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Polioencephalomalacia diagnosed in necropsied cattle in Korea

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Abstract

Polioencephalomalacia (PEM) is a neurologic disease of ruminants diagnosed by pathological approach. There is very little information available to understand bovine PEM in Korea. In this study, we investigated the diagnostic rate and pathological features of PEM in 334 necropsied cases of cattle submitted to the Animal and Plant Quarantine Agency in Korea from 2015～2017. PEM was diagnosed only in 13 (3.9%) Hanwoo, the Korean native cattle, and sporadically occurred in our country. The disease was the most diagnosed in fall season, and the age of the cows ranged from 1 month to 3 year. In all PEM cases, softening, and yellow discoloration of the gray matter in the cerebrum and fluorescence at the sites using ultraviolet illumination were grossly observed. Microscopically abundance of glial cells with vacuolar large cytoplasm and neuronal necrosis were commonly observed. This study suggests that future studies are necessary to identify the cause and pathogenesis for the control of PEM in our country.

Key words : Cattle, Cerebrocortical necrosis, Pathology, Polioencephalomalacia, Korea

INTRODUCTION

Polioencephalomalacia (PEM), also known as cerebrocortical necrosis, is a neurologic disease of ruminants characterized by necrosis of the cerebral cortex (Roberts and Boyd, 1974; Rachid et al, 2011; Amat et al, 2013; Maxie 2016; MSD, 2017). The term of PEM comes from a combination of the etymology of gray matter (polio), brain (encephalo), and softening (malacia). This disease is the end point of several conditions and the histopathological diagnosis.

Historically, thiamine deficiency, high sulfur intake, acute lead poisoning, and water deprivation-sodium ion toxicity are known etiological factors of PEM (Kul et al 2006; Rachid et al, 2011; Amat et al, 2013; MSD, 2017). Despite this, most veterinarians equate PEM with thiamine deficiency, but more recent reports suggest a causal relationship between high sulfur intake and PEM (Gooneratne et al, 1989b; Gould et al, 1991; Niles et al, 2002; Mckenzie et al, 2009). These factors produce similar brain lesions, but the lesions differ according to the severity and duration of the clinical course (Sant'Ana and Barros, 2010; Amat et al, 2013; Maxie 2016).

Grossly, in acute cases, there is no specific finding or restricted brain swelling. In more advanced cases the cortex displays more characteristic changes such as flattening of gyri, yellow discoloration, softening with gelatinous or depressed area. In chronic cases, cortical width can decrease or the cortical tissue can disappear in altogether. Histologically, in the acute cases there is segmental laminar necrosis of cerebrocortical neurons characterized by shrunken and eosinophilic cytoplasm, chromatolysis, pycnosis, and hypertrophy of the endothelial cells in vessels adjacent to the affected areas. In subacute or chronic cases, there is necrosis of neuroectodermic components and infiltration of large foamy

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macrophages.

PEM is affecting the number of ruminants such as cattle, sheep, and goats. The clinical signs include ataxia, blindness, circling, restlessness, sensitivity to light, standing in a corner, mild excitation and loss of appetite. In more severe cases, hyperexcitability, rigidity, head pressing, severe seizures, coma and finally death have been observed.

The diagnosis of PEM is based in the clinical, gross, histopathological, and epidemiologic findings. A useful diagnostic method is visualization of fluorescence of affected areas of the brain under ultraviolet (UV) light (Jackman and Edwin, 1983; Sant'Ana and Barros, 2010).

Also a therapeutic diagnosis can be achieved following the recovery of cattle treated with thiamine and corticoids (Sant'Ana and Barros, 2010). PEM is well-recognized syndrome in ruminants that is seen worldwide, but we have little information in Korea. In the present study, we describe the prevalence and pathological features of bovine PEM diagnosed in Animal and Plant Quarantine Agency (APQA).

MATERIALS AND METHODS

A total of 334 brains or bodies from necropsied cattle were submitted to the Animal Disease Diagnostic Division, APQA for disease diagnosis during the period of 2015～2017. The cut surface of each brain was observed gross lesion and fluorescence under UV illumination (365 nm wave length). All brain tissues were fixed in 10% neutral buffered formalin solution and embedded in paraffin wax for histopathology. The embedded tissues were sectioned and subsequently stained with hematoxylin and eosin.

RESULTS

Prevalence of PEM

Among 334 brains or bodies analyzed by pathologic examination, PEM was diagnosed in 13 (3.9%) in the last 3 years. As seen in Table 1, the prevalence of PEM in individual years varied from 3-6 cases, with a range of 2.9% of the cattle being positive in 2015, but as many as 4.2% of the tested cattle being PEM positive in 2017.

