Effects of Body Condition Score in Cows Peripartum on the Onset of Postpartum Ovarian Cyclicity and Conception Rates after Ovulation Synchronization / Fixed-Time Artificial Insemination

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Abstract. The aim of this study was to examine whether the nutritional state of cows peripartum was associated with the recovery of ovarian function and conception rates after synchronization of ovulation and fixed-time artificial insemination (OVSYNCH/TAI). The effect of the interval in days from calving to the first ovulation on conception rates after OVSYNCH/TAI was also investigated. Conception rates of cows after OVSYNCH/TAI (n=39) were 43.6%. The conception rates of cows with a body condition score (BCS) of 2.75–3.25 at 30 d postpartum and on the day of OVSYNCH treatment were significantly higher than in cows with a BCS ≤2.5 (P<0.05). The percentage of cows establishing ovarian cyclicity before 55 d postpartum in cows with a BCS of 2.75–3.25 at 30 d postpartum and on the day of OVSYNCH treatment were significantly higher than in cows with a BCS ≤2.5 (P<0.05). The conception rates after OVSYNCH/TAI in cows which recovered ovarian cyclicity within 34 d postpartum were significantly higher than in cows with first ovulation ≥56 d (P<0.05). These results indicated that the nutritional state in cows peripartum influenced the conception rates after OVSYNCH/TAI and the postpartum ovarian cyclicity and also suggested that the conception rates after OVSYNCH/TAI decreased in cows with delayed recovery of ovarian cyclicity.

Key words: Artificial insemination, Body condition score, Conception rate, Dairy cattle, Ovulation synchronization

nutritional state in the dairy cow [17–21]. Conception rates at first AI were reported to be lower in cows having a BCS ≤2.5 than in cows with a BCS >2.5 at 30 d postpartum [2, 5, 22]. In the early lactation period, dry matter intake does not catch up with the increase in the milk yield after calving [13, 17, 23–28], resulting in a negative energy balance and a decrease in BCS which is caused by the consumption of accumulated body fat [14]. The severe negative energy balance suppresses LH pulse frequency [13, 23]. Therefore, cows with a negative energy balance during the early lactation period become ovarian quiescent. Moreover, it is reported that the increase in the negative energy balance extends the period from calving to first ovulation and the period of anestrus [21, 26, 27, 29]. These results strongly suggest a significant relationship between the nutritional state and reproductive performance in dairy cows. Therefore, cows with a negative energy balance during the early lactation period become ovarian quiescent. Moreover, it is reported that the increase in the negative energy balance extends the period from calving to first ovulation and the period of anestrus [21, 26, 27, 29]. These results strongly suggest a significant relationship between the nutritional state and reproductive performance in dairy cows. Burke et al. [2] reported that the conception rates after OVSYNCH/TAI increased as the BCS of cows at the onset of OVSYNCH treatment rose. Moreira et al. [5] reported that the conception rates after OVSYNCH/TAI decreased in cows with a low BCS at OVSYNCH treatment but is known about the relationship of conception rates to changes in the BCS from the dry period to the start of OVSYNCH/TAI in dairy cows.

In this study, we have investigated the effect of the nutritional state of dairy cows from the dry period to the peak lactation period on conception rates after OVSYNCH/TAI and on the recovery of ovarian function after calving. The effect of the number of days required for recovery of ovarian cyclicity on conception rates after OVSYNCH/TAI was also examined.

Materials and Methods

Animals

The experiments were carried out from August, 1999 to July, 2000. Used were 54 Holstein-Friesian dairy cows from 2 herds in Betsukai, Hokkaido. The cows were in 2–5 parity and were being kept in a stanchion type dairy house. They were put out into a paddock every day. The number of cows in the two herds were 91 and 129, respectively. In cows with diseases such as mastitis, periparturient complications or delayed uterine involution, OVSYNCH was not conducted. When the cows showed signs of estrus within 8 weeks postpartum, they were inseminated based upon the detection of estrus. Cows which did not show signs of estrus until 8 weeks postpartum were subjected to OVSYNCH/TAI.

