



Ocular abnormalities associated with hypovitaminosis A in Hanwoo calves: a report of two cases

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ABSTRACT. This study reports on two Hanwoo (a native Korean breed of cattle) calves, a 3- and 6-month-old presenting with diarrhea, anorexia and blindness. Ophthalmoscopic examination revealed bilateral papilledema in both calves. Reverse-transcription polymerase chain reaction tests for bovine viral diarrhea virus, rotavirus and coronavirus were all negative. The levels of serum vitamin A in the two affected calves were 0.317 $\mu\text{g}/\text{dl}$ and 0.481 $\mu\text{g}/\text{dl}$, respectively. These values are much lower than the normal vitamin A levels; therefore, the calves were diagnosed with hypovitaminosis A.

KEY WORDS: blindness, calf, cattle, papilledema, vitamin A deficiency

Vitamin A is an essential micronutrient for reproduction, development, normal growth, and the functioning of the nervous system and vision, especially in growing animals [2, 5, 9]. Vitamin A deficiency can result in a series of pathologic changes and organ dysfunction [2, 5]. The clinical signs of hypovitaminosis A include poor weight gain, convulsions, diarrhea, exophthalmos, and blindness in calves and convulsions, ataxia, and blindness in adult cattle [3, 6, 7, 9].

Vitamin A levels in the animal body depend on dietary sources of β -carotene as de novo synthesis of this micronutrient does not occur in vertebrates [5]. Therefore, it has been reported that vitamin A deficiency could occur more often in winter or spring, when the animal diet might lack green plants, an important source of β -carotene. It is well-known that hypovitaminosis A occurs in young cattle [3, 6]. However, hypovitaminosis A accompanied by blindness has been uncommonly reported in Hanwoo calves [10]. The purpose of this case report is to present two bovine patients of hypovitaminosis A and to discuss its cause and the ways to prevent it.

MATERIALS AND METHODS

A herd comprised of 11 Hanwoo (a native Korean breed of cattle) cattle was placed in a feedlot, given easy access to water, and fed a total mixed ration (TMR) diet twice daily (at 06:30 AM and 18:00 PM). No supplements, vitamins, or minerals were given to the herd. The herd also had limited access to grass in the feedlot. Two castrated male calves from the herd, a 6-month-old (calf 1) and a 3-month-old (calf 2) presented with diarrhea, temporary anorexia, and blindness of a week's duration. The two affected suckler calves were housed along with the cows and their diet was supplemented with rice straw and a milk replacer. However, both calves denied the milk replacer and were, therefore, fed only by suckling and rice straw. Neither the physical condition nor the appetite of either calf was suppressed by the condition of the calves.

A full ophthalmological examination, including slit lamp biomicroscopy (portable Keeler PSL[®], Keeler Ltd., Windsor, U.K.) and indirect ophthalmoscopy (Vantage Indirect Ophthalmoscope[®], Keeler Ltd.), was performed. Based on the history and the ophthalmic findings, a tentative diagnosis of hypovitaminosis A was made. Blood samples were collected, transferred into light-blocking containers, and sent to the laboratory for serum vitamin A measurement using liquid chromatography.

RESULTS

A standard physical examination was performed on all cattle in the herd. No abnormalities were observed, except for complete blindness noted in the two calves from among 11 cattle, a morbidity rate of 18%. The calves exhibited bilaterally dilated pupils

