humans are recommended. This study showed a high risk of *L. serrata* for humans and other animal species. Adequate cooking of meat and viscera and drinking properly filtered water are crucial in preventing human infections.

Heightened public awareness of the danger of raw food and education of humans on different aspects of the epidemiology of the parasite together with preventing dogs or other canids ingesting infected materials should reduce the risk of infection and any such measures may also help to diminish other zoonoses.

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