Study design

The cows were first injected intramuscularly with 100 µg fertirelin (GnRH-A) (Conceral; Takeda Schering-Plough Animal Health., Tokyo, Japan) followed, 7 days later, by 500 µg cloprosterol (CLP) (Resipron-C; Teikoku Hormone Mfg. Co., Ltd. Tokyo, Japan). Two days after CLP administration, 100 µg GnRH-A was again administered, and 16–19 h after the second injection of GnRH-A, AI was carried out regardless of the presence or absence of estrus. The cows were inseminated once with one dose of semen from various sires [1]. Thirty-five days after AI, pregnancy diagnosis was performed by palpation per rectum. We checked the BCS 4 times at 10 d prepartum, 30 d and 40 d postpartum, and on the day of OVSYNCH treatment. The BCS was measured by the method reported by Ferguson et al. [30]. A BCS of 3.75–4 in the dry period and a BCS of 2.75–3.25 in the peak lactation period were considered to be in the proper range in this study. Blood samples were collected weekly from two weeks postpartum to the 9th week postpartum (a total of 8 times). Plasma progesterone concentrations were determined by enzyme immunoassay (EIA) to investigate the recovery of ovarian cyclicity.

Plasma progesterone profile

Plasma progesterone concentrations were determined with an EIA kit (Kanbegawa Laboratory, Tokyo) [31]. Intra-assay and inter-assay coefficients of variation were 6–12% and 8–9%, respectively. When the progesterone level increased to >1 ng/ml and, thereafter a normal estrus cycle was observed, ovarian cyclicity was defined as recovered one week before the progesterone concentration increased to >1 ng/ml.

Relationship between BCS and conception rates after OVSYNCH/TAI

The conception rates of cows with various BCS at 30 d prepartum, 30 d and 40 d postpartum and the day of OVSYNCH treatment were compared. The
conception rates after OVSYNCH/TAI were compared for ≥3.75 and ≤3.5 BCS at 10 d prepartum, and for ≥2.75 and ≤2.5 BCS at 30 d and 40 d postpartum and the day of OVSYNCH treatment.

Relationship between changes in BCS and conception rates after OVSYNCH/TAI

The conception rates among different groups of cows classified by changes in BCS from 10 d prepartum to 30 d and 40 d postpartum and the day of OVSYNCH treatment were compared.

Relationship between BCS and postpartum ovarian cyclicity

The percentages of cows in which the ovarian cyclicity was recovered by 55 d postpartum were compared for different groups of cows with various BCS at 10 d prepartum, 30 d and 40 d postpartum and the day of OVSYNCH treatment. It was also examined whether BCS at 10 d prepartum, 30 d and 40 d postpartum and the day of OVSYNCH treatment was related to the recovery of ovarian cyclicity.

Relationship between the day of recovery of ovarian cyclicity and the conception rates after OVSYNCH/TAI

The relationship between the day of recovery of ovarian cyclicity: ≤34 d, 35–55 d and ≥56 d postpartum, and the conception rates after OVSYNCH/TAI was investigated.

Statistical analysis

The significance of differences in the conception rates for OVSYNCH/TAI and the percentage of cows which recovered ovarian cyclicity after calving in different groups were analyzed by chi-square test.

Results

Of 54 cows, 6 had mastitis, 4 had periparturient complications and 2 had delay of uterine involution. These 12 cows were not used for OVSYNCH. Seven of the 12 cows had a BCS ≥4. The other 3 (5.6%) of the 54 cows came into estrus and were inseminated before OVSYNCH. Of the 54 cows, 39 were used for OVSYNCH/TAI. Conception rates after OVSYNCH/TAI were 43.6%.

Out of 39 cows, 25 cows (64.1%) had a BCS ≥3.75 at 10 d prepartum and the other 14 (35.9%) had a BCS ≤3.5 at 10 d prepartum. The changes in BCS in the 25 cows with a BCS ≥3.75 at 10 d prepartum are shown in Fig. 1. The BCS decreased greatly after calving, and was kept at a low level afterwards. There were no cows with a BCS less than 2.5 at 30 d postpartum (Fig. 2). In the 14 cows with a BCS ≤3.5 at 10 d prepartum, the BCS decreased greatly after parturition. Four cows had a BCS less than 2.5 at 30 d postpartum.
Relationship between BCS and conception rates after OVSYNCH/TAI
Table 1 shows the relationships between BCS at 10 d prepartum, 30 d and 40 d postpartum and the day of OVSYNCH treatment and conception rates after OVSYNCH/TAI.

