

## Diagnosis of a *Dicrocoelium dendriticum* infection in New World Camelids: a case report

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**ABSTRACT:** *Dicrocoelium dendriticum* plays an important role in New World Camelids as infected animals may suffer from severe clinical symptoms even leading to death of the animals. Intra vitam diagnosis may be difficult as clinical signs are atypical and *Dicrocoelium* eggs are shed only intermittently in faeces. The aim of this paper is to present four clinical cases of dicrocoeliosis in lammas as well as three asymptomatic infected animals to support the veterinarian in practice to diagnose infections. Furthermore, it is the first time that ultrasonographic examinations are described in this context. All seven lammas had been admitted to the Clinic for Ruminants at the University for Veterinary Medicine in Vienna. None of the animals had a history of *D. dendriticum* infection. The ultrasonographic examination of the liver revealed in all diseased animals as well as in two asymptomatic lammas hyperechoic areas representing calcified bile ducts typical for an infection with liver flukes. These findings together with blood examination of liver enzymes and parasitological examination may lead to the intra vitam diagnosis of dicrocoeliosis in lammas and alpacas. With an early diagnosis, the therapy of *Dicrocoelium* spp. could become more effective and the number of animals rescued may be increased.

**Keywords:** lama; liver fluke; ultrasound

One of the major health problems of New World Camelids are infections with endoparasites. The small liver fluke (*Dicrocoelium dendriticum*) plays an important role in lammas and alpacas in central European areas as infections may range in seriousness from severe disease to the death of the animal (Wenker et al. 1998; Gunsser et al. 1999). In the literature from North and South America this endoparasite is nearly never mentioned (Cheney and Allen 1989). Possibly these severe courses of the disease may result from a lack of evolutionary adaptation of New World Camelids to this parasite in Europe (Wenker 2004).

Affected animals show atypical clinical symptoms, e.g., loss of body weight, depressed attitude with increased lying times and decreased food intake. Faecal consistency may be altered; however, diarrhoea is nearly never observed. Furthermore Wenker et al. (1998) revealed regularly decreased

inner body temperatures and anaemia in diseased animals.

*D. dendriticum* has been diagnosed in 25.5% (Hengrave Burri et al. 2005a) to 34% (Hertzberg and Kohler 2006) of New World Camelids with no clinical signs observed in Switzerland. In 69% of New World Camelid farms examined in the course of a parasite observation programme in Switzerland, *D. dendriticum* infections have been found (Schönmann 2006). So far there are no studies concerning the prevalence of *D. dendriticum* in Austrian New World Camelid herds.

This paper presents case reports of seven lammas with clinically apparent liver disease caused by *D. dendriticum* as well as clinically inapparent infected animals. Our intent is that this article will assist veterinarians in practice to diagnose infections with this parasite. Further, this is the first time that ultrasonography is described in this context.

**Case description**

In summary, seven lamas that have been referred to the Clinic for Ruminants at the University of Veterinary Medicine in Vienna from five different herds are presented. Four of these animals were transferred to the Institute of Pathology and Forensic Veterinary Medicine at the University of Veterinary Medicine, Vienna for further examination. In the course of the post mortem examination, samples from different organs have been taken and fixed in 4 % buffered formaldehyde solution. For histological examination, tissues were routinely embedded in paraffin, cut into 5 µm thick slices and stained with haematoxylin and eosin (HE).

**Case 1**

The first two animals were male lamas which were kept as companion animals on one farm. The animals had contact to small ruminants and swine. An endoparasitic treatment had been performed by the owner with albendazole and doramectin. One of the two animals (lama 1) had a history of depressed attitude, increased lying times, difficulties to rise and decreased appetite. Another animal on the farm had already died with similar symptoms. The second lama (lama 2) was referred to the clinic as a companion for lama 1.