Table 1. Diagnosis of polioencephalomalacia (PEM) in necropsied cattle

Year	No. PEM/No. necropsied (%)	Individual information of cattle diagnosed PEM				
		Date[1]	Season[2]	Province	Breed	Age
2015	3/103 (2.9)	27 Feb	Winter	Incheon	Hanwoo[3]	3 Y
		20 Mar	Spring	Gyeonggi	Hanwoo	1 Y
		04 May	Spring	Gyeonggi	Hanwoo	13 M
2016	4/87 (4.6)	17 June	Summer	Gyeongbuk	Hanwoo	4 M
		09 Sep	Fall	Chungnam	Hanwoo	10 M
		02 Nov	Fall	Gyeonggi	Hanwoo	1 M
		15 Nov	Fall	Gyeonggi	Hanwoo	7 M
2017	6/144 (4.2)	01 Feb	Winter	Jeonnam	Hanwoo	28 M
		06 Sep	Fall	Gangwon	Hanwoo	4 M
		11 Oct	Fall	Gyeongbuk	Hanwoo	19 M
		20 Sep	Fall	Gyeonggi	Hanwoo	6 M
		17 Oct	Fall	Daejeon[4]	Hanwoo	13 M
		17 Oct	Fall	Daejeon[4]	Hanwoo	13 M
Total	13/334 (3.9)					

[1]The date the sample was received.
[2]Korea has four seasons as follows: spring (March-May), summer (June-August), fall (September-November), and winter (December-February).
[3]A kind of Korean native cattle.
[4]Cattle of the same farms from Daejeon province.

Whether considering data as individual providences, the case of PEM was highest in Gyeonggi province (5). This was followed by Daejeon (2), Gyeongbuk (2), Chungnam (1), Gangwon (1), Jeonnam (1), and Incheon (1) (Table 1). Among these two cattle commissioned at a farm in Daejeon province were diagnosed as PEM at the same time. All cattle diagnosed with PEM were Hanwoo, the Korean native cattle. The age of the cows diagnosed with PEM ranged from 1 month to 3 year. Especially, the number of cattle corresponding to 3-8 months was four (30.8%). The disease appeared to occur in all seasons but occurred more in autumn than in other seasons.

Macroscopic findings

There were no gross lesions when the abdominal, thoracic cavities and joints were incised. However, we observed local or diffuse necrosis, softening and yellow discoloration of affected cortical areas (Fig. 1A). Ultraviolet illumination of sections of the brain revealed marked segmental areas of auto-fluorescence in the cerebral cortex (Fig. 1B).

Histopathological findings

The initial histologic lesions are necrosis of cerebrocortical neurons (Fig. 2A). Histopathological findings that were common to all cases included abundance of glial cells with vacuolar large cytoplasm, gliosis, neuronal necrosis accompanied by shrunken neurons, eosinophilic cytoplasm, pyknotic, faded, or absent nuclei, pericapillary edema, and perivascular cuffing with monocytes, neutrophil and/or eosinophil (Fig. 2B).

DISCUSSION

Like many countries, bovine PEM in our country was related with necrotic lesions in the gray matter of the cerebral cortex (Radostis et al, 2007; Sant'Ana and Barros, 2010; Amat et al, 2013; Maxie 2016; MSD, 2017). We diagnosed PEM easily by characteristic gross and histopathological findings of the brain in the necropsied cattle. In addition, UV illumination recommended by many researchers was used as a powerful tool for PEM diagnosis in our study. As Fig. 1B, the lesions of cortical necrosis in brain fluoresce under UV light because of the presence of lipid metabolites within

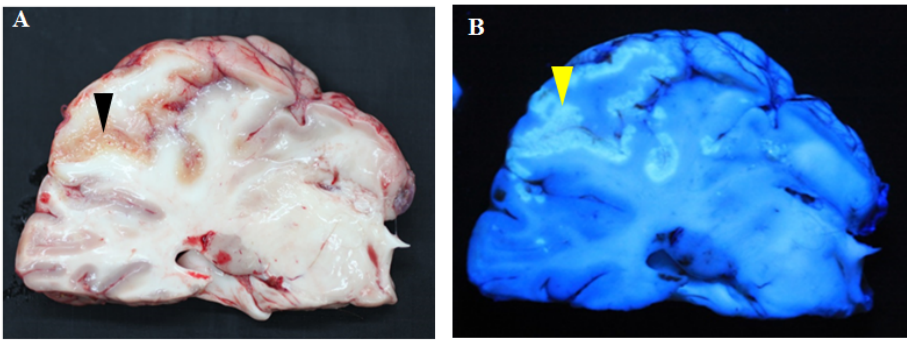

Fig. 1. Macroscopical findings of polioencephalomalacia. (A) Local or diffuse softening and yellow discoloration (arrowhead) of the gray matter in the cut surface of cerebrum. (B) Autofluorescence in the necrosis areas of the cut surface of cerebral cortex under ultraviolet light (arrowhead).