The conception rates of cows with a BCS of 3.75–4 at 10 d prepartum were higher than those of cows with a BCS \( \leq 3.5 \) (58.3 % vs 14.3 %; \( P<0.01 \)).

The conception rates of cows with a BCS of 2.75–3.25 at 30 d postpartum and the day of OVSYNCH treatment were higher than the figures for cows with a BCS \( \leq 2.5 \) (53.8% vs 11.1%, 59% vs 20%; \( P<0.05 \)).

Relationship between changes in BCS and conception rates after OVSYNCH/TAI
Table 2 shows the changes in BCS from 10 d prepartum to 30 d and 40 d postpartum and the day of OVSYNCH treatment and conception rates after OVSYNCH/TAI.

There was no significant difference in conception rates between cows showing a decrease in BCS \( \leq 0.75 \) during the postpartum period and these cows losing a BCS \( \geq 1.0 \).

The conception rates of cows with a decrease in the BCS \( \leq 0.75 \) at the day of OVSYNCH treatment tended to be higher than those of cows showing a decrease in the BCS \( \geq 1.0 \) (61.5% vs 34.6%).

Relationship between BCS and recovery of postpartum ovarian cyclicity
Table 3 shows BCS at 10 d prepartum, 30 d and 40 d postpartum and day of OVSYNCH treatment, and the percentage of cows in which ovarian cyclicity was recovered within 55 d postpartum.

Of 39 cows, 14 had a BCS of 3.5 or less and the other 25 had a BCS of 3.75 or more at 10 d prepartum. The percentage of cows with recovery of ovarian cyclicity within 55 d postpartum was higher in the 25 cows with a BCS of 3.75 or more than in the 14 other cows with a BCS of 3.5 or less. Nine cows had a BCS of 2.5 or less and the other 30 had a BCS of 2.75 or more at 30 d postpartum. The percentage of cows with recovery of ovarian cyclicity within 55 d postpartum was significantly higher in the 30 cows with a BCS of 2.75 or more than in the 9 other cows with a BCS of 2.5 or less. Eleven cows had a BCS of 2.5 or less and the other 28 cows had a BCS of 2.75 or more at 40 d postpartum. The percentage of cows with recovery of ovarian cyclicity within 55 d postpartum was significantly higher in the 28 cows with a BCS of 2.75 or more than in the 11 other cows with a BCS of 2.5 or less. Fifteen cows had a BCS of 2.5 or less and the 24 other cows had a BCS of 2.75 or more on the day of OVSYNCH treatment. The percentage of cows with recovery of ovarian cyclicity within 55 d postpartum was significantly higher in the 24 cows with a BCS of 2.75 or more than in the 15 other cows with a BCS of 2.5 or less.

Relationship between recovery of ovarian cyclicity and conception rates after OVSYNCH/TAI
Table 4 shows the relationship between interval from calving to recovery of ovarian cyclicity and the conception rates after OVSYNCH/TAI.

The conception rates after OVSYNCH/TAI were

<table>
<thead>
<tr>
<th>BCS</th>
<th>Days after calving</th>
<th>10d-30d</th>
<th>40d</th>
<th>56d&lt;*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.25</td>
<td>11.1 (%)</td>
<td>0 (0/2)</td>
<td>27.3</td>
<td>0 (0/4)</td>
</tr>
<tr>
<td>2.5</td>
<td>33.3 (1/3)</td>
<td>14.3 (1/7)</td>
<td>14.3 (1/7)</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>52.5 (10/19)</td>
<td>66.7 (12/18)</td>
<td>51.9</td>
<td>57.7 (12/14)</td>
</tr>
<tr>
<td>3.25</td>
<td>0 (0/4) (%)</td>
<td>75 (3/4) (%)</td>
<td>50 (1/2) (%)</td>
<td>50 (1/2) (%)</td>
</tr>
<tr>
<td>3.5</td>
<td>22.2 (2/9)</td>
<td>50 (2/4)</td>
<td>0 (0/1)</td>
<td>0 (0/1)</td>
</tr>
<tr>
<td>3.75</td>
<td>46.7 (7/15)</td>
<td>58.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>77.8 (7/9) (%)</td>
<td>0 (0/4)</td>
<td>0 (0/4)</td>
<td></td>
</tr>
<tr>
<td>4.25</td>
<td>100 (1/1)</td>
<td>0 (0/4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conception rates (No. of cows conceived/No. of cows examined).

