

Short Communication

First report of epidemic prevalence of cerebral coenurosis in ten sheep herds in Iran

Ghader Jalilzadeh-Amin ^{1*}, Aliasghar Tehrani ², Yaser Nozohour¹, Amir Farjami Moghadam³

- 1- Department of Internal Medicine and Clinical Pathology, Faculty of Veterinary Medicine, Urmia University, Urmia, Iran
- 2- Department of Pathology, Faculty of Veterinary Medicine, University of Urmia, Urmia, Iran
- 3- Department of Theriogenology, Faculty of Veterinary Medicine, Urmia University, Urmia, Iran

* **Corresponding author:** g.jalilzadeh@urmia.ac.ir

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Summary

Coenurosis is a neurological parasitic infection of sheep caused by the larval stage of *Taenia multiceps*. In spring 2020, several animals were referred from different flocks (10 sheep herds) to the Clinic of Faculty of Veterinary Medicine, Urmia University, Iran with a history of acute neurological dysfunctions associated with increased mortality. Affected animals were 5-8 months years-old from the mixed breed and both sex. Physical and ophthalmoscopic examinations were performed. The cerebrospinal fluid (CSF) samples were obtained from the lumbosacral region and were examined grossly and microscopically. The CSF examination showed a mixed population of mononuclear cells with a predominance of small lymphocytes and reduced number of monocytes. Neutrophils were also occasionally observed. Dissection of the brain revealed ventricular deformity *Coenurus cerebralis* with white protoscolices causing the obstruction of the ducts and thus resulting in internal hydrocephalus and lateral ventricles enlargement. This study, as the first report of the epidemic incidence of cerebral coenurosis in sheep from Urmia, Iran, implies a failure of prevention and control measures against a parasitic disease. Thus, regular chemical-prophylactic protocols of dogs and correct disposal of the infected brain upon slaughtering or death of animals to prevent scavenging by dogs can control it.

Keywords: *Taenia multiceps*, Coenurosis, Sheep, Outbreak, Cerebrospinal fluid

Introduction

Coenurosis is an infectious parasitic disease occurred by the invasion of the brain and spinal cord with *Taenia multiceps* larvae. *Coenurus cerebralis* (*C. cerebralis*) is the metacestode or

larval form of the dog tapeworm *T. multiceps* and the adult worm inhabits the small intestine of dogs and some other carnivores (Mahadevan et al., 2011). Sheep is the usual animal intermediate host, whereas it also has numerous other definitive

and intermediate hosts and, occasionally, humans. Coenurosis is present worldwide, mainly in sheep-farming regions of the world causing a disease known as gid (Sturdy), as the infected sheep shows ataxia and circles around its position. As a consequence, localized, space-occupying lesions by thin, translucent, and large uni- or multilocular cysts are produced in the central nervous system (CNS; Oryan et al., 2014). The cysts contain clear and watery fluid with hundred of white nodules on its inner surface, measuring a few millimeters in diameter (Varcasia et al., 2013). The leptomeninges, brain parenchyma, and ventricles are the preferred sites of cysts. In acute outbreaks, neurological signs of coenurosis rise with various degrees of muscle tremors, excitability, ataxia, blindness, and nystagmus, which in the majority of cases result in the death of the animal, due to starvation after several days (Abera and Wubit, 2016). These clinical signs are caused by an acute inflammatory response than by mechanical action of the cyst. The symptoms are strictly connected with the number of ingested eggs, the immune state of the host, and the localization of the parasites in the CNS (Scala and Varcasia, 2006).

It was previously reported that chronic form of cerebral coenurosis is more frequent than the acute form, although both forms are usually fatal (Alemu et al., 2015). Notably, chronic coenurosis mostly happens in older animals of more than six months of age (Oryan et al., 2014). When the cyst volume increases, the subsequent clinical signs become more evident (Scala and Varcasia, 2006). Because of the local lesion, the infected animal holds its

head to one side and turns in a circle (Oryan et al., 2014). However, other clinical symptoms like incoordination, ataxia, head pressing, drowsiness, blindness, and coma commonly lead to the death of the affected animal within several weeks (Abera and Wubit, 2016). In this regard, clinicopathological evaluations are not commonly applied in diagnosis in the suspected animals, and serological assays are not sufficiently specific to be of value. When necropsy is done, thin-walled cysts may be found anywhere in the brain, which is most commonly observed on the external surface of the brain. Many of the infected animals die after some weeks of starvation (Scala and Varcasia, 2006). Scrapie, louping ill, listeriosis, sarcocystosis, nasal bots syndrome, brain abscessation, and cerebrocortical necrosis due to thiamin deficiency should be considered as the differential diagnosis (Oryan et al., 2014).

