

Relationship between Halftime for Sulfobromophthalein Clearance and Post-Surgical Prognosis in Cows with Abomasal Displacement

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ABSTRACT. In 47 dairy cows with abomasal displacement, 34 (72%) cows were confirmed to have the lipid infiltration in liver by biopsy examinations. The pathological degree of the lipid infiltration was significantly higher in the cows with left abomasal displacement than in those with right one. The halftime for sulfobromophthalein clearance (BSP-T_{1/2}) was markedly increased in nonrecovered cows with left abomasal displacement. In left abomasal displacement cases, cows with the T_{1/2} less than 11 min recovered regardless of the degree of liver lipid infiltration, but those with the T_{1/2} longer than 11 min showed a significantly lower recovery rate (44%). Therefore, it was concluded that the BSP-T_{1/2} was one of valuable parameters for predicting the prognosis of this disease.—**KEY WORDS:** abomasal displacement, dairy cow, liver lipidosis, sulfobromophthalein clearance.

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Liver lipidosis in periparturient dairy cows with abomasal displacement has been reported [6, 7]. Abomasal displacement in dairy cattle is known as a multi-factorial disease [2] with common etiological factors to liver lipidosis [7]. The poor response to the surgical treatment strongly indicates the presence of liver lipidosis [15]; therefore, a thorough understanding of liver lipidosis in these cases of abomasal displacement will provide useful information to the surgical application on this disease.

The purpose of the present study is to clarify the degree of pathological changes in liver lipidosis of cows with abomasal displacement and the relationship between liver dysfunction and the prognosis of the disease after surgical treatment.

MATERIALS AND METHODS

Animals: During the period between April 1987 and March 1990, 47 dairy cows were admitted to the Hokkaido Veterinary Clinic and Training Center for surgical intervention for abomasal displacement. Most of the cases were Holstein-Friesian breed and ranged in age from 3 to 11 years, with the number of postpartum days up to the day of surgical treatment ranging between 1 and 60 days.

Clinical and pathological findings: Of the 47 cases, 35 cows were diagnosed on the basis of clinical signs and surgical findings [17] as left side displacement and 12 as right side displacement, including 6 cases of right dilation and 6 cases of right volvulus. Before surgical treatment, the main clinical findings, includ-

ing depression, dehydration and fecal abnormalities, were scored as 1 (none), 2 (slight), 3 (moderate), and 4 (severe), respectively. The presence of urine ketone bodies were scored as 1 (negative), 2 (1+), 3 (2+), and 4 (3+), respectively.

Blood sampling and analysis: Just prior to the operation, blood samples were collected from the jugular vein to separate the sera by centrifugation and the sera were stored at 4°C. It was used to determine concentrations of total cholesterol (Chl) and non-esterified fatty acid (NEFA) with an automated analyzer (Hitachi 736-type autoanalyzer) [14, 16], total bilirubin concentration (Bil) by the azobilirubin method [11] and serum enzyme activities of aspartate aminotransferase (AST) and γ -glutamyl transpeptidase (γ GT) with commercial test kits (Kinetest, Amco, Tokyo) within 12 hrs of collection.

Halftime for sulfobromophthalein clearance: Immediately after blood collection for the above tests, 1 or 1.5 g of sulfobromophthalein (BSP; Hepatosulphalein, Daiichi Seiyaku, Tokyo) was administered intravenously [10] and the T_{1/2} for BSP clearance (BSP-T_{1/2}) was calculated at twice of 5 to 11 min after administration [3].

Liver biopsy: Liver samples for histological examination were taken by biopsy needle during the surgical operation. Each liver sample was fixed in 10% neutral-buffered formalin and stained with hematoxylin-eosin and Sudan III. The samples were then assigned a numerical morphologic lipid score from 1 (no morphologic evidence of lipids) to 6

(100% hepatocytes infiltrated lipids) in the same manner as that previously described by Herdt [6].

Statistical analysis: Statistical significances between the means were determined by *t* test or by Cochran-Cox test [9] when variances were different, and differences between the ratios were assessed for significance by use of the chi-square test [9] at a significant level of 5 percent.

RESULTS

A centrilobular pattern of lipid infiltration in the liver was recognized in 26 of 35 (74.3%) cows with left abomasal displacement, and in 8 of 12 (66.7%) cows with right abomasal displacement. Total cases of lipid infiltration were accounted for 72.3% of the cows with abomasal displacement. The rate of incidence of liver lipid infiltration did not differ significantly among the cases with left and right abomasal displacement, but the mean morphologic lipid score of liver lipid infiltration was significantly ($p < 0.05$) higher in the cows with left side abomasal displacement (4.0 ± 1.1) than those with right side abomasal displacement (2.8 ± 1.2). The liver samples with no lipid infiltration showed hydropic degeneration of liver cells. Liver cell necrosis was recognized in 2 of 35 cows with left abomasal displacement and

in 3 of 12 cows with right abomasal displacement.