* The day when OVSYNCH was conducted.

a/b : \( P<0.01 \), c/d : \( P<0.05 \).
significantly higher in cows with recovery of ovarian cyclicity within 34 d postpartum than in cows with the recovery later than 56 d (72.7% vs 27.3%; P<0.05).

Discussion

In cows with a BCS ≥3.75 at 10 d before calving, their BCS remained ≥2.5 postpartum until the start of OVSYNCH/TAI but in cows with a BCS ≤3.5 at 10 d before calving, the BCS of 4 cows had decreased to below 2.5 postpartum before OVSYNCH/TAI. It has been reported that the conception rates were decreased in cows with a low BCS at OVSYNCH [5]. It is necessary that the BCS of cows early in lactation is kept at ≥2.5 regardless of the BCS prepartum [30]. Therefore, the maintenance of a suitable BCS during the prepartum period is necessary to keep the BCS ≥2.5 during the postpartum period but a high incidence of periparturient complications was found in cows overconditioned in the dry period [19, 30]. The occurrence of periparturient complications causes a negative energy balance due to a poor appetite, which results in the consumption of body fat and a reduction in BCS [30]. Moreover, the occurrence of periparturient complications after calving was reported in the cows overconditioned during the

Table 2. Relationship between changes in the BCS from day –10 to days 30 and 40 postpartum, day of OVSYNCH and conception rates after OVSYNCH/TAI in dairy cows (n=39)

<table>
<thead>
<tr>
<th>Degree of reduction of BCS*</th>
<th>30 d</th>
<th>40 d</th>
<th>56 d&lt;**</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>66.7 (2/3)</td>
<td>0 (0/1)</td>
<td>0 (0/1)</td>
</tr>
<tr>
<td>0.5</td>
<td>25 (2/8)</td>
<td>35.7 (%)</td>
<td>28.6 (2/7)</td>
</tr>
<tr>
<td>0.75</td>
<td>35.3 (6/17)</td>
<td>45.5 (5/11)</td>
<td>83.3 (5/6)</td>
</tr>
<tr>
<td>1.0</td>
<td>75 (6/8)</td>
<td>46.7 (7/15)</td>
<td>22.2 (4/18)</td>
</tr>
<tr>
<td>1.25</td>
<td>0 (0/2)</td>
<td>63.6 (%)</td>
<td>33.3 (1/3)</td>
</tr>
<tr>
<td>1.5</td>
<td>100 (1/1)</td>
<td>100 (2/2)</td>
<td>100 (2/2)</td>
</tr>
</tbody>
</table>

Conception rates (No. of cows conceived/No. of cows examined).
* Changes in BCS from 10 d prepartum to 30 d and 40 d postpartum and day of OVSYNCH.
** The day when OVSYNCH was conducted.

Table 3. Relationship between the BCS at days –10, 30 and 40 and day of OVSYNCH and percentage of cows which recovered ovarian cyclicity within 55 d postpartum (n=39)

<table>
<thead>
<tr>
<th>Days after calving</th>
<th>BCS –10</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.25</td>
<td>2.5</td>
<td>2.75</td>
<td>3.0</td>
<td>3.25</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>4.0</td>
<td>4.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of cows (No. of cows in which ovarian cyclicity were recovered/No. of cows examined).</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Table 4. Relationship between interval from calving to recovery of ovarian cyclicity and conception rates after OVSYNCH/TAI in dairy cows (n=39)

<table>
<thead>
<tr>
<th>Days postpartum until ovarian recovery</th>
<th>&lt;34</th>
<th>35–55</th>
<th>56&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of AI cows</td>
<td>11</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>Conceived cows</td>
<td>8</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Conception rate (%)</td>
<td>72.7*</td>
<td>50</td>
<td>27.3b</td>
</tr>
</tbody>
</table>

a/b : P<0.05.
dry period, even if the BCS of the cow was suitable at parturition [19]. In the present study, 12 cows were withdrawn before OVSYNCH, because of mastitis, periparturient complications and delayed uterine involution. Of these 12 cows, 7 were BCS ≥3.5 at 10 d prepartum and a BCS ≤2.5 postpartum had low conception rates after OVSYNCH/TAI. Conversely, high conception rates were achieved in cows with a BCS of 3.75–4 at 10 d prepartum and a BCS of 2.75–3.25 postpartum. It was reported that the conception rates in response to OVSYNCH/TAI protocol were improved as the BCS of the cow increased [2], which supports the present results. Loeffler et al. [32] found that conception rates in cows with a BCS of 3 at the time of AI were higher than in cows with a BCS ≥3.25 or ≤2.75. The present results indicate that a BCS ≥3.75 in the dry period and a BCS ≥2.75 at the start of OVSYNCH are essential in order to obtain high conception rates. In addition, the BCS should be <4 in the dry period to avoid the incidence of disease.

