NOTE *Clinical Pathology*

Occurrence of Cerebrocortical Necrosis in A Goat in Okinawa Prefecture, Japan

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ABSTRACT. A 6-month-old male Nubian goat suddenly showed dullness, tachypnea, recumbency and opisthotonus in August 2011 in Okinawa, Japan. The goat was consequently necropsied: gross lesions in the brain included slightly swollen foci of yellowish discoloration on the cerebral hemisphere. Histopathologically, necrosis of the cortex with ischemic changes of neuronal cells was present, and swelling of the vascular endothelium, thickening of the basement membrane and diffuse infiltration of macrophages were observed in the cerebral lesion. Autofluorescence of the cerebral cortex was confirmed by an ultraviolet light test. The thiamine levels of the blood serum and tissue samples (brain, liver and heart) of the goat were low compared with goats from the same herd. The goat was diagnosed with cerebrocortical necrosis (CCN). This is the first case report of caprine CCN in Japan.
KEY WORDS: cerebrocortical necrosis, goat, thiamine.

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Cerebrocortical necrosis (CCN) in ruminants is a common metabolic disease mainly induced by thiamine deficiency that shows neurological signs as follows: ataxia, recumbency, convulsion and opisthotonus [1, 3, 5, 11]. Feeding of a low-forage and high-concentrate diet is suggested as the cause [2, 12]; younger animals are generally more often affected than adults. CCN was first described in cattle and sheep in 1956 [5], and since then, additional cases have been reported worldwide, including in Japan [9, 11]. The occurrence of CCN in goats, however, would appear to be recognized but poorly documented [8, 12]. This is the first case report of caprine CCN in Japan.

In August 2011, 70 goats were being fed a diet of hay, concentrated feed and brewer's grain at a farm in Okinawa, Japan. A 6-month-old male Nubian goat weighing 30 kg in the herd presented dullness, tachypnea and recumbency with a high rectal temperature (41.0°C). The patient was administered an intramuscular injection of ampicillin alone twice a day; however, neurological signs including convulsion and opisthotonus progressed over a period of 24 hr. The patient was consequently euthanized due to the poor prognosis.

A blood sample was obtained for hematological and biochemical analyses, and the results were as follows: RBC count, 26.2 × $10^6/\mu l$; WBC count, 26,000/μl; packed cell volume, 36%; total protein, 6.9 g/d*l*; albumin, 3.2 g/d*l*; blood glucose, 62 mg/d*l*; creatinine (Cre), 2.6 mg/d*l*; blood urea nitrogen (BUN), 41 mg/d*l*; total bilirubin (T-Bil), 1.2 mg/d*l*; alanine aminotransferase, 55 IU/*l*; γ-glutamyltransferase (GGT), 280 IU/*l*; aspartate aminotransferase (AST), over 1,000 IU/*l*; total cholesterol, 105 mg/d*l*; and inorganic phosphorus (iP), 9.8 mg/d*l*. High levels of Cre, BUN, T-Bil, GGT, AST and iP were observed. Pathogenic bacteria were not isolated from the organs on aerobic and anaerobic cultures.

At necropsy, swollen foci of yellowish discoloration were observed on the cerebral hemisphere. Samples of the organs including the brain were fixed in 10% buffered formalin, processed through a conventional histological method and stained with hematoxylin and eosin (HE). Histopathologically, necrosis of the cortex with ischemic changes of neuronal cells was present (Fig. 1A). Swelling of the vascular endothelium, thickening of the basement membrane and diffuse infiltration of macrophages were observed in the cerebral lesion (Fig.1B). In addition, laminar vacuolation was present in the tectum mesencephali. Our histological observations resemble those of two caprine cases reported by Smith [12].

An ultraviolet light test at a wavelength of 365 nm showed autofluorescence in the lesions of the cerebral cortex. The cut surface also showed distinctive autofluorescence (Fig. 2). This test is a rapid and simple aid to diagnose CCN [4, 6, 7].The evidence for cerebral autofluorescence of the specimen indicated CCN.

The total thiamine concentrations of blood serum and the organ samples (brain, liver and heart) of the patient, the goats from the same herd and the controls were determined by the thiochrome method using a high-performance liquid chromatography (HPLC) system [3]. The thiamine con-

