Mineral Concentrations in Cerebrospinal Fluid and Serum of Calves Affected with Akabane Disease

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Incidence of Akabane virus in large numbers of beef cows and subsequent prenatal infection of newborn calves with arthrogryposis-hydranencephaly syndrome was reported in Iwate prefecture in 1985 and 1986. Akabane disease is caused by Akabane virus infection [8, 9], and congenital abnormalities are frequently present in calves [6, 7]. The lesions of the disease are different due to the stage of the epizootic, exhibiting non-purulent encephalomyelitis in the early stage, dysplastic muscular changes in the middle to late stages and hydranencephaly in the late stage [6, 7]. Although hydranencephaly is one of the conspicuous lesions of the disease, no analytic studies have been performed on the components of cerebrospinal fluid (CSF). In this report the mineral concentrations of Na, K, Cl, Mg, Ca and inorganic P (iP) in the CSF of calves suffering from Akabane disease were analyzed.

Four Japanese short horn calves which were diagnosed as having Akabane disease with hydranencephaly, aged 7–15 weeks and weighing 53–95 kg, were used for the study (Table 1). Blood was withdrawn from the jugular vein and serum (3,000 rpm for 10 minutes) was used. CSF (10 ml) was withdrawn from a small orifice of the parietal bone by a dental drill. Concentrations of Na and K were analysed with a flame spectrophotometer, Cl by the method of Schales-Schaes [5], Mg and Ca with an atomic absorption spectrophotometer and iP by the colorimetric method of Goldenberg [1] in both CSF and serum, respectively.

In all of the 4 calves, the bulk of the cerebrum was deficient and the brain weight was much less than the normal value (Table 1). Regarding the mineral components of the CSF (Table 1), concentrations of K, Cl and iP were in the normal range, but concentration of Na was higher and that of Ca was lower than the normal value. In 2 of 4 calves, concentration of Mg was lower than the normal value. Although serum concentrations of Na, K and Ca were almost within the normal range, those of Mg, Ca and iP were below the normal range in all 4 calves (Table 1).

The lower value of the serum concentrations of Mg, Ca and iP might be due to deficiency of feed intake. The components of CSF are formed by blood components which pass through the choroid plexus by means

of filtration, diffusion, facilitated diffusion or active transport [4]. The ratio of CSF to serum (C/S) in concentrations of K and Cl was almost the normal value (Table 1); therefore, K and Cl in the CSF were speculated to be transported with increased water from blood at a constant rate. However, values of C/Ss of Na, Mg and iP were higher than the normal value, because Na in the CSF was above the normal range, Mg in the CSF was relatively higher in spite of hypomagnesemia and iP in the serum was below the normal range. Thus, the transport of Na and Mg into CSF might be accelerated by increased water from blood. Although it is reported that the Mg level of CSF might not change even if the plasma level of Mg is seriously abnormal for a long period [2], decreased Mg concentration in CSF was recognized in 2 calves (Nos. 3 and 4), in which remarkable hypomagnesemia was detected. Both Ca concentration in the CSF and C/S of Ca were considerably lower than the normal values. Since Ca is usually transported mainly by active transport [13], decreased concentration of Ca in the CSF might be due to dilution by increased water. The relationship between Mg and Ca, when relatively high C/S of Mg and remarkably low C/S of Ca were caused by remarkably increased water in CSF, was correlated with that between Mg and Ca in the intestine of ewes with elevated Mg and decreased Ca concentration in the serum due to significantly increased water intake [10].

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Table 1. Mineral concentrations in cerebrospinal fluid (CSF) and serum of calves affected with Akabane disease

Item	Animal No.				Mean±S. D.	Normal range	
	1	2	3	4			
Age (week)	15	12	7	12	11.5± 3.3	11 ^{c)}	
Body weight (kg)	93	95	53	81	80.5 ±19.3	56	
Brain weight (g)	100	130	80	100	102.0 ±20.6	240	
Na (mEq/l)	CSF	138	141	138	140	139.3 ± 1.5	111–123 [3]
	Serum	137	165	137	132	124.8 ±15.0	132–152 [11]
	C/S ^{a)}	1.01	0.85	1.01	1.06	0.98± 0.09	0.82 ^{d)}
K (mEq/l)	CSF	2.9	3.5	2.9	2.9	3.05± 0.30	2.9–3.5 [3]
	Serum	4.5	4.4	4.8	4.9	4.65± 0.24	3.9–5.8 [11]
	C/S	0.64	0.80	0.60	0.59	0.66± 0.10	0.66
Cl (mEq/l)	CSF	116	121	118	118	118.3 ± 2.1	111–123 [3]
	Serum	101	102	99	102	101.0 ± 1.4	97–111 [11]
	C/S	1.15	1.19	1.19	1.16	1.17± 0.02	1.13
Mg (mg/dl)	CSF	2.26	2.44	1.44	1.44	1.90± 0.53	2.1–2.4 [3]
	Serum	1.57	1.32	1.12	1.19	1.30± 0.20	1.9–2.7 [12]
	C/S	1.44	1.85	1.29	1.21	1.45± 0.28	0.98
Ca (mg/dl)	CSF	2.74	3.08	3.26	2.84	2.98± 0.23	5.1–6.3 [3]
	Serum	7.76	8.98	7.86	8.46	8.27± 0.57	9.4–10.8[12]
	C/S	0.35	0.34	0.41	0.34	0.36± 0.03	0.56
iP ^{b)} (mg/dl)	CSF	3.2	2.0	2.0	1.8	2.25± 0.61	0.9–2.4 [3]
	Serum	7.8	6.9	8.0	6.2	7.20± 0.85	8.3–9.5 [12]
	C/S	0.42	0.30	0.25	0.28	0.31± 0.07	0.19

a) Cerebrospinal fluid/serum.

b) Inorganic phosphorus.

c) From a case of the normal brain of a Japanese short horn.

d) Calculated with the middle value of each normal range.

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要 約

アカバネ病罹患子ウシの脳脊髄液と血清のミネラル濃度（短報）：志賀瑞郎・石田 貢・堀井菜摘子・菅原伯・岡田幸助¹⁾・沼宮内茂¹⁾・大島寛一¹⁾（岩手大学農学部家畜生理学教室，¹⁾家畜病理学教室）——大脳の著しい欠損と欠損部脳脊髄液（CSF）の貯留を示す4頭の子病牛のCSFでは全例でNaが高値，Caが低値を示し，2頭でMgが低値を示したが，K，Cl，iPでは全例正常値であった。血清では，全例Mg，Ca，iPが低値を示したが，Na，K，Clは正常値であった。