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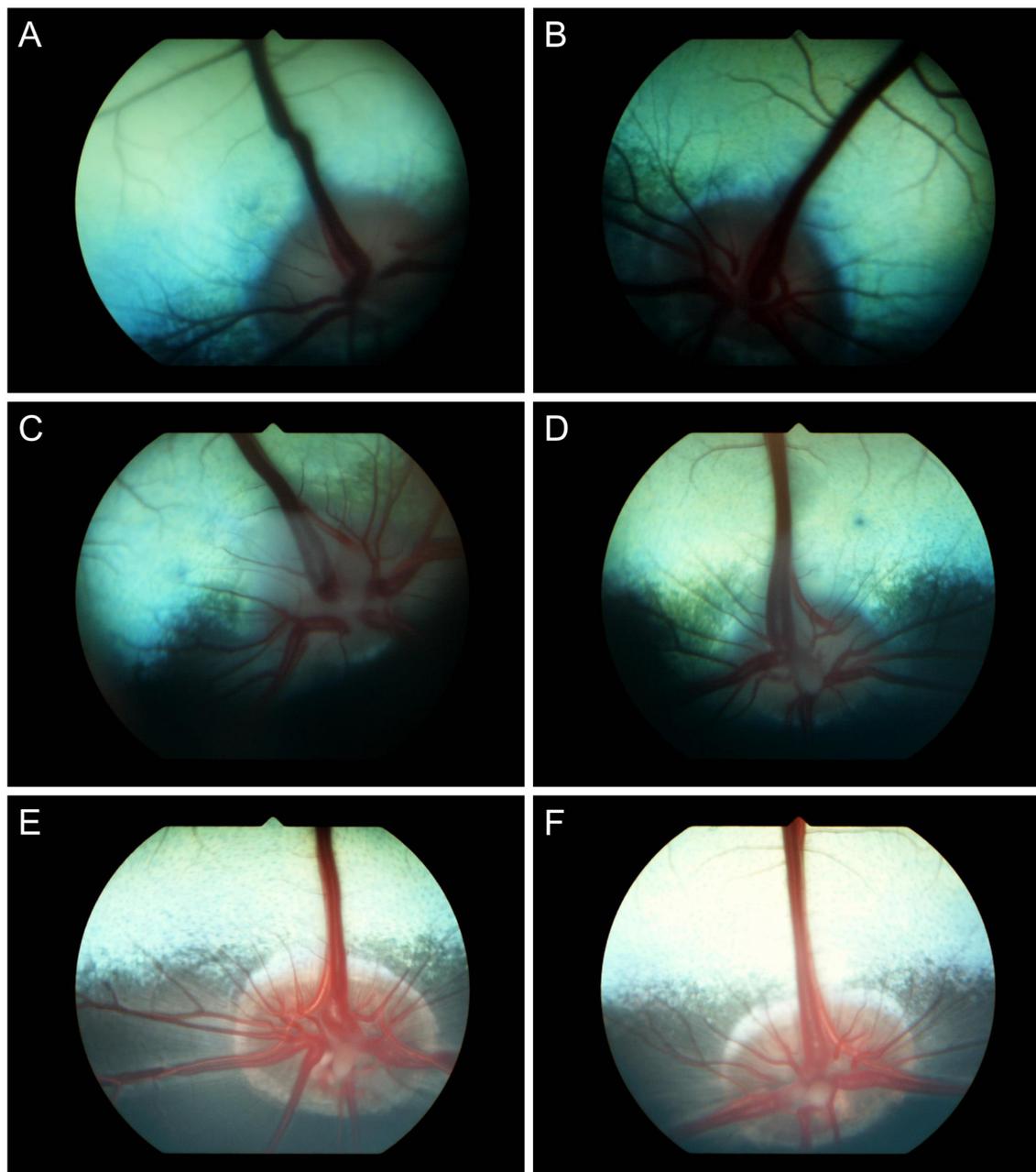


Fig. 1. Ophthalmoscopic appearance of the fundus. (A) and (B) right and left eyes, respectively, of calf 1; (C) and (D) right and left eyes, respectively, of calf 2. Bilateral papilledema showing a pale and swollen optic disc accompanied by enlarged retinal veins is observed in both cases; (E) and (F) normal bovine fundus appearances of another calf in the same age-group, presented as control.

on slit lamp biomicroscopy, with no menace response or pupillary light reflex. The fundus examination using the indirect ophthalmoscope and a portable fundus camera (Genesis[®], Kowa, Tokyo, Japan) revealed swollen optic discs with indistinct margins bilaterally in both calves. No retinal changes, except for papilledema and an enlargement of the retinal veins, were observed (Fig. 1).

Reverse-transcription polymerase chain reaction (RT-PCR) was performed using an i-BD multi detection kit (D60060, Intron, Seongnam, South Korea) to detect bovine viral diarrhea (BVD) virus, rotavirus and coronavirus; negative results were obtained for all three viruses from both the serum and the fecal samples of the two calves (Fig. 2). No significant changes were observed in routine serum chemistry and electrolyte levels in either of the calves (Table 1). The serum vitamin A concentration in both calves was low, with values of 0.481 $\mu\text{g}/\text{dl}$ and 0.317 $\mu\text{g}/\text{dl}$ for calf 1 and calf 2, respectively.