The most common affected site in the spinal cord is the lumbar region. In this line, local pressure atrophy of nervous tissue is detectable, which may extend to softening of the overlying bone. It is necessary that this should be differentiated from other local space-occupying lesions of the CNS, including abscess, tumor, and hemorrhage. As a matter of decision, it is possible to fatten the infected animal for slaughter, after surgical drainage of the cyst. The control of mature worm infestation in dogs can satisfactorily break the life cycle of tapeworm. Thus, it is believed that a periodic treatment of farm dogs by a tenicide therapy is necessary for prevention of this and other tapeworms. Moreover, it is suggested that the carcasses of the infested livestock with the larva

should not be available to dogs. Also, a previous study has reported that anthelmintic agents demonstrate efficacy in treating coenurosis in naturally affected sheep, as presented by degeneration of the cysts in the treated animals (Oryan et al., 2014). As more details, the best results have been reported with oral albendazole, or combination of fenbendazole and praziquantel. Recently, high rates of sheep mortalities with neurological clinical signs were observed in several sheep herds in the Urmia region, in the northwest of Iran. Thus, the present study aimed to demonstrate the potential role of *C. cerebralis* in such sheep mortalities. This study is the first report of a cerebral coenurosis outbreak in sheep from Iran.

Materials and methods

In spring 2020, several animals were referred to the Clinic of Faculty of Veterinary Medicine, Urmia University, Iran from different flocks (10 sheep herds) with a history of acute neurological dysfunctions and with increased mortality. Animals were 5-8 months years-old from the mixed breed and both sex. Physical and ophthalmoscopic examinations were performed. The blood sample was obtained from the right jugular vein. The CSF obtained from the lumbosacral region and was examined grossly and microscopically.

Results

Clinical signs

The affected animals presented the typical clinical neurological signs such as circling behavior,

incoordination, depression, visual defects, poor appetite, star gazing, head tilt, a tendency to keep away from other animals in the flock, neck rigidity, and irregular gait. The absence of menace reflex with the presence of direct pupillary light reflex demonstrated a central blindness. Also, a moderate congestion of retinal venules was indicated in the ophthalmoscopic examination.

Herd history findings

Examination of the herd's history revealed that there was an unusual population of dogs (over ten dogs) in the herd, which had not received any antiparasitic treatment. Interestingly, the herdsmen were unaware of the transmissible disease between dogs and sheep and the necessity of an antiparasite therapy program for the herd dogs.

Laboratory findings

The analysis of hematology parameters is presented in Table 1. A neutrophilic reaction with an increase in total protein and fibrinogen levels was detected that may be attributed to other concurrent infectious diseases. The CSF examination showed a mixed population of mononuclear cells with the predominance of small lymphocytes and the low numbers of monocytes. Neutrophils were also occasionally observed. The CSF protein concentration was slightly increased. The biochemical alterations with more details are shown in Table 2. Calcium level was normal, whereas that of magnesium showed a slight increase in the CSF of the affected animals. Other factors that have not yet been evaluated in sheep CSF, were compared with the values reported in cattle. Creatine kinase and lactate dehydrogenase activity were increased compared to the normal

range of values reported in the references (Kaneko, 2008). The increase in the enzyme activities was very significant. The results of microbial culture for detection of *Listeria monocytogenes* in the brain tissues were negative.

Table 1. Hematology values of the infected sheep.

Hematology Parameters	Normal range*	Sampled sheep (Mean)
PCV (%)	24-49	31.1 ± 0.41
HB(g/dl)	8.0-16	10.3 ± 0.13
RBC	8.0-15	12.2 ± 0.73
MCV (fL)	23-48	25.4 ± 0.40
MCH (pg)	8.0-12	8.4 ± 0.00
MCHC (g/dl)	31-34	33.1 ± 0.21
Total WBC (/μL)	4000-12000	7600 ± 10.00
Neutrophil	1000-5000	4940 ± 22.80
Eosinophil	100-750	152 ± 6.90
Lymphocyte	2000-9000	2356 ± 43.11
Monocyte	0-750	152 ± 8.30
Platelets	3.0-8.0	7.82 ± 0.90
Total protein(g/dl)	6.0-7.9	9.8 ± 0.51
Fibrinogen(mg/dl)	100-500	700 ± 0.00

*Normal range for hematology parameters in ruminant adopted from reference indexes (Kaneko, 2008).