**Lama 1.** Clinical examination of this eight year old lama revealed depression, poor body condition, enhanced vesicular breathing sounds with

Table 1. Blood analysis of five lamas with a *Dicrocoelium dendriticum*-infection

Parameter	Reference*	Lama				
		1	3	5	6	7
<b>Red blood cell count</b>						
Erythrocytes (10 <sup>12</sup> /l)	10.9–14.3	10.38	13.74	<b>10.39</b>	<b>8.99</b>	<b>10.77</b>
Haemoglobin (mmol/l)	8.27–10.26	<b>7.1</b>	<b>8.1</b>	<b>7.5</b>	<b>6.2</b>	<b>6.6</b>
Haematocrit (l/l)	0.29–0.39	<b>0.42</b>	0.36	0.34	0.29	0.32
MCV (fl)	24.8–29.2	<b>40.2</b>	27.0	<b>32.8</b>	<b>32.5</b>	<b>30.0</b>
MCH (fmol)	0.66–0.73	0.68	<b>0.60</b>	0.73	0.69	<b>0.61</b>
MCHC (mmol/l)	24.8–26.7	<b>16.9</b>	<b>22.4</b>	<b>22.0</b>	<b>21.3</b>	<b>20.5</b>
<b>White blood cell count</b>						
Leucocytes (10 <sup>9</sup> /l)	9.7–16.1	<b>37.7</b>	12.7	12.4	<b>24.3</b>	9.7
Non-segmented granulocytes (%)	0–2.3	0	0	0	0	0
Segmented granulocytes (%)	42.4–73.5	<b>95.5</b>	<b>81.5</b>	<b>75.1</b>	<b>93.0</b>	55
Lymphocytes (%)	8–32.5	<b>3.3</b>	12.6	12.5	<b>4.0</b>	<b>35</b>
Monocytes (%)	1.5–6.0	<b>0.7</b>	1.7	<b>1.1</b>	2.0	<b>1</b>
Eosinophiles (%)	5.8–27.7	<b>0.4</b>	<b>3.0</b>	10.5	<b>0</b>	9
Basophiles (%)	0–1		0.5	0.3	1.0	0
Non-segmented granulocytes (10 <sup>9</sup> /l)	0–0.3	0	0	0	0	0
Segmented granulocytes (10 <sup>9</sup> /l)	4.62–11.19	<b>35.97</b>	10.42	9.27	<b>22.58</b>	5.34
lymphocytes (10 <sup>9</sup> /l)	1.09–4.28	1.24	1.61	1.54	<b>0.97</b>	3.4
Monocytes (10 <sup>9</sup> /l)	0.18–1.13	0.26	0.22	<b>0.14</b>	0.49	<b>0.10</b>
Eosinophiles (10 <sup>9</sup> /l)	0.8–3.7	<b>0.15</b>	<b>0.38</b>	1.3	<b>0</b>	0.87
Basophiles (10 <sup>9</sup> /l)	0–0.12	0	0.06	0.04	<b>0.24</b>	0

Values outside the normal range\* are bold outlined

\*Hengrave Burri et al. (2005b)

Table 2. Results of blood metabolite measurements of six animals with diagnosed *Dicrocoelium dendriticum* infections

Parameter	Reference*	Lama					
		1	3	4	5	6	7
Total protein (g/l)	58–69.3	<b>73</b>	–	–	–	–	–
AST (IU/l)	177–285	<b>729</b>	<b>562</b>	–	251	188	–
GGT (IU/l)	27.1–51.5	<b>793</b>	<b>810</b>	–	29	<b>202</b>	31
GLDH (IU/l)	6–50.3	<b>442.7</b>	<b>292.1</b>	–	<b>87.44</b>	<b>75,2</b>	8.88
CK (IU/l)	49–556	–	<b>953</b>	–	–	–	–
Bilirubin (µmol/l)	0.21–1.38	<b>8.38</b>	<b>3.25</b>	–	1.37	<b>1.88</b>	0.0
Urea (mmol/l)	6–10.2	<b>23.7</b>	<b>23.0</b>	<b>105</b>	6.5	–	–
Creatinine (µmol/l)	123.8–179.7	<b>335.93</b>	<b>344.7</b>	<b>6.49</b>	167.96	–	–

Values outside the normal range\* are bold outlined

\*Hengrave Burri et al. (2005b)

– = not examined

rustling and a holosystolic heart sound at auscultation. Activity of the compartments could not be detected. The consistency of faeces was normal.

Blood gas analysis showed a mild acidosis with a pH of 7.29 and a base excess of 3.7 mmol/l. Results of additional blood examinations are shown in Tables 1 and 2.

