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Clinical, Pathological and Parasitological Evaluation of Coenurus cerebralis Infecting Domestic and Wild Ruminants

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Abstract

The aim of this study was to evaluate the natural cases of *Coenurus cerebralis* in domestic and wild ruminants clinically, pathologically and parasitologically. The material of this study consisted of eight sheep, six mountain goats and three cattle admitted to our department, between 2016 and 2019, for necropsy. The animals presented various neurological symptoms, including rotation around their axis, opistotonus, loss of coordination, unilateral blindness and torticollis. Subsequently, routine systemic necropsy was performed. After routine tissue procedures, 5 µm thick sections were taken from paraffin blocks prepared for Hematoxylin and Eosin staining. Sections were examined under light microscope to determine the pathologic changes. During the systemic necropsy, typical *Coenurus cerebralis* cysts were observed in the right and left cerebral hemispheres and cerebellum. The cysts were usually superficial, approximately ping pong ball sized, filled with clear liquid, fluctuant, sometimes single and sometimes several in number. In the histopathological examination of the brain and cerebellum, nonpurulent meningoencephalitis, large and small scolexes were detected.

Key Words: Coenurus cerebralis, cattle, mountain goats, parasitology, pathology, sheep

Coenurus cerebralis ile Enfekte Evcil ve Vahşi Ruminantların Klinik, Patolojik ve Parazitolojik Olarak Değerlendirilmesi

Öz

Çalışmamızda evcil ve yabani ruminantlarda gözlenen *Coenurus cerebralis* vakalarını sunmayı amaçladık. Bu çalışmanın materyali, 2016 ve 2019 yılları arasında, nekropsisi yapılmak üzere kürsümüze kabul edilen sekiz koyun, altı dağ keçisi ve üç sığır oluşturdu. Hayvanlarda, ekseni etrafında dönme, opistotonus, koordinasyon kaybı, tek taraflı körlük ve tortikollis gibi çeşitli nörolojik semptomlar gözlendi. Hayvanların sistemik nekropsisi yapıldı. Rutin doku takip işlemlerinden sonra, Hematoksilen ve Eozin boyaması için hazırlanan parafin bloklardan 5 µm kalınlığında kesitler alındı. Patolojik değişiklikleri belirlemek için kesitler ışık mikroskobu altında incelendi. Sistemik nekropsi esnasında sağ ile sol serebral hemisferlerde ve serebellumda tipik *Coenurus cerebralis* kistleri gözlendi. Kistlerin genellikle yüzeysel, yaklaşık ping pong topu büyüklüğünde, berrak sıvı ile dolu, fluktan, bazen tek ve bazen çok sayıda olduğu tespit edildi. Beyin ve serebellumun histopatolojik incelemesinde, nonpurulent meningoensefalit ile irili ufaklı skoleksler tespit edildi.

Anahtar Kelimeler: Coenurus cerebralis, dağ keçisi, koyun, parazitoloji, patoloji, sığır

INTRODUCTION

Coenurus cerebralis is the larval form of *Taenia multiceps*, which is one of the cestod parasites of carnivores such as dogs, foxes and jackals. Sheep, goats, cattle, buffalo, horses, yak, wild ruminants, and rarely humans serve as intermediate hosts for the parasite (1-4). Rotation around their axis, opistotonus, tooth grinding, depression, head shaking, unilateral blindness, lack of coordination, torticollis, atrophy of the brain, and softening and thinning of the skull bones are observed in affected animals, in relation to the location of the *Coenurus cerebralis*, their dimensions and the amount of pressure they exert (5-9). Such animals are weakened because they do not feed well, and eventually they die (10). The disease is also known as 'Gid or Sturdy' because of its clinical symptoms (11-14). Coenurosis causes important problems especially in sheep and goat breeding, but this disease is rarely encountered in cattle (12, 15, 16). Coenurosis, a common and zoonotic infection, is prevalent throughout the world, especially in developing countries of Africa and Asia (16, 17).