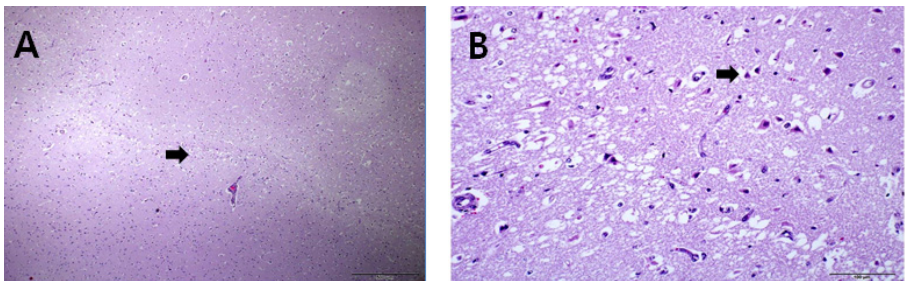

Fig. 2. Histopathological findings of polioencephalomalacia. (A) Necrosis of cerebral cortex. H&E. Bar= 500 μm. (B) Abundance of glial cells with vacuolar large cytoplasm and neuronal necrosis. H&E. Bar= 100 μm.

macrophages, or of high-molecular-weight collagen-like substance (Radostis et al, 2007; Maxie 2016). In general, there is a good correlation between the presence of characteristic fluorescence and the biochemical changes in cases of PEM. However, since there may be a small percentage of false negatives, the laboratory should have a systematic diagnostic system. Histologically the lesions are widespread but most common in the cerebral cortex. The necrosis is most prominent in the dorsal occipital and parietal cortex, but bilateral areas of necrosis are also seen less frequently in the thalamus, lateral geniculated bodies, basal ganglia, and mesencephalic nuclei (Radostis et al, 2007; Maxie 2016; MSD, 2017). Lesions of cerebellum are also present. We did not observe other sites because the cerebral lesions were so characteristic.

PEM occurred sporadically in many provinces of cattle breeding farms in Korea. In our survey, except for on farm in Daejeon, all of them occurred by individual. According to the personal communication, there have been cases of herd outbreaks in fields but veterinarians and farmers did not ask for diagnosis. The reason is that first, it is difficult to carry the bodies to the diagnostic laboratory and that is abandoned. The second, affected animals were too different to reach the dying or dead state and were not sent for the diagnosis again.

There have been no reports of seasonal preference for PEM. In our survey, PEM was diagnosed mainly in cattle submitted in fall. There might be subacute or chronic cases, but most of them were acute cases according to clinical history. Young animals with PEM usually die more rapidly than old ones, and this study indirectly suggests that the disease progressed acutely because it occurred at the age of 2 years or younger.

Merino sheep were reported to be much more resistant that other breeds in previous studies, but there is no clear evidence of preference for breed in cattle (Sant'Ana and Barros, 2010; Maxie, 2016). In our study, the disease was diagnosed only in Hanwoo. Hanwoo is a breed of Korean native cattle and is grown for meat use. The cattle are fed almost without grazing, but with concentrated grain feed and forage within the house, and are slaughtered around 30 months. If a high proportion of grain feed is fed in the whole feed without a balanced ration to adult cattle, ruminal microorganisms cannot survive, resulting in a lack of thiamine produced by these microbes in general. Thus, we hypothesized that PEM may be caused by thiamine deficiency, we actually measured thiamine in the blood of 9 out of 13 PEM-cattle and found that five of them were lower than normal (not data shown).

PEM is known to have a high incidence in young animals. The incidence is highest in sheep in the age group from weaning to 18 months, and is highest in cattle in younger stock of 3～8 months of age, but in Colorado affected animals are mainly 1～2 years of age (Maxie 2016). In our sample, PEM was not prevalent in certain ages, and varied from one month to three years of age: 4 cases were diagnosed at 3～8 months, and 5 cases were diagnosed at 1～2 years of age.

The mortality rate of PEM is known to be close to 100%, but can be very low if treated in the beginning of the disease (Sant'Ana and Barros, 2010). In order to understand the early state of the disease, it is necessary to study the etiological factors, pathogenesis, and so on.

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