Ultrasonographic examination revealed the accumulation of anechogenic fluid in the pleural and abdominal cavity as well as signs of pericarditis. Within the liver bile ducts appeared highly echoic, although no appreciable acoustic shadows could be seen. The liver parenchyma appeared homogeneous.

The parasitological examination of the faeces revealed gastrointestinal strongylides, *Capillaria* spp., *Eimeria* spp. as well as *D. dendriticum*.

This animal died and a *post mortem* examination confirmed a poor body condition, ascites and a mild hydrothorax. Small liver flukes could be seen macro- and microscopically within the bile ducts. Furthermore, the histological examination of the liver revealed a cirrhosis and moderate fresh necrosis. High calcifications of renal tubuli and proteinuria could also be seen. The heart showed a mild fibrotic pericarditis and a mild right- and left heart hypertrophy as well as myocardial degeneration with a reactive inflammation. In the respiratory tract mild peribronchial pneumonia was evident.

**Lama 2.** This companion animal showed no abnormal clinical findings. Nevertheless, by using ultrasonography calcification of bile ducts similar to that in lama 1 were found.

In the faeces of this lama eggs of *D. dendriticum* could be detected.

The animal was treated orally with albendazole (Valbazen 10%-Suspension, Fa. Pfizer Corporation Austria, Vienna) at a dosage of 10 mg/kg body weight twice within a five day interval. Fourteen days after the second treatment, *D. dendriticum* eggs could still be found in a moderate amount within the faeces. After another administration of a higher dose of albendazole (15 mg/kg body weight) the egg count was increased.

Therefore, therapy recommended by Wenker and others (1998), utilising 50 mg of oral Praziquantel/kg body weight (Cestocur 2.5%-Suspension, Fa. Bayer, Leverkusen, Germany) was performed. A parasitological control revealed a considerable reduction in the shedding of *D. dendriticum* eggs via faeces.

The lama was sent back home to the owner. Two years later no clinical signs of dicrocoeliosis could be seen in the lama and another parasitological examination revealed mild *D. dendriticum* shedding (107 eggs per gram faeces).

## Case report 2

The lamas from the second case report originated from a farm where the animals were used for trekking tours. Lama number 3 was referred to the clinic in July 2007 and the second lama (lama 4) in August 2009. Between these two years, new lamas were introduced to the herd as well as sold from it. Similar to the other farm, the animals had contact with sheep on pasture.

**Lama 3.** This lama was castrated 16 days before it was transferred to the clinic and showed at the

time of admittance, reduced feed intake as well as a depressed attitude with increased lying times and reduced urination. Although all four lamas were at the same age, this one was physically smaller than the others and was light-107 kg compared to 140 to 160 kg body weight.

During the physical examination the lama lay down and was recumbent afterwards (varying between sternal and lateral recumbency). The inner body temperature was elevated (39.4 °C) and the mucous membranes of the eyes and mouth showed a dirty red, faded colour. On auscultation enhanced vesicular breathing sounds with rustling and pounding heart beats could be heard. Activity of the compartments could not be detected. Defecation and urination were normal.

Evaluation of the nervous system revealed a highly decelerated pupillary reflex bilaterally.

On admission the animal was treated systemically with an infusion of 5000 ml of a 0.9% NaCl solution (NaCl 0.9% Fresenius-Solution, Fresenius Kabi AG, Bad Homburg, Germany), 500 ml of a 30% glucose solution (Glucose 30% Fresenius-Infusion solution; Fresenius Kabi AG, Bad Homburg, Germany) and 20 ml of a Vitamin B-complex (Vanavit B-Komplex, Vana, Vienna, Austria). Approximately 250 ml of fresh rumen fluid from a cow were transferred to the animal.

Blood gas analysis showed acidosis (pH 7.32; BE – 8.2 mmol/l). Results of additional blood analysis are shown in Tables 1 and 2.

Abdominal and thoracic ultrasonography revealed high amounts of anechogenic fluid within the abdomen, thorax and pericard. The liver showed multiple nodules on the surface and nonhomogene-



Figure 1. Necropsy finding of patient 3: liver with nodular margin

ous parenchyma with echogenic bile ducts without remarkable acoustic shadows.