Postmortem findings

Cysts of various sizes were detected in cerebral hemispheres (figure 1 and 2). Dissection of the brain revealed ventricular deformity *C. cerebralis*

with white protoscolices causing the obstruction of the ducts and consequently resulting in internal hydrocephalus and lateral ventricles enlargement.

Discussion

Cerebral coenurosis is a serious endemic disease of small ruminants in the world and especially in the Middle Eastern countries that has already been reported from Iran, Oman, Egypt, Turkey, Jordan, and Iraq (El-Neweshy et al., 2019). In this regard, there has been only a little number of scientific reports focusing on the occurrence of coenurosis in sheep in Iran, though the outbreak form has not yet been reported. In the current study, the problem as an outbreak of coenurosis was detected in 10 semi-industrial sheep raising farms. Notably, the affected goats presented non-specific nervous system manifestations. Different clinical signs like ataxia, circling, incoordination, blindness, drowsiness, head pressing, hind leg paralysis, and coma have been indicated in the affected animals as reported in previous studies (Abera and Wubit, 2016; El-Neweshy et al., 2019; Oryan et al., 2014).

Table 2. Biochemical characteristics of CSF in the infected sheep.

Biochemistry Parameters	Normal range in sheep*	Sampled sheep (Mean)	Normal range in cow
Calcium (mg dL-1)	5.6 ± 0.3	5.23 ± 0.30	-
Magnesium (mg dL-1)	2.88	1.52 ± 0.01	1.8–2.1
Sodium (mg dL-1)	-	100.7 ± 0.00	132–142
Potassium (mEqL-1)	-	3.22 ± 0.04	2.7–3.2
Creatine kinase (U/l)	-	64 ± 0.00	2–48
lactate dehydrogenase (U/l)	-	54 ± 0.00	2–25

*Normal range for biochemistry parameters of CSF in ruminant adopted from reference indexes (Kaneko, 2008).

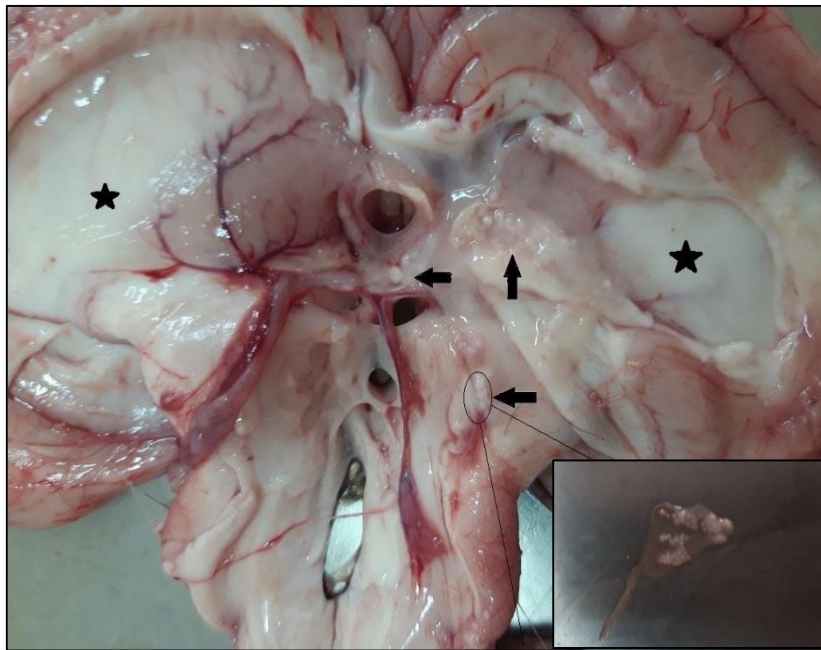


Fig. 1. Many small and white protoscolices (arrows) and the hydrocephalus (stars) are shown in the figure.