Comparisons of items between recovered and nonrecovered cows are shown in Table 1. In the cases of left abomasal displacement, 30 cows (group 1) recovered and 5 cows (group 2) did not. Mean BSP-T1/2 value, total bilirubin level, depression score and dehydration score were significantly ($p < 0.05$) higher in group 2 than in group 1. In the cases of right abomasal displacement, 6 cows with right dilation recovered (group 3) and the remaining 6 cows with right volvulus did not recover (group 4). Mean NEFA level and NEFA/Chl were significantly ($p < 0.05$) lower in group 4 than in group 3, and the number of postpartum days and the mean dehydration score of group 4 were significantly ($p < 0.05$) higher than those of the other groups. Serum enzyme activities of AST and γ GT did not differ among these 4 groups.

BSP-T1/2 values for cases of abomasal displacement were plotted in Fig. 1. In the cases of left abomasal displacement, BSP-T1/2 value with morphologic lipid score of more than 4 varied widely from 2 to 20 min, and the cases were divided into 2 groups depending on the prognosis. Twenty-six out of 35 cases of left abomasal displacement with BSP-T1/2 value of lower than 11 min recovered; on the other hand, 9 of 35 cases with BSP-T1/2 value of

Table 1. Comparison of mean morphologic lipid score, serum biochemicals, postpartum days, and scores of clinical findings and urine keton bodies in cows between recovered and nonrecovered

Item (Unit)	Left abomasal displacement		Right abomasal displacement	
	Recovered (Group 1)	Nonrecovered (Group 2)	Recovered (Group 3)	Nonrecovered (Group 4)
Number	30	5	6	6
Morphologic lipid score	3.1 ± 1.4^a	4.0 ± 2.7	2.6 ± 1.7	1.8 ± 0.7^b
BSP-T $^{1/2}$ (min.)	7.3 ± 1.4^a	16.6 ± 4.3^b	7.8 ± 1.9^a	9.0 ± 3.3^a
Cholesterol (mg/dl)	76 ± 26^a	128 ± 126	80 ± 29	141 ± 67^b
NEFA (μ Eq/l)	1645 ± 659^a	1840 ± 953^a	1471 ± 440^a	773 ± 522^b
Bilirubin (mg/dl)	1.1 ± 0.5^a	1.7 ± 0.7^b	1.1 ± 0.6	0.5 ± 0.3^c
NEFA/Cholesterol	24 ± 12^a	21 ± 16	21 ± 10^a	6 ± 4^b
AST (IU/l)	197 ± 104	232 ± 146	255 ± 207	225 ± 181
γ GT (IU/l)	54 ± 60	276 ± 362	74 ± 62	84 ± 45
Postpartum days (day)	15 ± 12^a	14 ± 15^a	12 ± 9^a	50 ± 29^b
Depression score	1.6 ± 0.8^a	3.0 ± 0.7^b	1.6 ± 0.5^a	3.5 ± 0.5^b
Dehydration score	1.8 ± 0.9^a	2.8 ± 0.8^b	$2.1 \pm 0.4^{a,b}$	3.8 ± 0.4^c
Fecal abnormalities score	2.4 ± 1.1^a	3.4 ± 0.5	2.8 ± 0.9	3.8 ± 0.4^b
Urine ketone bodies score	2.8 ± 1.3^a	2.2 ± 1.3	2.0 ± 1.0	1.1 ± 0.4^b

Values are expressed as mean \pm SD.

a), b), c) Means with different superscripts within the same row are significantly different ($p < 0.05$).

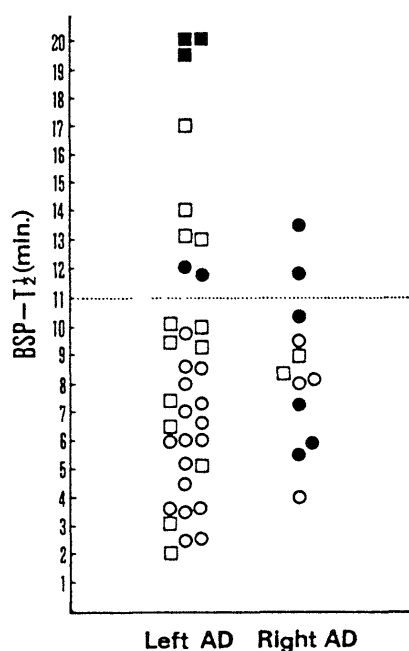


Fig. 1. BSP-T1/2 values in the cases of abomasal displacement (AD).