Because of worsening of the general condition and the poor prognosis, the lama was euthanized and necropsy was performed.

*Post mortem* findings included a poor body condition, ascites and hydrothorax as well as a mild pneumonia. Macroscopically and histologically the liver showed cirrhosis with multiple nodules (Figure 1 and 2). Small liver flukes could be seen macro- and microscopically within the bile ducts.

**Lama 4.** The second lama from this farm was admitted to the clinic in August 2009 with a history of increasing depression and missing urination. Approximately one month prior, the animals had been dewormed with albendazole.

On admission the lama was 5.5 years old. The animal was in sternal recumbency, the body condition was poor and the inner body temperature was 39.1 °C. A mixed dyspnoea with open mouth breathing could be observed. The lung sounds were moderately enhanced vesicular and heart beats were pronounced. Movement of the fore stomach could not be detected. No urination could be seen and the prepuce was dry. The amount and consistency of faeces were normal but small amounts of mucus could be seen.

Blood gases revealed acidosis (pH 7.25; BE – 10.8 mmol/l).

In this animal, therapy was initialised with an intravenous fluid treatment of 5000 ml of a 0.9% NaCl solution, 500 ml of a 30% glucose solution and 20 ml of a Vitamin B-complex. Additionally,

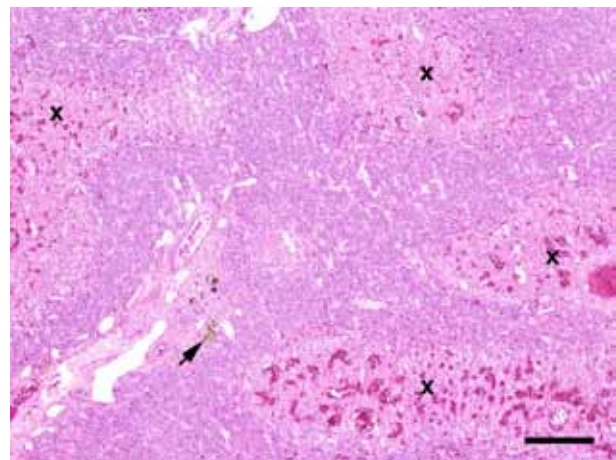


Figure 2. Histological picture of liver (HE staining): unremarkable liver parenchyma (x), in between pseudotubuli and small liver flukes (↑), balk = 400 μm

a combined spasmolytic and analgetic drug was administered (0.32 mg Butylskopalaminiumbromid and 40 mg Metamizol-Sodium/kg body weight; Buscopan compositum-Solution, Boehringer Ingelheim Vetmedica, Ingelheim, Germany).

The animal died within a few hours. A post mortem examination confirmed a poor body condition score and a severe alveolar lung oedema as well as moderate alveolar lung emphysema. The liver showed severe nodular cirrhosis with moderate hepatitis and large quantities of macroscopically visible small liver flukes.

### Case report 3

**Lama 5.** This animal was an eight year old clinical healthy male lama. At a routine parasitological examination *D. dendriticum* could be detected in its faeces.

The results of blood analysis are shown in Tables 1 and 2. A marginal elevated activity of the enzyme glutamate-dehydrogenase (GLDH) was noted.

Ultrasonography of the abdomen revealed no significant findings, apart from the liver. Liver parenchyma was widely homogeneous but multiple hyperechogenic, up to 1 cm long linear and dot-shaped structures with a distinct acoustic shadow could be seen.

### Case report 4

**Lama 6.** Lama 6 was a 14 year old castrated male. It was housed with a group of male animals on a farm with 40 New World Camelids. The owner dewormed the animals on a regular basis, most recently with 0.4 mg Moxidectin per kg body weight (Cydectin 0.1%-oral Solution for sheep, Fort Dodge Vet., Wuerselen, Germany). Two years before, a study was conducted on that farm to evaluate the endoparasitic status. The endoparasites detected were mainly *Eimeria* spp. and different nematodes. In contrast to the group of the female lamas where two of the 19 examined lamas shed *D. dendriticum* eggs (< 200 eggs per gram faeces), no trace of this parasite was found in the group of male lamas.