Treatment with intramuscular injection of aqueous vitamin A accompanied by dietary vitamin supplement was recommended, but the owner chose only dietary supplementation of vitamin. Necropsy after slaughter of the calves was also suggested, but this,

Table 1. Serum chemistry and electrolyte profiles for both calves

	Calf 1	Calf 2	Reference range
ALB (g/dl)	3.8	4.1	2.8–3.9
ALP (U/l)	251	299	0–488
AST (U/l)	105	135	45–132
CA (mg/dl)	11.2	10.9	9.7–12.4
TP (g/dl)	7.5	6.7	6.2–8.2
GLOB (g/dl)	3.7	2.6	3–3.5
BUN (mg/dl)	6	6	8–25
Na (mM/l)	134	135	132–152
K (mM/l)	5.7	6.3	3.9–5.8
Cl (mM/l)	98	103	99–110

ALB, albumin; ALP, alkaline phosphatase; AST, aspartate aminotransferase; CA, calcium; TP, total protein; GLOB, globulin; BUN, blood urea nitrogen.

too, was refused by the owner for financial reasons. Dietary supplementation of vitamin A at a dose of 80,000 iu per head once a day was added to the ration of the herd [3, 6, 7]. No clinical response was identified in the affected calves. However, no further ocular problems were observed in this herd. The affected calves were planned to be brought to market weight and presented for slaughter.

DISCUSSION

The normal serum level of vitamin A in calves is reported to be between 25 and 35 $\mu\text{g/dl}$; a level below 20 $\mu\text{g/dl}$ is classified as hypovitaminosis A. The reference range for adult cattle is reported to be between 40 and 50 $\mu\text{g/dl}$ [7]. In this study, the serum vitamin A concentrations of the two affected cattle were substantially below normal values. The minimal duration of vitamin A deficiency capable of inducing papilledema has been reported to be six to eight weeks, based on a previous study on experimentally induced hypovitaminosis A [3]. Papilledema, if untreated, can progress to optic nerve atrophy, which leads to permanent vision loss [3]. Both calves in this study had papilledema, accompanied by vision loss. Changes in the optic nerve and the optic nerve head have been reported to be caused by necrosis resulting from stenosis of the optic canal and an increase in cerebrospinal fluid (CSF) pressure in hypovitaminosis A [3, 4]. In growing animals, an increase in CSF pressure is a significant event brought about by hypovitaminosis A [1]; faulty absorption and increased resistance to outflow are the possible causes for this increase [1].

However, disproportionate bone growth related to hypovitaminosis A has been reported in some studies as an even more important change in growing animals because it affects the remodeling of various foramina (including the optic canal), and leads to vascular impairment of the optic nerve [3, 4]. In addition, retinal changes, including retinal degeneration and dysplasia, are known causes of blindness [3, 6].

In young calves, the clinical signs of hypovitaminosis A include poor weight gain, convulsions, diarrhea, exophthalmos and blindness [3, 6, 9]. In this study, both affected calves exhibited diarrhea, but the RT-PCR tests for viral diseases, including the BVD virus, rotavirus and coronavirus, were all negative. As intrauterine BVD infection shows similar ocular symptoms [6], it should be ruled out in calves presenting with blindness.

In a previous study, the clinical signs of hypovitaminosis A were observed in male cattle, similar to the calves in this case study [7]. In addition, it is notable that among the herd of 11 cattle, it was the 2 youngest calves that were affected with blindness from vitamin A deficiency. On a diet deficient in vitamin A, the length of time until clinical signs develop is dependent on the extent of the liver stores. Young animals have small stores but require more vitamin A; thus, they are more susceptible to hypovitaminosis A [3]. Because the liver is the normal site for vitamin A storage, measuring the vitamin A concentration in the liver might allow for the detection of hypovitaminosis A [7]. It has also been reported that the clinical signs of hypovitaminosis A develop between 6 and 12 months of being administered a diet deficient in vitamin A, after the depletion of vitamin A stores in the liver [6]. In this