○=Recovered with less than 3 of morphologic lipid score; □=Recovered with more than 4 of morphologic lipid score.
●=Nonrecovered with less than 3 of morphologic lipid score;
■=Nonrecovered with more than 4 of morphologic lipid score.

higher than 11 min were in poor prognosis. The cases of right abomasal displacement showed a poor prognosis with no especially demarcation of BSP-T1/2 value and liver lipid infiltration, but 2 cases with a BSP-T1/2 value of higher than 11 min did not recover.

Rates of recovery and incidence of liver lipid infiltration with morphologic lipid score more than 4 are shown in Table 2. In the cases of delayed BSP-T1/2 values, comparison of the 2 types of

abomasal displacement indicated a significantly lower recovery rate ($p < 0.05$) and a higher incidence of liver lipid infiltration with a morphologic lipid score of more than 4 in left abomasal displacement.

DISCUSSION

Lipid infiltration in the liver was observed in 34 (72%) out of 47 cows with abomasal displacement. Although the rate of incidence of liver lipid infiltration did not differ significantly, the pathological degree of liver lipid infiltration was significantly higher in cases of left abomasal displacement than in right one, suggesting the presence of severe liver lipidosis in cattle with left abomasal displacement.

In the cases of left abomasal displacement, nonrecovered cases (group 2) showed a significant increase in BSP-T1/2 value, which seemed to be associated with high values of bilirubin, NEFA and NEFA/Chl and with a high dehydration score because BSP clearance is influenced by circulatory failure [10], rise in bilirubin level [1], energy deficiency [18] and fasting [12]. Therefore, the elevated BSP-T1/2 value of group 2 was likely the result from liver insufficiency and extra-liver factors, which worsened the prognosis of the cases with abomasal displacement.

In the cases of right abomasal displacement, the values of NEFA and NEFA/Chl were significantly lower and the number of postpartum days and dehydration score were significantly high in nonrecovered cases than in the recovered ones. The latter high values of NEFA and NEFA/Chl indicated the increased transport of lipids to the liver and lipid retention in the liver [8]. These findings suggested that the nonrecovered cases of right displacement associated with right volvulus were complicated mainly by severe gastric obstruction rather than liver

Table 2. Rates of recovery and incidence in cows with lipid infiltration (LI) in the liver and with morphologic lipid score of more than 4 in association with BSP-T1/2 values

	Type of abomasal displacement	BSP-T1/2 values (min)	
		<11	>11
Recovery rates (%)	Left	100(26/26) ^{a)}	44(4/9) ^{b)}
	Right	60(6/10)	0(0/2)
Rate of incidence (%)	Left	35(9/26) ^{a)}	78(7/9) ^{b)}
LI with morphologic lipid score (≥ 4)	Right	20(2/10)	0(0/2)

a), b) Rates with different superscripts within the same row are significantly different ($p < 0.05$).

dysfunction and disturbance of lipid metabolism, which may be attributable to an imbalance in feeds before calving. Unlike left abomasal displacement volvulus rather than liver lipidosis was considered to be the cause of lower recovery of right abomasal displacement. Guard [5] also described the sporadic onset of right volvulus, which did not fit the epidemiologic findings for left abomasal displacement. Abomasal volvulus seems to have some different etiologic factors from those in left abomasal displacement.

The varying levels of BSP-T1/2 in 35 cows with left abomasal displacement demonstrated a demarcating value of 11 min in association with the effects of surgical treatment. Liver function appeared to be seriously impaired when lipid infiltration was severe [7, 13], and such liver lipidosis was observed in 3 nonrecovered cases with BSP-T1/2 value of higher than 19 min. Four nonrecovered cows including 2 cows with left abomasal displacement and 2 cases of right abomasal displacement with BSP-T1/2 value of higher than 11 min showed none or low degree of liver lipid infiltration. Therefore, it was assumed that the cases with BSP-T1/2 value of higher than 11 min did not always indicate liver lipidosis, but the prognosis of the cases with higher BSP-T1/2 value was poorer than that with lower one because the increased BSP-T1/2 was probably attributable to liver lipidosis and other liver lesions or extra-liver factors. In the present study, the serum AST and total bilirubin values were not accurate parameters in predicting the prognosis of abomasal displacement cases as was shown in a previous report [4]. The BSP test, however, seemed to be valuable for predicting prognosis.

Result of the present study indicated that cows with left abomasal displacement were more severely affected by liver lipidosis than those with right one. It was also concluded that the BSP-T1/2 value of 11 min or less might be a useful parameter for predicting the surgical treatment of cows with abomasal displacement.

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