The history of this animal included the ingestion of high amounts of pears one week earlier. The animal now suffered from a lack of appetite, and urination was not observed.

Similar to the other diseased animals presented in this report, this animal showed a poor body condition. Its wool was rough and shaggy. The animal was depressed and showed increased lying times. The inner body temperature was 36.9 °C and the pulse was weak. At auscultation an enhanced vesicular breathing sound with rustling and a holosystolic heart sound could be heard. The ventral abdomen was enlarged. Activity of the compartments could not be detected. Faeces were normal.

Blood gas analysis revealed mild alkaloses with a pH of 7.52 and a base excess of 4.8 mmol/l. Further blood parameters are listed in Tables 1 and 2.

Parasitological examination of the faeces revealed high numbers of gastrointestinal strongylides.

From all presented lamas, this one showed sonographically the most extensive calcification of the bile ducts (including distal acoustic shadowing). The margin of the liver presented multiple nodules (Figure 3). Additionally, severe ascites and hydrothorax was diagnosed.

This animal was euthanized because of the severe clinical signs and the poor prognosis.

At necropsy the animal showed a poor body condition, severe ascites and a moderate hydrothorax. The liver was cirrhotic and the bile ducts showed multiple calcifications. Small liver flukes could be seen macro- (Figure 4) and microscopically. Furthermore, moderate microurolithiasis, fibrosis of the pleura, multifocal fibrosis of alveolarsepts

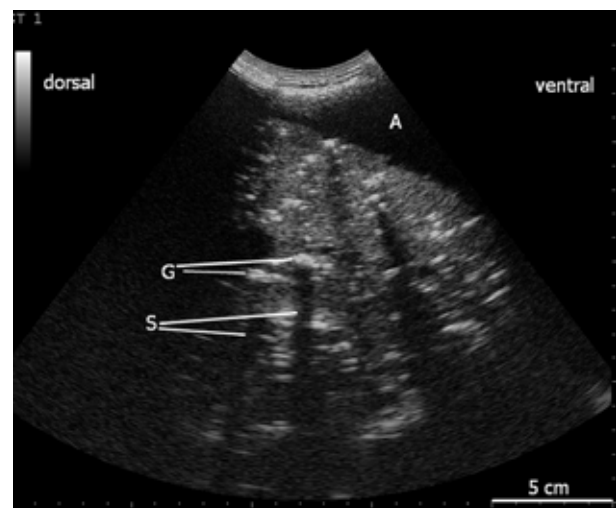


Figure 3. Ultra-sonographic picture of the intra costal part of the dorsal abdomen of a 14 year old lama (patient 6) with hypoechoic ascites (A), uneven liver margin caused by cirrhosis and calcification of bile ducts (G) with distal acoustic shadows (S)

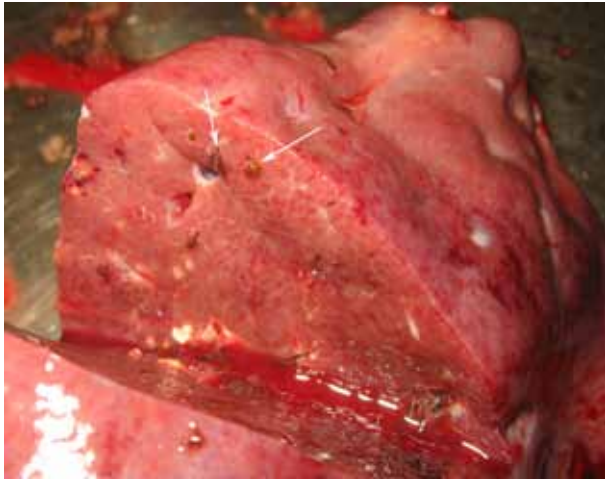


Figure 4. *Post mortem* finding: cirrhotic liver with macroscopically apparent small liver flukes

and a focal myocardfibrosis in the area of the apex cordis could be detected.

### Case report 5

**Lama 7.** The final animal presented here was a two year old male lama with anamnesis of dyspnoea. The clinical examination revealed that the animal had a poor body condition, mucous membranes of the eyes were severely reddened, the animal coughed spontaneously and suffered from a mild in- and expiratory dyspnoea with accessory movements of the nostrils. The lung sounds were slightly increased vesicular and the heart beats unremarkable on auscultation. Faeces were normal.