In this study, we aimed to present the cases of *Coenurus cerebralis* in sheep, wild mountain goats and cattle admitted to our department between 2016 and 2019 for pathological and parasitological evaluation.

MATERIALS AND METHODS

Animals

The material of this study consisted of eight sheep, six mountain goats and three cattle admitted to Kafkas University, Faculty of Veterinary Medicine, Department of Pathology, between 2016 and 2019, for necropsy. The animals presented various neurological symptoms, including rotation around their axis, opistotonus, loss of coordination, unilateral blindness and torticollis (Table 1). Subsequently, routine systemic necropsy was performed.

Table 1. Animals, location of cysts and dimensions.

Case No	Species	Gender	Age	Location of Cysts	Clinical Symptoms	Dimensions
1	Mountain Goat	Male	24 months	Cerebral Hemispheres (Right Frontal Lobe)	Rotation around its axis	4x6 cm
2	Mountain Goat	Female	18 months	Cerebral Hemispheres (Right Frontal Lobe)	Rotation around its axis	5x6 cm
3	Cattle	Female	10 months	Cerebral Hemispheres (Left Occipital Lobe)	Balance loss, Blindness	4x4 cm
4	Cattle	Male	18 months	Cerebral Hemispheres (Right Parietal Lobe)	Torticollis, Loss of appetite	6x7 cm
5	Mountain Goat	Male	24 months	Cerebral Hemispheres (Right and Left Frontal Lobe)	Rotation around its axis	6x7 cm
6	Mountain Goat	Female	12 months	Cerebral Hemispheres (Left Frontal Lobe)	Rotation around its axis, dullness, rhinitis, pneumonia	5x7 cm
7	Sheep	Female	4 months	Cerebral Hemispheres and Cerebellum	Rotation around its axis, incoordination, mental astonishment	Large number of pores
8	Sheep	Female	7 months	Cerebral Hemispheres (Right and Left Parietal Lobe)	Rotation around its axis, head pressed against objects, rhinitis	3x4 cm
9	Mountain Goat	Female	24 months	Cerebral Hemispheres (Right Parietal Lobe)	Rotation around its axis	5x6 cm
10	Mountain Goat	Male	18 months	Cerebral Hemispheres (Right Parietal Lobe)	Rotation around its axis, balance loss, unable to stand up	5x5 cm
11	Sheep	Female	9 months	Cerebral Hemispheres (Left Frontal Lobe)	Rotation around its axis, pneumonia	5x6 cm
12	Sheep	Male	12 months	Cerebral Hemispheres (Right Parietal Lobe)	Rotation around its axis, weakness, nystagmus	4x5 cm
13	Sheep	Female	15 months	Cerebral Hemispheres (Left Frontal Lobe)	Rotation around its axis, head pressed against objects	5x6 cm
14	Sheep	Female	15 months	Cerebral Hemispheres (Right Frontal Lobe)	Rotation around its axis, head pressed against objects	3x4 cm
15	Cattle	Female	12 months	Cerebral Hemispheres (Right Parietal Lobe)	Rotation around its axis	7x9 cm
16	Sheep	Female	18 months	Cerebral Hemispheres (Right Frontal Lobe)	Rotation around its axis, torticollis, rhinitis	5x7 cm
17	Sheep	Male	5 months	Cerebral Hemispheres (Right and Left Occipital, Temporal, Parietal Lobe) and Cerebellum	Rotation around its axis	1.8x2.5 cm

Parasitological Examinations

When the skulls of the three cattle, eight sheep and six mountain goats were opened, fluid filled cysts were encountered. The cysts were removed carefully without rupture, placed in petri dishes and brought to the Parasitology Laboratory of the Parasitology Department of Kafkas University in containers containing 70% ethyl alcohol. The structure and content of each separate cyst were subjected to microscopic examination and the strain scans were examined by looking at the advanced scolex structures.

