ENERGY BALANCE AND FOLLICULAR PROFILES DETECTED BY ULTRASONOGRAPHY IN EARLY POSTPARTUM DAIRY COWS

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INTRODUCTION

Early establishment of cyclical ovarian activity following parturition is essential to attain 365-day calving interval. The importance of postpartum energy balance on the resumption of normal ovarian cycles in dairy cows has been recognized in several studies (1). Energy balance is the net result of associations among yield of milk, diet, intake, and use of nutrients by cows. Dairy cattle undergo an energy deficit in early lactation because maximum milk production is attained prior to maximum feed consumption (2). More than 80% of dairy cows experience negative energy balance during early lactation, but magnitude and duration of negative energy balance are variable among cows (8). An extremely negative energy balance will dampen pulsatile secretion of LH (4) and delay ovulation, which contributes to on-farm inefficiency through economic losses associated with postpartum anestrus. Ultrasonic examination of the ovary has been shown to be an accurate and reliable method quantitating ovarian follicle populations (6).The objective of this study was to determine the effects of energy balance on the follicular profiles using ultrasonography in postpartum dairy cows.

MATERIALS AND METHODS

Animals: Forty Holstein cows were studied from parturition to 60 d postpartum. All the cows obtained were in their 2nd - 7th parity, experiencing normal parturition, and healthy throughout the study. Cows were fed ad libitum a total mixed diet (50% roughage: 50% grain on DM basis).

Energy Balance: Feed intake was determined daily for each individual cow (feed offered minus orts). The Total Digestive Nitrogen (TDN) was determined by the digestion trial using four wethers. Calculation of the TDN intake was made by multiplying the DM consumption by the calculated TDN of the ration. Daily milk production was recorded electronically and body weight measurements were made weekly. Milk fat composition was determined by Milco Scan 103B (Fos Electric, Denmark) for weekly samples. Weekly value for fat in milk was used to calculate daily 4% FCM for 3 d before and after the date of actual test. Requirements of net TDN for maintenance were based on estimated daily body weight and calculated as suggested by Japanese Feeding Standard (5), which is patterned after NRC: $TDNm = 0.037\times(kg\ BW^{0.75})$. Net TDN in the secreted milk was calculated using the equation $TDN1 = Milk \times (0.13 + 0.05 \times Fat)$ (5). TDN energy balance (TDNEB) was derived on a daily basis using the equation

TDNEB = TDNI / (TDNm + TDN1) x 100.

Ultrasonography: Six days after parturition, reproductive organs of cows were examined twice weekly by the same veterinarian using linear array ultrasound scanner, Model SSD-630 (Aloka, Tokyo, Japan). The ultrasonic probe used was a trans-rectal T-shape veterinary probe in 7.5 MHz frequency (UST-556T-7.5). Each organ was scanned from several directions and moving images were frozen to obtain hard printer photography film. Examinations were recorded also with a video unit to be precisely reviewed. Ovarian follicles were organized into four classes based on diameter: class 1, 2 to 4 mm; class 2, 5 to 9 mm, class 3, 10 to 14 mm, and class 4, ≥15 mm. Dominant follicle (DF) was defined as the largest follicle in the ovary of ≥10 mm in diameter in the absence of other large follicles.

Cows were observed for estrus twice daily with an aid of heat mount detector device stuck on the rump. The day of conception was defined as the day of final insemination. The number of DF before first ovulation and postpartum interval to ovulations were compared by TDNEB types. Student's t-test was used for the statistical significance of differences between means.

RESULTS

In the early postpartum, the average number of small (class 1 and class 2) follicles decreased, whereas the number of large (class 4) follicles increased with increasing days postpartum. Follicular profiles prior to first ovulation, 1, 2, 3, and 4 DF were detected from 25, 10, 4, and one cows, respectively. But after first ovulation, two waves of DF prevailed. Variation in TDNEB, explained largely by intake of TDN, was mainly typed into four in early postpartum. Type I (28 cows) was characterized by prompt elevation of TDNEB after short falls postpartum, while the elevation after falls was rather delayed in type II (5 cows). Severe energy deficit less than 50% of requirement was observed before elevation in type III (4 cows), while no significant elevation was observed in type IV (3 cows). In relation to follicular profiles, first DF was detected in early postpartum ultrasonography and ovulated at the vicinity of first peak of TDNEB in type I. In type II and IV, first DF also emerged but failed to ovulate, and succeeding second or third DF ovulated first accompanied with the elevation of TDNEB. In type III, folliculogenesis was suppressed during severe energy deficit, and then first DF emerged with elevation of TDNEB after 20 d postpartum. The number of DF identified before first ovulation, and postpartum interval to ovulations and conception characterized by TDNEB type are shown in Table 1.