To examine the upper respiratory airways, a rhinotracheoscopy was performed. Within the nasal cavity a mild mucous discharge could be seen and the epiglottis was oedematous.

Due to the poor body condition, blood (results are shown in Tables 1 and 2) and faeces for endoparasites were examined. Parasitological examination revealed excretion of *Trichuris*, *Capillaria* and *Nematodirus* as well as of *Dicrocoelium* eggs.

The ultrasound examination revealed comet-tail artefacts on the lung surface. The abdomen and heart were unremarkable. The parenchyma of the liver appeared homogeneous.

The lama was sent home with the recommendation to deworm all lamas on the farm with praziquantel (50 mg/kg body weight) and to check the body condition of the animals and faeces parasito-

logically on a regular basis with regard to infection with *D. dendriticum*.

### Summary of findings

**Signalment and anamnesis.** All of the seven animals were adult male lamas between the ages of two and 14 years. None of the animals were admitted to the clinic with suspicion of dicrocoeliosis or endoparasitosis. Four of the seven animals were euthanized or died. In the remaining three animals infections were diagnosed during the course of routine examinations. Four of the animals were previously treated with antiparasitics (albendazole, doramectin or moxidectin).

All animals were kept in groups on pasture for the whole year. Four of the lamas had direct contact to small ruminants.

Lamas 1, 3, 4 and 6 were admitted to the clinic with a history of weakness and decreased feed intake. The patients 3, 4 and 6 had disturbances of urination.

**Clinical examination.** Results of the clinical examination were atypical in all cases. Faeces were normal; only in one animal small amounts of mucus could be seen. All lamas with clinical signs showed a depressed attitude with increased lying times up to recumbency. The condition was poor in all diseased animals (lamas 1, 3, 4 and 6) and activity of the fore stomach was not observed in any of the animals.

**Blood analysis.** Blood gas analysis revealed acidosis in three of the animals and mild alkalosis in one animal.

In five lamas (lamas 1, 3, 5, 6 and 7) blood was further examined for additional parameters. In all of the five animals, haemoglobin levels were increased, while the haematocrit as well as the MCV and MCHC were partially increased. In two animals, leucocytosis was diagnosed. An elevation of segmented granulocytes was found in four of the five animals and eosinopenia in three of five lamas. The activity of the enzymes aspartate-aminotransferase (AST), gamma-glutamyl-transferase (GGT) and glutamate-dehydrogenase (GLDH) as well as the total bilirubine were increased in lamas with clinical signs. In animals without clinical findings these serum constituents were within normal ranges with the exception of GLDH in lama 5.

**Ultrasonographic examination.** In six of the seven lamas presented here ultrasonographic examination revealed point- or line shaped hyper-

echoic zones within the liver parenchyma with different degrees of acoustic shadowing, representing calcification of bile ducts. Animals with clinical signs (lamas 1, 3, 4 and 6) also showed liver cirrhosis with marginal nodules and moderate to severe accumulation of fluids in the thoracic or abdominal cavity. Only in patient 7 was the liver unremarkable by ultrasonography.

**Pathological examination.** All examined animals (lamas 1, 3, 4 and 6) had a poor body condition. Lamas 1, 3 and 6 showed ascites and hydrothorax. In all four animals cirrhosis of the liver could be diagnosed and small liver flukes could be detected macro- and microscopically.

## DISCUSSION AND CONCLUSIONS

In contrast to the literature from North and South America, there are reports from Germany and especially Switzerland on the significance of *D. dendriticum* infections in New World Camelids (Wenker et al. 1998; Gunsser et al. 1999; Hertzberg and Kohler 2006; Schönmann 2006). Similar to our neighbouring countries, Germany and Switzerland, the number of lamas and alpacas have increased in Austria, and consequently veterinarians are confronted more frequently with health concerns for these species (Kriegel et al. 2005). The aim of this work was to highlight a disease with an occasionally lethal outcome and to give an overview of practical diagnostic methods for dicrocoeliosis in New World Camelids.