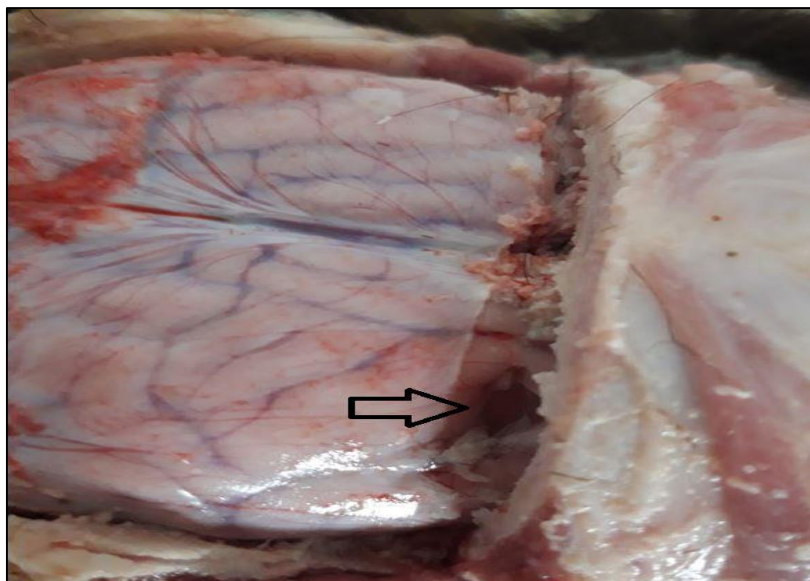


Fig. 2. Coenurus cyst located on the left cerebral hemisphere (arrow).

Although, many other differential diagnosis such as sarcocystosis, nasal bots syndrome, brain abscessation, and polioencephalomalacia, thiamin deficiency was considered (Oryan et al., 2014), the post-mortem demonstration of *C. cerebralis* cyst in necropsy suggests that the coenurosis is the main pathological condition being prevalent and is likely

to constitute a significant health problem in sheep herds with noticeable economic losses. In the present study, we reported unique clinical and pathological findings of sheep coenurosis. We found a large number of small cysts in the brain parenchyma with a loose connection to the tissue, which easily separated; interestingly, the number

and sizes of the recovered cysts were similar to those reported in the literature (Alemu et al., 2015; El-Neweshy et al., 2019; Tavassoli et al., 2011). Here, pathological lesions of the affected brain tissues were more extensive than the focal granulomatous lesions reported in the previous studies (Nourani and Kheirabadi, 2009; Sharma and Chauhan, 2006; Shivasharanappa et al., 2017). This variation of the cyst-induced inflammatory response may be related to the host immune status and parasitic burden. When *C. cerebralis* is posited in the nervous tissues, lead to space-occupying lesions, and the mortality rate may reach 100% (Sharma and Chauhan, 2006). Growing evidence suggests that chemotherapy is ineffective and surgical intervention is only recommended for valued animals (Sharma and Chauhan, 2006). The CSF examination showed a mixed population of mononuclear cells with the predominance of small lymphocytes and the low numbers of monocytes. Neutrophils were also occasionally observed and protein concentration was slightly increased. The presence of a large blood clot on the cerebellum surface represents various migration routes and entrance sites of larva from vessels to the neural tissue and subsequent vessel laceration. As it was anticipated, such severe hemorrhage led to death. It seems that infection propagation is ecology-dependent, as that increased by high moisture, rainfall, and moderate temperature of the region. In these climatic conditions, the parasitic eggs are viable for a longer period and facilitate their incidence (Scala and Varcasia, 2006). On the other hand, a potential possible reason could be the increase in the rainfall and humidity of the study

area in the recent year (2020). Following the rainy season, many street dogs have taken refuge to Urmia Mountains and ranges where the affected sheep were grazing.

A seasonal variation has already been reported for occurrence of coenurosis with the highest rates during the spring, in chronic forms and more commonly in lambs (Scala and Varcasia, 2006). Many factors including unhygienic disposal of dead animals, poor management, no guard dogs deworming, and exposure to stray dogs and wild canids could keep the parasite life cycle in such open livestock grazing areas. It was notable that there was not any anti-parasitic program in the herds examined.

Conclusion

The present study demonstrates the first outbreak of cerebral coenurosis in sheep from Urmia, based on clinical, postmortem, and laboratory findings. Given the zoonotic implications and economic losses, the current study highlights the importance and necessarily of suitable prevention and control methods of the cerebral coenurosis.

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Conflict of interest statement

There is no conflict of interest.

Ethical approval

Not applicable.

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