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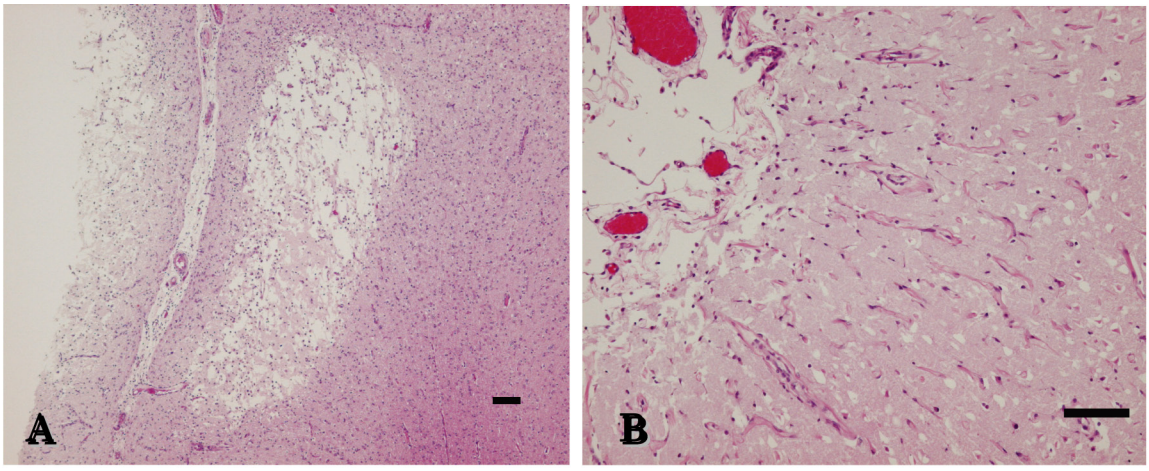

Fig. 1. A: Necrosis of the cortex with ischemic changes of neuronal cells was present. HE stain. Bar: 100 μm. B: Swelling of the vascular endothelium, thickening of the basement membrane and diffuse infiltration of macrophages were observed in the cerebral lesion. HE stain. Bar: 100 μm.

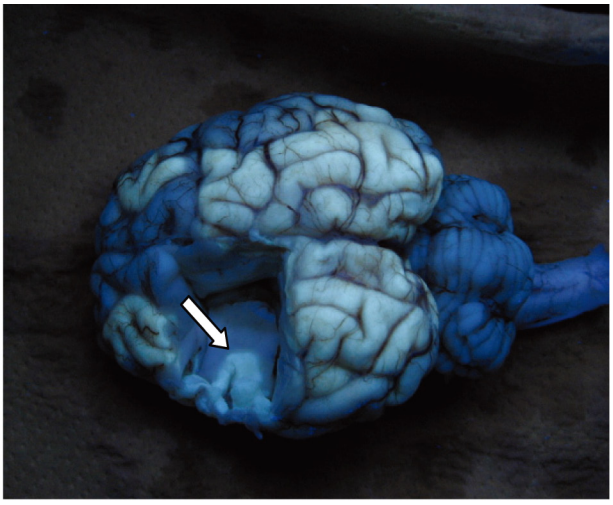

Fig. 2. Cut surface of the cerebral cortex exhibits distinctive autofluorescence under ultraviolet light (arrow).

Table 1. Total thiamine concentrations of serum in the patient, goats from the same herd and controls (*ng*/m*l*)

	Age (sex)	Concentration (*ng*/m*l*)
Patient	6 months (male)	3.0
Goat No. 1	6 months (female)	33.0
Goat No. 2	6 months (female)	23.1
Goat No. 3	6 months (female)	27.1
Goat No. 4	6 months (female)	25.0
Goat No. 5	6 months (female)	23.4
Control [a)] No. 1	5 months (male)	32.8
Control No. 2	6 months (male)	37.8
Control No. 3	5 months (male)	46.9
Control No. 4	5 months (male)	23.9

a) Apparently healthy goats from a control farm.

centration of the serum sample of the patient was markedly low; in contrast, those of 5 other goats from the same herd and 4 controls were within the normal ranges (Table 1). The concentrations of the tissue samples from the case were as follows: cerebral cortex, 0.10 μg/g; cerebral medulla, 0.10 μg/g; liver, 0.10 μg/g; and heart, 0.30 μg/g. Thomas *et al.* [13] measured thiamine concentrations of tissues and reported values of 1.6 ± 0.3 μg/g (n=25) in the liver and 0.7 ± 0.1 μg/g (n=8) in the brain in normal goats and values of 0.3 ± 0.4 μg/g (n=4) in the liver and 0.3 ± 0.1 μg/g (n=6) in the brain in tissues from goats with CCN. Our data are almost consistent with their values.

In general, CCN in goats may result from tissue thiamine deficiency due to 1) thiaminase type 1 production by ruminal bacteria, possibly following ingestion of moldy or fungal contaminated feed or acidosis resulting in changes in rumen microflora; 2) prolonged diarrhea, *e.g.*, coccidiosis; 3) drug therapy, *e.g.*, therapy with thiabendazole, levamisole and amprolium; and 4) plant thiaminase ingestion, *e.g.*, bracken poisoning (*Pteridium aquilinum*) [7].

The diagnosis of CCN in goats requires determining the total thiamine concentrations in tissue samples such as of the brain, liver or heart [7, 10, 13].

Thiamine is believed to be an essential factor in the central nervous system, participating in the excitation of peripheral nerves. Overt cases of CCN would lead to a lethal condition unless treated with thiamine in the early stage [7, 12, 13]. Therefore, unaffected animals in a group should be treated as a preventative measure, such as by thiamine supplementation. On the basis of these findings, the patient was considered to have been overfed with a grain or concentrate diet. Few cases of CCN have been reported in goats; however, it should be noted that practitioners expect that a caprine case may occur under the conditions resulting from inadequate diet.

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