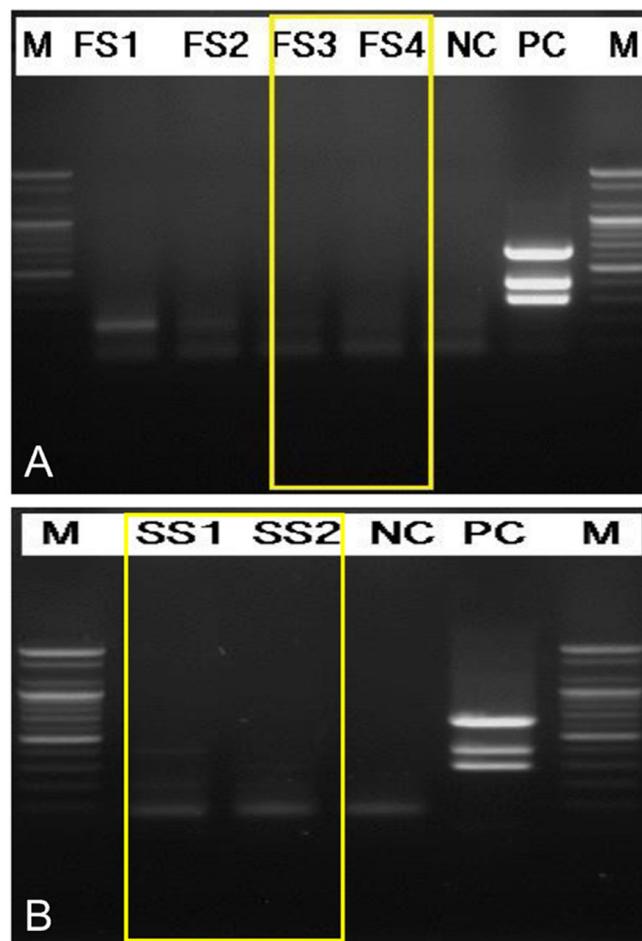


Fig. 2. Reverse-transcription polymerase chain reaction for the detection of bovine viral diarrhea virus, rotavirus, and coronavirus. The results for bovine viral diarrhea virus (297 bp), rotavirus (400 bp), and coronavirus (660 bp) in (A) fecal and (B) serum samples (M, marker; FS1 and FS2, other farm samples; FS3, fecal sample for calf 1; FS4, fecal sample for calf 2; SS1, serum sample for calf 1; SS2, serum sample for calf 2; NC, negative control; PC, positive control).

study, both calves were suckling or weaning; therefore, it was suggested that the cows had developed early onset hypovitaminosis A [7]. Thus, the other 9 cattle should have been tested to measure their serum vitamin A levels, as cattle can be affected by varying degrees of blindness and early blindness can be reversed by vitamin A therapy [3, 9]. In this study, testing for all cattle was refused by the owner for financial reasons. The measurement of vitamin A content in the feed available to this herd could have been helpful in confirming vitamin A deficiency [5], but it was unfortunately not tested. However, it has been reported that beef cattle fed with a diet composed of white leas, rice straw and concentrate feed without green forage, similar to the diet in this study, were affected with hypovitaminosis A, and the vitamin A content of the cattle diet was demonstrated to be far below normal values [5]. Blindness resulting from hypovitaminosis A can be classified into one of three types: 1) night blindness related to the deficiency of the visual pigment rhodopsin made from vitamin A, which is reversible; 2) degenerative changes in the retina associated with prolonged vitamin A deficiency; and 3) stenosis of the optic canal, which induces an irreversible loss of vision [9]. However, the earliest signs of night blindness, which can be reversed by administering a vitamin A supplement, generally go unnoticed by cattle owners [3]. In this study, the two affected calves could not regain their vision following dietary supplementation with vitamin A. This suggested that the dietary vitamin supplements alone might not be enough to reverse blindness, or that blindness might be the result of permanent optic nerve necrosis and/or retinal degeneration due to vascular impairment caused by a narrowed optic canal due to altered skeletal growth [3, 6].

TMR is a method of feeding cattle with all the food ingredients blended into a complete ration [8]. TMR consists of minimal forage and a high proportion of grain, thus increasing growth in and profitability of feedlot cattle [8]. However, hypovitaminosis A has been reported to occur in cattle fed on rations with insufficient green forage [6, 7]. Hypovitaminosis A can be treated with an intramuscular injection of aqueous vitamin A or, more economically, a dietary supplement [3, 7]. Treatment with intramuscular injection of vitamin A at 3,000–6,000 iu/kg every 60 days [3] or continuous dietary supplement containing 80 iu/kg (for cattle on a high energy ration) or 100 iu/kg (for a pregnant cow or a growing heifer) vitamin A daily has been recommended in previous studies [3, 6]. A case study also reported that 5,000 iu/head vitamin A added to the ration daily and the administration of a long-acting vitamin A preparation during winter can prevent ocular problems as well as abortion or infertility [7]. Long-term supplementation of vitamin A according to the stage of production and reevaluations of serum vitamin A levels are required to prevent new cases of blindness arising from hypovitaminosis A [3, 6].

Cattle that are fed a diet containing little or no green forage are at risk for developing symptoms of vitamin A deficiency [10]. In addition, a previous study reported that hypovitaminosis A occurred in cattle fed diets with expired mineral/vitamin supplements. Moreover, light, heat and minerals have been reported to hasten the destruction of vitamin A in supplements [6]. As a precaution, strategic dietary supplementation of vitamin A and monitoring the vitamin A levels would be helpful in reducing the incidence of hypovitaminosis A among cattle [3, 6].

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