Pathological Examinations

Brain tissue samples taken after systemic necropsy of the mountain goats, cattle and sheep were fixed in 10% buffered formaldehyde solution. Following the routine tissue procedures, 5µm thick sections were obtained from paraffin blocks for Hematoxylin and Eosin (H&E) staining. Sections were stained with H&E, examined under a light microscope (Olympus Bx53) and photographed using the Cell^P program (Olympus Soft Imaging Solutions GmbH, 3,4) to evaluate histopathological changes.

RESULTS

Clinicopathologic findings

The animals presented various neurological symptoms, including rotation around their axis, opistotonus, loss of coordination, unilateral blindness and torticollis (Table 1).

During the systemic necropsies, typical *Coenurus cerebralis* cysts were observed in the right and left cerebral hemispheres (Figure 1 a-b) and cerebellum (Figure 1 c). The cysts were usually superficial, approximately ping pong ball sized, filled with clear liquid, fluctuant, sometimes single and sometimes several in number. The size of the *Coenurus* cysts (average value) was measured as 5x6.2 cm in mountain goats, 3.83x4.93 cm in sheep and 5.56x6.66 cm in cattle. Multiple scolexes, composed of hyaline membrane filled with translucent fluid and liquid, were observed on the surface of the *Coenurus cerebralis* cysts (Figure 1 d-e). A large number of pores were found in the brain and cerebellum of a 4-month-old sheep, as a result of acute coenurosis due to migration of larvae (Figure 2 a-b). White, pinhead size scolexes were detected in these sacs.

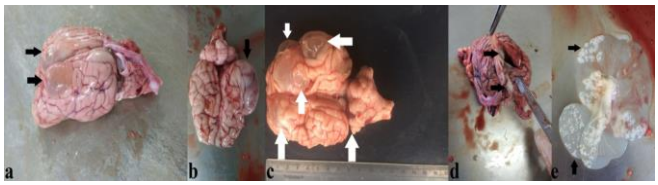

Figure 1. a) Mountain goat, *Coenurus cerebralis* cysts in the right and left cerebral hemispheres (arrows). **b)** Sheep, *Coenurus cerebralis* cysts in the left cerebral hemisphere (arrow). **c)** 5-month-old sheep, *Coenurus cerebralis* cysts in the right and left cerebral hemispheres and cerebellum (arrows). **d-e)** Mountain goat, *Coenurus cerebralis* cysts and scolexes (arrows).

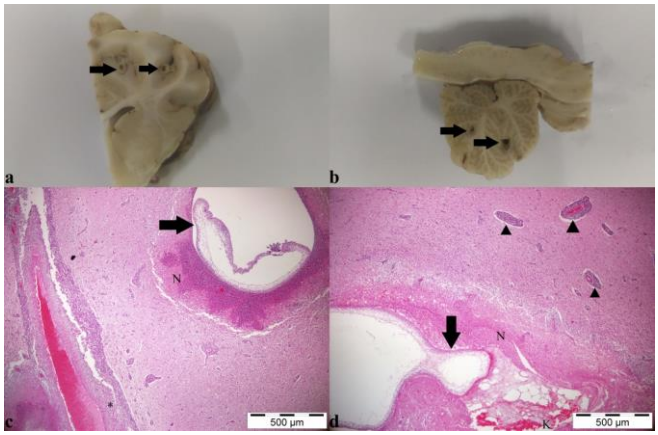

Figure 2. a-b) 4-month-old sheep, acute coenurosis, a large number of pores were found in a: the brain (arrows) and b: the cerebellum (arrows). **c)** Acute coenurosis, Nonpurulent meningoencephalitis (*), necrosis (N) and larvae (arrow), H&E, Bar= 500 µm. **d)** Acute coenurosis, perivascular mononuclear cell infiltration (arrowheads), necrosis (N), larvae (arrow) and bleeding area (K), H&E, Bar= 500 µm.

