pISSN 1598-298X / eISSN 2384-0749
J Vet Clin 34(3) : 222-224 (2017)
http://dx.doi.org/10.17555/jvc.2017.06.34.3.222

Journal of Veterinary Clinics
www.ksvc.or.kr

Prepartal Decrease in Plasma Total Cholesterol Concentration in Dairy Cows Developed Subclinical Ketosis

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(Received: February 15, 2017 / Accepted: June 03, 2017)

Abstract : A retrospective study was designed to determine whether there were any differences in prepartal blood biochemical parameters between cows developed subclinical ketosis (SCK) and non-SCK cows. Data on blood biochemistry from 33 Holstein parturient cows (15 SCK and 18 non-SCK cows) in one farm for one year, were compared. Plasma beta-hydroxybutyrate, non-esterified fatty acid and glucose concentrations were utilized in the diagnosis of SCK and showed significant differences between SCK and non-SCK cows after calving. Before calving, however, only plasma total cholesterol concentration in SCK cows was significantly lower than that in non-SCK cows. Consequently, it seems that lower plasma total cholesterol concentration before calving is related to the occurrence of SCK immediately after calving.

Key words **:** subclinical ketosis, total cholesterol, dairy cows, negative energy balance.

Ketosis is a metabolic disease characterized by abnormally increased ketone bodies in body tissues and fluid with lowered milk production in the early lactation period. Negative energy balance during the transition period contributes to the production of ketone bodies, which can be detected in milk, urine, and blood (6). The plasma β-hydroxybutyrate (β-HB) concentration of greater than 1.2 to 1.4 mmol/L and 3.0 mmol/L is diagnosed as subclinical ketosis (SCK) and clinical ketosis, respectively (5). With a regular measurement of β-HB concentration in blood during the transition period, the occurrence of SCK or clinical ketosis can be monitored. However, plasma β-HB concentration is rarely increased before the initiation of lactation. Other parameters are needed to predict the risk before parturition. Therefore, this retrospective study was designed to analyze the clinical data acquired from one dairy farm for one year to determine whether there were any differences in prepartal blood biochemical parameters between SCK cows and non-SCK cows.

Clinical data were acquired from 33 parturient Holstein cows in the University Animal Farm in Seoul National University. Two months before calving, cows and heifers were moved to and reared in the same pen. At 2-week intervals from 8 weeks prepartum to 6 weeks postpartum, physical examination, body condition scoring, and blood sampling were performed. After calving, milk yield was recorded by a robotic milking system (DeLaval, Sweden). Heparinized blood samples were collected from a coccygeal vessel and were transported to a laboratory in an ice box within 1 hour. Plasma was separated, and biochemical parameters, including total protein (TP), albumin (Alb), total cholesterol (T-Chol), glucose (Glu), non-esterified fatty acid (NEFA), β-HB, blood urea nitrogen (BUN), γ-glutamyl transferase (GGT), aspartate aminotransferase (AST), calcium (Ca), and inorganic phosphate (iP), were analyzed with an automatic analyzer (BS-400, Mindray, China). With the results of plasma biochemistry, SCK was diagnosed in 15 cows (1.3 ± 0.5 parities) and treated with oral administration of glycerol at 500 g once daily for 3 to 8 days. The other 18 cows (1.6 ± 0.6 parities) did not develop SCK. For statistical analysis, clinical data were divided into 4 periods; 32 to 16 days prepartum (P-2), 15 to 1 days prepartum (P-1), 1 to 15 days postpartum (P+1), and 16 to 32 days postpartum (P+2). All statistical analyses were performed using SigmaPlot 12.5 (Systat Software, USA). After normality testing, significant differences were analyzed using two-way repeated measure ANOVA followed by Holm-Sidak test at $p < 0.05$ or $p < 0.01$.

