Bovine Serum Prolactin, Growth Hormone, and Triiodothyronine Levels during Late Pregnancy and Early Lactation

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Abstract Changes of serum prolactin (PRL), growth hormone (GH), and triiodothyronine (T3) levels in Holstein dairy cows during late pregnancy and early lactation were determined by radioimmunoassays. The cows calved in September. Mean serum PRL ranged 9.9 ng/ml to 12.4 ng/ml during the 3rd to 7th day prepartum. It increased to a peak value of 87.3 ng/ml on the day of parturition from 57.5 ng/ml on the day before calving, and decreased to 13.9 ng/ml within 3 days postpartum. During the 2nd to 30th day prepartum, serum GH varied between 2.4 and 4.0 ng/ml and increased to 8.0 ng/ml on the day of calving. During a week postpartum, serum GH ranged from 5.2 to 8.2 ng/ml. Mean serum GH during a week postpartum was higher than that of prepartum ($P < 0.001$). Mean serum T3 level during 5 days prepartum varied 104.2 to 108.8 ng/dl and decreased to 93 ng/dl on the day of calving. During 5 days postpartum, mean T3 level varied 73.0 to 83.8 ng/dl. Contrary to GH, mean serum T3 level during 5 day postpartum was significantly lower than that of prepartum ($P < 0.001$).

It has been shown that administrations of prolactin (PRL), growth hormone (GH), glucocorticoids, and thyroid hormone restore or reinitiate lactation after hypophysectomy in goats¹⁾ and sheep²⁾. In the small ruminants, the combination of these hormones is considered to be essential for milk secretion after pituitary ablation^{1,2)}. On the other hand, little has been known about bovine lactogenic hormones *in vivo*. Previous studies demonstrated a PRL surge around parturition in the cows³⁻⁶⁾. However, there have been limited studies on circulating levels of GH and thyroid hormones during lactogenesis in cows. In the present report, changes of serum PRL, GH, and triiodothyronine (T3) levels in Holstein dairy cows during late pregnancy and early lactation are described.

Materials and Methods

Experimental animals and blood sampling. Five Holstein dairy cows, 3 to 5 years of age, expected to be 2nd to 4th calving from the Institute herd were used. The cows calved in September. After parturition, calves were separated and the cows were milked twice daily at 08:30 and 18:30 h. Jugular venous blood samples were obtained by venipuncture between 15:30 and 16:30 h. Serum was separated by centrifugation and stored at -20°C until assay.

Radioimmunoassays for prolactin, growth hormone, and triiodothyronine. Serum PRL levels were estimated by a radioimmunoassay method using bovine PRL (NIH-P-B2) as the standard^{7,8)}. Serum GH was determined by a double antibody method using bovine GH (NIH-GH-B12)

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as the standard hormone⁸). Serum T3 concentration was estimated by T3 RIA kits (Dinabot Radioisotope Laboratory).

Results

Prolactin. From 3 to 7 days prior to parturition, serum PRL levels in 5 cows ranged between 9.9 ± 3.2 ng/ml and 12.4 ± 2.9 ng/ml (Mean $\pm$ S.E.). The value increased to a peak of 87.3 ± 22.3 ng/ml on the day of calving from 57.5 ± 23.7 ng/ml on the day before parturition (Fig. 1). The level decreased to 13.9 ± 3.3 ng/ml on the 3rd day postpartum. The value varied 9.0 ± 2.8

Fig. 1. Serum PRL (○) and GH (●) concentrations around parturition in the dairy cows. Each point and vertical bar indicate the mean and standard error (S.E.) of 5 determinations.

Fig. 2. Serum GH concentrations during late pregnancy and early lactation in the dairy cows. Each point and vertical bar represent the mean and S.E. of 5 observations.

Fig. 3. Serum T3 level around calving in the dairy cows. Each point and vertical bar indicate the mean and S.E. of 5 observations.

ng/ml to 13.9 ± 3.3 ng/ml during 4th to 7th day postpartum. No significant difference was observed between the mean serum PRL level during 2nd to 7th day prepartum and that during 2nd to 7th day postpartum.

Growth Hormone. Until 2 days before parturition, serum GH varied between 2.4 ± 0.5 ng/ml and 4.0 ± 0.4 ng/ml during a month prepartum (Fig. 2). On the day of parturition, serum GH level increased to 8.0 ± 1.8 ng/ml from 5.3 ± 0.7 ng/ml on the day before parturition (Fig. 1). In postpartum, serum GH concentration varied between 5.2 ± 0.8 ng/ml and 12.2 ± 1.2 ng/ml. Mean serum GH level during 7 days postpartum was significantly higher than that during 7 days prepartum ($P < 0.001$).