In the pathological examination of the brain and cerebellum, nonpurulent meningoencephalitis was found (Figure 3 a). In addition, large and small scolexes were detected (Figure 3 b). Inflammatory infiltrates of lymphocytes, histiocytes, plasma cells and a small number of eosinophils were observed around the cysts, and prominent hyperemia was observed in the vessels in this region. In addition to large and small liquefaction necrosis, a large number of foreign body giant cells were identified, localized on the opposite side of the necrosis of the cyst membrane (Figure 3 c). Perivascular mononuclear cell infiltration and calcification were the other pathological findings. Necrotic nonpurulent meningoencephalitis and larvae were detected in the brain and cerebellum of the acute coenurosis in one of the sheep (Figure 2 c). In addition, perivascular mononuclear cell infiltration and large areas of hemorrhage were observed (Figure 2 d).

Figure 3. a) Nonpurulent meningoencephalitis, H&E, Bar= 200 µm. **b)** Scolex (arrow), H&E, Bar= 500 µm. **c)** A large number of foreign body giant cells (arrows) localized on the opposite side of the necrosis of the cyst membrane, H&E, Bar= 100 µm.

DISCUSSION AND CONCLUSION

The mature forms of *Taenia multiceps* (Leske 1780) live in the small intestine of wild and domestic carnivores such as dogs (mostly), foxes and jackals (18-20). The eggs of *T. multiceps* enter the environment through the feces of the definitive hosts and the intermediate hosts are infected by consuming grass and water contaminated with these parasitic eggs (21-23). The oncosphere, which is released in the small intestine after oral ingestion of eggs by the intermediate hosts, reaches the brain and spinal cord at the same time as the intramuscular and subcutaneous tissues, by the hematogenous route, and mostly affects young animals (7, 15, 22, 24). Especially in Asian countries, there are studies reporting that *Taenia gaigeri* in goats is located in tissues other than in the brain and spinal cord (25-27). The young larvae penetrate the surrounding tissue and migrate to the brain and spinal cord to form tunnels filled with blood, cell clusters, neutrophil and eosinophil leukocytes (8, 28). *Coenurus cerebralis*, the larval form or metacestode of *Taenia multiceps*, causes cerebral coenurosis (gid, sturdy), characterized by locomotor disorders (26, 29-31). In fact, Hippocrates is known to have described cases of epilepsy caused by a fluid in the brain in sheep and goats (32-33). Coenurosis, which is a fatal disease, is mostly seen in sheep, but it can be seen in goats, cattle, buffalo, camels, cows, horses, cats, pigs and, rarely, in humans (34-36). There are many studies on human coenurosis recorded in Africa, France, England, Brazil, Israel, Canada and America (21, 37). *Coenurus cerebralis* in sheep and goats often settles in the brain and spinal cord, in the central nervous system (36, 38, 39). In infected sheep, Coenurus cysts are located on the right and left cerebral hemispheres (88-96%) and, to a lesser extent, in the cerebellum (4-12%) (34, 40). In this study, consistent with the data in the literature, *Coenurosis cerebralis* was found mainly in the right cerebral hemispheres (9 of 17 cases), left cerebral hemispheres (4 of 17 cases) and both right and left hemispheres (4 of 17 cases) of the sheep, goats and cattle examined. In only two cases were cysts found in the cerebellum, while no cysts at all were detected in the intramuscular and subcutaneous tissues.

Various researchers have reported cysts sized 5.5 cm in a sheep (8), 4-9.5 cm in clinically healthy sheep (2), 5-6.5 to

10.4-11.5 cm in 3 cattle (41), 2x2 cm to 6x5 cm in sheep (17) and 2-6 cm in sheep (42). In our study, we measured the average size of cysts as 5x6.2 cm in mountain goats, 3.83x4.93 cm in sheep and 5.56x6.66 cm in cattle. In the case of the acute form, the presence of a large number of pores caused by the migration of larvae in the brain and cerebellum was consistent with the literature (24). Cestode larvae are filled with clear liquid and contain many pouches of varying sizes (2, 13, 42, 43) which contain hundreds of white, pinhead sized scolexes, clustered in places (10, 17, 44). Our study found similar scolexes present in the pouches.