Domecq et al. [14] reported that the conception rates decreased in cows with a large decrease in BCS after calving and that the range of reduction in BCS after calving but not the BCS value itself was the crucial factor influencing the conception rates. Nevertheless in this study, no significant difference was observed between cows with a reduction in the BCS ≥1 from 10 d prepartum to 30 or 40 d postpartum and cows with a ≤0.75 reduction in the BCS. The reason why the relationship between the degree of BCS decrease after calving and the conception rate as reported by Domecq et al. [14] was not seen in this study is not known.

A smaller percentage of cows with a BCS ≤3.5 in the dry period recovered their ovarian cyclicity within 55 d postpartum, compared to cows with a BCS ≥3.75. Moreover, recovery of ovarian cyclicity in cows with a BCS ≥2.5 at 30 d postpartum and the day of OVSYNCH treatment was delayed, compared with cows with a BCS ≥2.75. In dairy cows, milk yield increases rapidly after calving and it reaches its maximum at 5–7 weeks postpartum [17, 25, 33]. On the other hand, malfunction of the rumen and a decrease in dry matter intake are caused late in pregnancy by growth of the fetus and estrogen secretion [25]. Dry matter intake increases gradually after calving and reaches a peak at 8–22 weeks postpartum [25], although dry matter intake cannot reach the amount required for milk production, leading to a severe negative energy balance in the early lactation period [13, 17, 23–28]. It was reported that the increase in a negative energy balance extended in duration both from calving to the first ovulation and in anestrus [13, 21, 26, 27, 29]. The present results also strongly suggested that the nutritional state of the dairy cow is related to the recovery of ovarian cyclicity after calving. Therefore, the BCS should be ≥3.75 in the dry period and ≥2.75 postpartum to avoid delayed recovery of ovarian cyclicity after calving.

The conception rates of cows after OVSYNCH/TAI in which ovarian cyclicity was recovered ≤34 d postpartum were significantly higher than in cows with recovery of ovarian cyclicity delayed to beyond 56 d. It was reported that progesterone concentrations in the luteal phase after the first ovulation were lower than those after the second or third ovulation [13, 26, 27, 34]. The higher progesterone concentrations in the luteal phase before AI resulted in higher conception rates [35–37]. Therefore, it is suggested that conception rates after OVSYNCH/TAI are decreased in cows with delayed recovery of ovarian cyclicity after calving.

Pursley et al. [7, 8] reported that conception rates of cows in which OVSYNCH/TAI was conducted at 50–75 d after calving were lower than in cows subjected to the protocol at ≥76 d. This may be because recovery of ovarian cyclicity in many cows was delayed at 50–75 d postpartum. But the reports did not show the effects of postpartum ovarian cyclicity. In the present study, half the number of cows had their ovary cyclicity delayed more than 56 d postpartum. These cows had lower conception rates after OVSYNCH/TAI. Therefore, it is indicated that the reduction in conception rates in cows after OVSYNCH early postpartum is attributable to a delay in the recovery of ovarian cyclicity. Moreover, it is speculated that, in cows with delayed recovery of ovarian cyclicity, conception rates can be improved by delaying the start of the OVSYNCH treatment.

In conclusion, it is clarified that BCS, one of the indicators of the nutritional state in the dairy cow influenced the conception rates after OVSYNCH/TAI and the recovery of ovarian cyclicity after calving and that conception rates after OVSYNCH/TAI were decreased in cows with delayed recovery of ovarian cyclicity. It is important to check the BCS of cows regularly and to detect nutritional
problems early and solve them in order to increase the conception rates after OVSYNCH/TAI. The findings suggested that appropriate treatment should be conducted to improve ovarian function before OVSYNCH.

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References