Triiodothyronine. Serum T3 levels were determined from 5th day prepartum to 5th day postpartum. During 5 days prepartum, serum T3 showed little change and ranged between 104.2 ± 8.9 ng/dl and 108.8 ± 9.9 ng/dl (Fig. 3). The value decreased to 93.0 ± 16.3 ng/dl on the day of parturition. The postpartum levels varied between 73.0 ± 12.2 ng/dl and 83.8 ± 10.1 ng/dl. The mean serum T3 level in postpartum was significantly lower than that in prepartum ($P < 0.001$).

Discussion

The occurrence of a marked PRL surge near parturition confirmed our previous report⁽⁴⁾ and other's^(2,5,6). The serum level in PRL surge near parturition varied with season as in the case of response to milking or TRH^(8,9). The observed increase of plasma GH level near parturition is in agreement with the results in heifers⁽⁶⁾ and cows⁽¹⁰⁾. Furthermore, the mean serum GH level during a week postpartum was significantly higher than that of prepartum, though a marked day to day variation was observed. Although many factors to elevate serum PRL and GH in cows have been clarified, the factors to enhance PRL and GH secretion around parturition have not been well established.

One of the possibilities is the conspicuous increase of circulating level of estrogen and precipitous drop of progesterone^(11,12). Administration of estrogen increased plasma concentrations of PRL⁽¹³⁾ and GH⁽¹⁴⁾ in the cows. Another possibility is the effect of stress associated with parturition. It has been found that stressful stimuli enhanced PRL release in cattle⁽¹⁵⁻¹⁸⁾. Bovine GH did not respond to stress such as venipuncture^(8,18). However, there is a possibility that GH respond to "severe" stress such as parturition. Removal of the fetus by the caesarian section induced a marked increase of plasma concentrations of PRL and GH in the cows⁽¹⁹⁾. Although caprine pros-

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taglandin F concentration in vena caval plasma near parturition paralleled with that in uterine vein²⁰), and prostaglandin $F_2\alpha$ administration induced a marked increase of plasma concentrations of PRL and GH in heifers²¹), physiological significance of circulating prostaglandin F for enhanced secretion of both hormones near parturition in ruminants remains to be elucidated. Increase in PRL and GH secretions by enhanced endogenous TRH release around parturition is not likely, for there was no appreciable rise of plasma TSH near parturition (Johke and Hodate unpublished data). During later stage of pregnancy, high placental lactogen concentrations in blood may suppress PRL and GH secretion from the pituitary gland in the cow. Bovine placental lactogen has both GH-like and PRL-like activities²²).

The elevated levels of plasma PRL and GH around parturition presumably accelerate lactogenesis in the cow. Suppression of PRL secretion around parturition by administration of 2-Br- α -ergocryptine, a PRL inhibitor, or 2-Br- α -ergocryptine and an antiserum to bovine PRL, induced a marked depression of lactogenesis in the cows^{23,24}). Furthermore, the concentrations of α -lactalbumin, lactose, and caseins in colostrum and milk decreased significantly in the cows²⁴). It was well established that GH has a potent galactopoietic activity in lactating cows^{25,26}). The rise of serum GH level around calving and during postpartum may also be responsible for a marked increase in milk secretion during early stage of lactation. No marked change of serum thyroxine level was found during late pregnancy and early lactation in cows²⁷). The low serum thyroxine level was also reported in lactating cows as compared to that of dry cows²⁸). The decline in plasma T3 level in postpartum may be attributable to an increased T3 utilization in peripheral tissues by enhanced general metabolism in lactation.

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乳牛の血清プロラクチン，成長ホルモンおよびトリヨード サイロニンの妊娠末期から泌乳初期における変化

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9月に分娩した経産ホルスタイン種乳牛の妊娠末期から泌乳初期における血清プロラクチン (PRL)，成長ホルモン (GH)，およびトリヨードサイロニン (T_3) 濃度の変化を，ラジオイムノアッセイで測定して次の結果を得た。(1) 妊娠末期の平均血清 PRL 値は，分娩3日前まで大きな変化を示さなかったが，分娩2日前から上昇して，分娩の日に最高値 87.3 ng/ml を示した。分娩後は低下して，4日以降のレベルは妊娠末期とほぼ同様であった。(2) 妊娠末期の平均血清 GH 値は，分娩2日前まで 2.4~4.0 ng/ml の間を変動したが，分娩1日前から

上昇して，分娩日には 8.0 ng/ml の最高値を示した。分娩後1週間の血清 GH 値は 5.2~8.2 ng/ml であったが，その平均値は，分娩前1週間の値よりも有意に高かった ($P<0.001$)。 (3) 分娩前5日間の平均血清 T_3 値は，104.2~108.8 ng/dl であったが，分娩日には 93 ng/dl に減少した。分娩後5日間のレベルは 73.0~83.8 ng/dl であったが，その平均値は分娩前にくらべて有意に低かった ($P<0.001$)。 (4) 分娩前後における乳牛の血清 PRL，GH および T_3 を変化させるいくつかの要因について論議した。