Clinical symptoms vary depending on the location, number and size of the Coenurus cysts (45,46). Coenurosis, usually seen in 6-18 months old sheep, is divided into two forms: acute and chronic (47, 48). In the acute form, which is rarely seen, fever, ataxia, contractions and lesions such as hemorrhagic retinal lesions are observed. Death occurs after 30 days due to encephalitis. In the chronic form, which is more common, rotation around the animal's axis, paralysis, blindness, nystagmus, torticollis, loss of appetite, dullness, loss of coordination, lethargy, and a lack of response to stimuli are observed. In chronic cases, also due to mature *Coenurus cerebralis* cysts, there is displacement of the brain tissue, atrophy, and varying degrees of necrosis and obstruction. Infected animals tend to move away from the herd and press their heads against objects (24, 25, 47, 49). In most cases, the animals are weakened by not being well fed and, after several weeks, eventually die from starvation (22, 50). Coenurosis can only be detected after death because some animals do not show any symptoms (51). In the animals of this study, consistent with the literature, clinical symptoms such as rotation of the animal around its axis, pressing of the head against objects, inability to remain standing, balance disorder, blindness, fatigue, loss of appetite, nystagmus and torticollis were observed. The acute form was found in only one of 17 cases.

In this study, as in previous studies, pathological examination of the brain revealed the presence of nonpurulent meningoencephalitis (13, 41). In addition, the presence of large and small scolexes (8) was detected. Inflammatory infiltrates of lymphocytes, histiocytes, plasma cells (15) and a few eosinophils (7, 41) were observed around the cysts, and prominent hyperemia (8, 42, 52) was detected in the vessels in this region. A large number of foreign body giant cells (3, 9, 42) were identified, localized on the opposite side of the necrosis of the cyst membrane, in addition to various small liquefaction necrosis (5, 9). Perivascular mononuclear cell infiltration (3, 8, 42) and calcification (17, 41) were among the other pathological findings observed. Again consistent with the literature (24), we found larvae, meningoencephalitis, large areas of necrosis and bleeding and perivascular cell infiltration in the case of acute coenurosis in a sheep.

Coenurosis, a common and zoonotic infection, is widespread throughout the world, especially in developing countries in Africa and Asia (1.3-9.8%) (16, 17, 49). In Turkey, the prevalence of Coenurosis has been reported in various studies to be 0.5-20% in sheep and 6.9-7.1% in cattle, in Samsun, Diyarbakir, Marmara and Ege, Karacabey Stock Farm and Kayseri (53); 1.3% in sheep in Istanbul (54); 24.6% in sheep in Istanbul (55); 16.3% in sheep in Konya (43); 15.5% in sheep in Kars (12); 3.54% in sheep and cattle in the Northeast Region of Anatolia (56); 0.47% in cattle in Erzurum (15); 12% in sheep in Kirikkale (2); 12.9% in sheep in Mus (57); and 1.3% in sheep and cattle in Isparta (58).

In conclusion, in this study, eight sheep, six mountain goats and three cattle, admitted to the Department of Pathology of the Kafkas University Faculty of Veterinary Medicine between 2016 and 2019 were diagnosed with *Coenurus cerebralis,* in the light of clinical, pathological and parasitological findings. The species, sex, age, clinical symptoms, location of the cysts in the brain and the dimensions of the animals in the study are given in detail in the tables. In addition, neurological findings in wild animals were more severe than in the other domestic animals. The acute form of the disease was found only in one case. In the literature, although there are numerous studies of *Coenurus cerebralis* in which domestic ruminants were evaluated, there are few studies in which domestic and wild ruminants are evaluated together. It is thought that the findings obtained from the study will be valuable for the province of Kars, which is an important farming and wildlife region and will contribute to the literature.

Conflict of Interest Statement

The authors declare no conflicts of interest with respect to the publication of this manuscript.

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