Plasma β-HB, NEFA, and glucose concentrations based on the diagnosis of SCK fluctuated significantly during the sampling period (Fig 1). Plasma β-HB concentrations in SCK cows were significantly higher than those in non-SCK cows after calving, whereas postpartal plasma Glu concentrations were significantly decreased in SCK cows. The fluctuations in two parameters were negatively correlated during the sampling period ($r = -0.831$, $p < 0.001$). There was a significant difference in plasma NEFA concentration only at P+1. Before parturition, however, no parameters showed the significant difference between groups.

Other biochemical parameters are presented in Table 1. In prepartal data, the only significant difference was observed in

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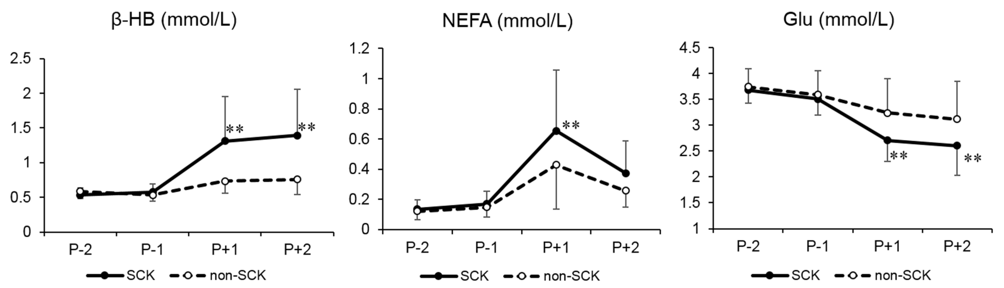

Fig 1. Periparturient changes in plasma concentration of β-hydroxybutyrate (β-HB), non-esterified fatty acid (NEFA), and glucose (Glu) utilized in the diagnosis of subclinical ketosis. Data are expressed as means ± SD. Significant difference between SCK and non-SCK cows at the same period is denoted as $^{*}(p < 0.05)$ and $^{**}(p < 0.01)$.

Table 1. Comparison of blood biochemical parameters, body condition score (BCS) and milk yield (MY) between SCK and non-SCK cows. Least square means are expressed with SEM. Significant group difference at the same period is denoted as $^{*}(p < 0.05)$ and $^{**}(p < 0.01)$

Parameter	Group	P-2	P-1	P+1	P+2	SEM	*p* values of two-way RM ANOVA		
							Treatment	Period	Interaction
TP (g/L)	SCK	76	71	75	81	1.741	0.091	< 0.001	0.607
	Non-SCK	79	75	78	82	1.590			
Alb (g/L)	SCK	38	37	36	36	0.610	0.579	< 0.001	0.017
	Non-SCK	37	37	37	37	0.550			
T-Chol (mmol/L)	SCK	2.84**	2.41**	2.28*	3.83*	0.208	0.024	< 0.001	0.933
	Non-SCK	3.44	2.94	2.82	4.24	0.190			
BUN (mmol/L)	SCK	3.88	4.17	4.62	4.74	0.281	0.306	0.003	0.864
	Non-SCK	4.38	4.44	4.80	4.94	0.256			
GGT (U/L)	SCK	19	17	25	32*	2.760	0.745	0.001	0.004
	Non-SCK	23	21	21	23	2.520			
AST (U/L)	SCK	59	63	125**	100	8.467	0.082	< 0.001	0.010
	Non-SCK	65	63	86	81	7.729			
Ca (mmol/L)	SCK	2.24	2.20	2.16	2.18*	0.030	0.034	0.067	0.479
	Non-SCK	2.28	2.23	2.22	2.28	0.027			
iP (mol/L)	SCK	2.11	2.07	1.93	2.01	0.225	0.073	< 0.001	0.475
	Non-SCK	2.13	2.01	1.77	1.96	0.066			
BCS	SCK	3.61	3.58	3.35	3.25	0.055	0.642	< 0.001	0.021
	Non-SCK	3.53	3.47	3.39	3.29	0.050			
MY (kg)	SCK	-	-	25	34	1.704	0.279	< 0.001	0.504
	Non-SCK	-	-	23	31	1.547			