Type of TDNEB did not influence the total number of follicles recorded. However, the number of follicles more than 10 mm in type III was smaller than that in type I and II in early postpartum (Fig.1).

Table 1. Number of dominant follicles before first ovulation, and the interval from calving to ovulations and conception characterized by TDNEB[1] type

TDNEB type	No.of cows	No.of Dominant Follicles	Postpartum Interval to Ovulations First	Second	Third	Conception
I	28	1.1	15.9	39.3	60.0	90.2
II	5	2.2	26.8	47.8	58.5	74.8
III	4	2.3	36.3	58.1	72.5	75.5
IV	3	3.3	47.7	84.7	90.6	120.0

[1]TDNEB: Total Digestive Nitrogen Energy Balance

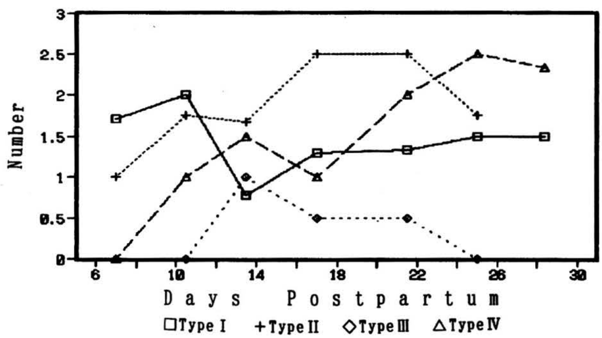

Fig.1 Average number of follicles more than 10 mm in diameter characterized by four types of TDNEB

DISCUSSION

The number of follicles showed mostly singular follicular wave prior to first ovulation as compared with bimodal or trimodal after first ovulation. This profile is similar to the previous reports (7). The follicular events leading up to first ovulation were characterized by decreasing numbers of smaller (class 1 and 2) follicles and increasing numbers of larger (class 4) follicles as day postpartum increased. This pattern is consistent with the concept of follicular recruitment and selection leading to terminal follicular growth and dominance (3).

TDN energy balance seems to modify these population changes and affects the average number of follicles in early postpartum. As TDNEB increases, first DF developed and ovulated. During the TDNEB deficit, there developed DF but failed to ovulate. This theoretically leads to an earlier ovulation in cows with higher TDNEB. An interesting finding in this study was a first postpartum ovulation to be associated with peak TDNEB.

In conclusion, TDNEB influences follicular growth in early postpartum. These effects of TDNEB seem to influence day to first ovulation by increasing the number of larger size follicles.

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SUMMARY

The effects of postpartum energy balance on the follicular profiles were monitored by ultrasonography in dairy cows. The average number of small follicles decreased, whereas the number of large follicles increased with increasing days postpartum. Daily TDN energy balance was defined as the balance between intake of energy and energy required for maintenance and lactation. The ovaries were scanned twice weekly by ultrasonography from 6 d until 60 d postpartum. Variation in TDN energy balance in early postpartum was mainly typed into four. Type I (28 cows) was characterized by prompt elevation of TDNEB after short falls postpartum, while the elevation of energy balance was rather delayed in type II (5 cows), severe energy deficit less than 50% of requirement was observed in group III (4 cows), and no significant peak was observed in type IV (3 cows). First DF was detected soon after parturition and ovulated at the vicinity of first peak of TDNEB in type I. In type II and IV, second or third detected DF ovulated first accompanied with the elevation of energy balance. In type III, folliculogenesis was suppressed during severe energy deficit.

These results indicate the importance of postpartum energy balance to initiation of folliculogenesis in dairy cows.