As already stated in the literature, animals suffering from dicrocoeliosis only show atypical clinical signs. None of the animals presented here were admitted by the practicing veterinarian to the clinic with suspicion of *D. dendriticum* infection or even endoparasitosis.

Clinical examination at admittance revealed only atypical signs, e.g., depressed attitude, increased lying times up to recumbency, poor body condition and missing activity of the fore stomach. Faeces were found to be normal in all animals; only in one patient was a small amount of mucus admixed. That led to the conclusion, by clinical examination, that a diagnosis was not possible. If the mentioned symptoms (weakness with loss of body weight and missing fore stomach activity) occur, however, the practitioner has to take into account the possibility of infection with *D. dendriticum*.

None of the lamas admitted to the clinic with clinical signs could be rescued. Despite sympto-

matic therapy the animals worsened and had to be euthanized or died. Similar results have been presented by Wenker et al. (1998). Hence, it can be concluded that if severe symptoms are manifested, therapy may often be too late.

Through blood analysis of lamas and alpacas, Wenker et al. (1998) diagnosed dicrocoeliosis anaemia. This was not the case in our patients. Therefore, this parameter may only hint at the presence of an endoparasitosis (including dicrocoeliosis), as even in some severely diseased lamas, blood values fell within the normal ranges. Neither in this report nor in the one presented previously by Wenker et al. (1998), was any eosinopenia found. In contrast to Wenker et al. (1998) our report showed that three of the examined animals had elevated activity of liver specific enzymes (GLDH, GGT) and increased concentrations of total bilirubin. It must be taken into account that the case studies presented in this report were in the terminal stages of the disease. A pronounced increase in these two enzymes has also been described by Gunsser et al. (1999) in animals shedding over 600 *Dicrocoelium* eggs per gram faeces. This leads to the conclusion that an elevation of liver specific enzymes may suggest dicrocoeliosis as a potential diagnosis. Further research is required to examine the correlation between infection, disease and enzyme activity.

As New World Camelids do not have a gall bladder constant egg shedding would be expected. However, the parasitological examination of faeces for *D. dendriticum* has frequently been negative. Comparable results have been published by Wenker et al. (1998).

So far the optimal time for faeces sampling to detect *Dicrocoelium* infection is not known as in the literature only cross section studies are available.

Further problems arise because of complicated parasitological diagnosis as the (approximately 25 × 40 µm large) eggs of *D. dendriticum* cannot be found by use of routine flotation methods (with a specific density of > 1.45) as well as common sedimentation methods (Gunsser et al. 1999). Hence, modified methods are necessary. A combined sedimentation and flotation (Eckert 2000) with a zinc-sulfate solution with specific densities of 1.2 to 1.3 (Bauer 2006) have proven to be of the required sensitivity.

This would mean for the veterinarian in practice that even a negative result at coprological examination does not rule out infection with *D. dendriticum*. In such cases follow-up examinations are suggested.

This is the first time that ultrasonographic examinations are described in the context of infection with the small liver fluke in New World Camelids. In six of the seven animals presented here (including two clinical healthy lamas), typical changes within the liver could be seen. Only in one animal (lama 7), which shed low numbers of *Dicrocoelium* eggs was the liver inconspicuous by ultrasonographic scanning. Hence, the use of ultrasonography seems to be a suitable method to monitor liver changes occurring over the course of infection with the small liver fluke. Studies with a higher number of animals should follow.

The sonographic changes within the liver are similar to those of cattle with liver fluke associated calcifications of the bile ducts (Floeck et al. 2003). In addition, the lamas that died or were euthanized showed the accumulation of fluids in the thorax and abdomen and evidence of liver cirrhosis characterised by a nodular surface. These findings could not be detected in the clinically inconspicuous animals. The most severe calcifications were seen in the oldest lama, leading to the hypothesis of a chronicity of the disease. Furthermore these findings were associated with near normal or only slightly increased activity of the enzymes AST and GLDH as well as total bilirubin in this animal, but an elevated GGT-activity (Floeck et al. 2003).

These results suggest that an ultrasonographic examination together with blood analysis and parasitological examination of faeces may permit an early diagnosis of dicrocoeliosis. Consequently, therapy could be initiated at earlier stages of the disease leading to the rescue of more animals.