plasma T-Chol concentration, in which SCK cows had significantly lower T-Chol concentrations at P-2 and P-1 than non-SCK cows ($p < 0.01$). The significantly low T-Chol concentration of SCK cows persisted during the early lactation period. In postpartal data, significantly higher activities of AST at P+1 and of GGT at P+2 were detected in SCK cows compared to those in non-SCK cows ($p < 0.01$ and $p < 0.05$, respectively). Moreover, plasma Ca concentration of SCK cows was lower than that of non-SCK cows at P+2 ($p <$ 0.05). A decrease in body condition score was observed in all parturient cows regardless of the occurrence of SCK, and there was no significant difference between groups in milk yield during early lactation.

During the transition period, 3 weeks before to 3 weeks after calving, dairy cows experience nutritional, physiological and metabolic changes, thus, are susceptible to a variety of diseases. To reduce the occurrence of diseases in this period, the early detection through regular monitoring including blood biochemistry should be followed by timely treatments. Especially, the early treatment for subclinical diseases can be directly related to the improvement of productivity in dairy farms.

As an initiation of lactation, most transition cow is in a state of negative energy balance, in which absorbed energy from a diet is less than energy demand for lactation. This phenomenon results in a decrease in Glu as well as increases in ketone bodies and NEFA in the blood (7). Especially, NEFA is known as one of the biochemical parameters to reflect the negative energy balance in cattle (7), and a value greater than 0.4 mmol/L and 1.0 mmol/L is reported to indicate the risk of developing SCK in prepartum and postpartum, respectively (6,7). In this study, however, a significant prepartal increase in NEFA was not observed in cows developed SCK.

On the other hand, T-Chol was a parameter shown significant difference during all sampling periods in this study. Plasma T-Chol is not a biochemical parameter to be utilized in the diagnosis of diseases in bovine medicine. Rather, it is used to evaluate liver function and energy metabolism in a metabolic profile test, in which the decrease in plasma T-Chol concentration is usually meant as a disorder in a synthetic function of liver or a status in lowered feed intake (3). In dairy cows, plasma T-Chol concentration fluctuates with milk yield during the lactation period, is decreased in the dry period, and has a lower value around the calving day (1). This alteration is closely associated with the dry matter intake and is supposed to reflect the energy balance in dairy cows (1,4). Moreover, a decrease in plasma T-Chol concentration is also observed in cattle showing anorexia and parturient cows with metritis (2,8). Plasma concentration of T-Chol is reported to be influenced not by season, but by fat content in feed, parity, health status, milk yield, and lactation period (4). Because this retrospective study analyzed data acquired from one dairy farm, similar parity number, and the same lactation period, significant differences in T-Chol seem to be affected by health status, including dry matter intake. Therefore, cows developed SCK may be sensitive to some stress factors such as transportation, being in a new herd, drying procedure, changes in feed material, and a subsequent lower feed intake before calving. Consequently, negative energy balance was developed earlier than in non-SCK cows during the dry period and resulted in SCK immediately after calving.

Increased AST and GGT activities in parturient cows with SCK are consistent with previous studies (3,5,9). Negative energy balance induces the mobilization of fat to the liver especially in parturient cows developed metabolic and infectious diseases. Mild hepatic lipidosis due to SCK may increase in the plasma activities of liver-specific enzymes without destruction of hepatocyte (9).

In this retrospective study, the only prepartal difference in blood biochemical parameters between SCK cows and non-SCK cows was observed in plasma T-Chol concentration. It seems that lower plasma T-Chol concentration before calving is related to the occurrence of SCK immediately after calving more specifically than NEFA. However, further studies will be needed to utilize the prepartal T-Chol concentration as an indicator for the risk of developing SCK.

Acknowledgements

This work was carried out with the support of "Cooperative Research Program for Agriculture Science and Technology Development (Project No. PJ010855)" Rural Development Administration, Republic of Korea.

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