As intra vitam diagnostic possibilities remain restricted and clinical symptoms appear only at the advanced stage of the disease, and because treatment usually only leads to a reduction but not eradication of the parasite, prophylactic measures are of the highest importance.

The section for New World Camelids of the Advisory and Health Service for Small Ruminants in Switzerland proposes: animals newly introduced to the herd should be examined for *D. dendriticum*, animals grazing on pasture (for example together with sheep) should be screened on a regular basis. Especially weak animals should be checked and examined and the evaluation and treatment of any herds from which dicrocoeliosis has been reported should be performed (Schoenmann, 2006).

So far only praziquantel at a dosage of 50 mg/kg body weight has proven to be effective for treat-

ment (Wenker et al. 1998; Gunsser et al. 1999). As mentioned above, in most cases only a reduction but no eradication of the endoparasite is possible. Studies concerning repetition and interval of treatment of *D. dendriticum* infections as well as those reporting the optimum time of coprological control are still missing.

Given that all animals admitted to the clinic suffered from poor body condition, we further suggest that owners should weigh or check the Body Condition Score as described by Hilton et al. (1998) of all their New World Camelids on a regular basis. This is especially important because of the tight packing of the wool which can hide weight loss in lamas and alpacas. Hence, specific examination may identify any body weight loss at an earlier stage and infected animals can therefore be examined and treated earlier.

## REFERENCES

- Bauer C (2006): Examination methods. In: Schnieder T (ed.): Veterinary Parasitology (in German). 6<sup>th</sup> ed. Parey, Berlin. 84–104.
- Cheney JM, Allen BS (1989): Parasitism in lamas. Veterinary Clinics of North America: Food Animal Practice 5, 217–225.
- Eckert J (2000): Helminthological methods. In: Rommel M, Eckert E, Kutzer E, Körtnig W, Schnieder T (eds.): Veterinary Parasitology (in German) 5<sup>th</sup> ed. Parey, Berlin. 69–84.
- Floeck M, Baumgartner M, Bago Z, Schilcher F (2003): Photosensitivity due to liver fluke in cattle (in German). Tierärztliche Praxis 31, 143–149.
- Gunsser I, Hänichen T, Maierl J (1999): Liver flukes in New World Camelids. Parasitology, Pathology, Clinics and Therapy (in German). Tierärztliche Praxis 27, 187–192.
- Hengrave Burri I, Martig J, Sager H, Liesegang A, Meylan M (2005a): South American camelids in Switzerland. I. Population, management and health problems (in German). Schweizer Archiv für Tierheilkunde 147, 325–334.
- Hengrave Burri I, Tschudi P, Martig J, Liesegang A, Meylan M (2005b): South American camelids in Switzerland. II. Reference values for blood parameters (in German). Schweizer Archiv für Tierheilkunde 147, 335–343.
- Hertzberg H, Kohler L (2006): Prevalence and significance of gastrointestinal helminths and protozoa in South American Camelids in Switzerland. Berliner und Münchener Tierärztliche Wochenschrift 119, 291–294.



- Hilton CD, Pugh DG, Wright JC, Waldrige BM, Simpkins SA, Heath AM (1998): How to determine and when to use body weight estimates and condition scores in llamas. *Veterinary Medicine* 93, 1015–1018.
- Kriegl C, Klein D, Kofler J, Fuchs K, Baumgartner W (2005): South American Camelids husbandry in Austria (in German). *Veterinary Medicine Austria* 92, 119–125.
- Schoenmann M (2006): Small liver flukes in New World Camelids, sheep and goats (in German) *Kleinwiederkäuer Forum* 12, 34–35.
- Wenker Ch (2004): Dicrocoelioses (in German). In: *Proceeding 2. Neuweltkamelidentagung der Schweizer Vereinigung für Wiederkäuermedizin*, 01.–02.10.2004, Tänikon, Switzerland, 14–16.
- Wenker Ch, Hatt JM, Hertzberg H, Ossent P, Hänichen T, Brack A, Isenbügel E (1998): Dicrocoeliosis in New World Camelids (in German). *Tierärztliche Praxis* 26, 355–361.

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