Estrus Synchronization and Conception Rate after a Progesterone Releasing Intravaginal Device (PRID) Treatment from the Early Luteal Phase in Heifers

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Abstract. The objective of the present study was to evaluate estrus synchronization and conception rate after progesterone releasing intravaginal device (PRID) treatment from the early luteal phase in the presence or absence of estradiol benzoate (EB) in heifers. Heifers (n=11) were assigned randomly to two treatments; insertion of a PRID containing 1.55 g progesterone with a capsule attached including 10 mg EB (P+EB; n=6) and the PRID withdrawn the EB capsule (P-EB; n=5). The PRID was inserted into the vagina on Day 2 of the estrous cycle (Day 0 was the day of ovulation) and was left for 12 days. The proportion of heifers exhibiting standing estrus within 3 days after PRID removal was 83.3% (5/6) for the P+EB group, and 80.0% (4/5) for the P-EB group, respectively. Conception rate by artificial insemination on synchronized estrus was 80.0% (4/5) in the P+EB group, and 100% (4/4) in the P-EB treatment group, respectively. These results suggest that a PRID treatment from 2 days after ovulation for 12 days in the presence or absence of EB has an effect on the synchronization of estrus and produces a beneficial conception rate in heifers.

Key words: Early luteal phase, Estradiol benzoate, Estrus, Heifers, PRID

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Sreenan et al. [2] and Macmillan et al. [3] mentioned that the day of device removal fell on the functional stage of the corpus luteum (CL) during the normal estrous cycle if the device was implanted for 10 or 12 days from the early luteal phase. In this case, it is possible that progesterone secretion from the functional CL inhibits the occurrence of estrus. Moreover, it is reported that supplemental administration of estradiol benzoate (EB) at the start of progesterone treatment improved the induction rate of estrus and conception rate in cows [4]. In view of this finding, it is necessary to clarify the advantageous role of EB treatment in cows treated with a progesterone intravaginal device from the early luteal phase.

The aim of the present study was to evaluate the beneficial effects of progesterone treatment from the early luteal phase in heifers. Our protocol was to insert a progesterone releasing intravaginal device (PRID) for 12 days, starting 2 days after ovulation. The effects of the PRID were also evaluated for the induction rate of estrus and conception rate in the presence or absence of EB.

Materials and Methods

Eleven cyclic Holstein heifers maintained at a farm in Saitama Prefecture, Japan, were used. The experiment was conducted during the period from December to March. Their heifers were from 14 to 18 months of age. Their body weights ranged from 324 to 411 kg and the status of the body condition was good at the time of treatment. All animals were maintained in a paddock. They were fed 1.5 to 2.0 kg of concentrates, and they had free access to a low-moisture silage of orchardgrass or Italian ryegrass and fresh water.

Animals were divided into two groups, the P+EB (n=6) and P-EB (n=5) groups. The P+EB group received a progesterone releasing intravaginal device with a capsule attached containing 10 mg of estradiol benzoate (PRID®; CEVA SANTE ANIMALE SA, France). The P-EB group received a PRID® withdrawn the EB capsule. The PRID was inserted into the vagina on Day 2 (Day 0=the day of ovulation as determined by rectal palpation) and was left in the animals for 12 days. After removal of the PRID, standing estrus was monitored twice daily by visual observation. Artificial insemination (AI) was carried out within 12 h after detection of standing estrus (i.e., AM/PM rule). In this study, the estrous cycle was considered to be synchronized when the length of the estrous cycle was shortened and standing estrus was observed within 3 days after PRID removal. Pregnancy diagnosis was conducted using per rectum palpation of the uterus between 50 and 60 days after AI.

Blood samples were collected via jugular venipuncture to determine the ovarian steroid profiles on Days 0, 2, 3, 4, 6, 8, 10, 12 and 14, and daily from Day 15 to the following day of ovulation. Samples were collected in heparinized syringes and placed on ice. Within 30 min of collection, the samples were centrifuged at 3000 rpm for 15 min at 4°C, and the plasma was stored at −20°C until assay for the concentrations of progesterone and estradiol—17β by a procedure previously described [5].

The sensitivities of the assays were 0.02 ng/ml for progesterone and 0.38 pg/ml for estradiol-17β. The intra- and inter-assay coefficients of variation were 10.1% and 28.0% for progesterone and 23.8% and 21.1% for estradiol-17β, respectively.

During PRID treatment, the significance of differences of the mean progesterone and estradiol—17β concentrations for each group was tested using the Student's t-test. Conception rate was analyzed by Fisher’s exact probability test. P<0.05 was considered to be statistically significant.

Results

In all heifers, the PRID remained in the vagina until removal, and no vaginitis was found clinically throughout the experiment.

Occurrence of estrus

The occurrence of estrus after PRID removal is summarized in Table 1. The proportion of heifers exhibiting standing estrus within 3 days after PRID removal in the P+EB and P-EB groups were 83.3% and 80.0%, respectively. The inter-ovulatory interval in these heifers were 17 or 18 days. The remaining two heifers, No. 35 in the P+EB group and No. 26 in the P-EB group, exhibited estrus on days 5 and 7 after PRID removal, respectively. The inter-ovulatory interval in these heifers were 20 and 22 days, respectively.
Plasma progesterone and estradiol-17β

The profiles of plasma progesterone and estradiol-17β in the heifers exhibiting estrus within 3 days after PRID removal are shown in Fig. 1. Plasma progesterone concentrations increased markedly after PRID insertion and were maintained at a level between 2 and 15 ng/ml until PRID removal in both groups. There were no significant differences in the plasma concentrations of progesterone throughout the experiment between the P+EB and P-EB groups. The concentrations of estradiol-17β on the day following PRID insertion in the P+EB group were significantly higher than in the P-EB group (7.1 ± 4.5 pg/ml vs 1.0 ± 0.6 pg/ml, P<0.05). In these heifers, concentrations of progesterone decreased immediately after PRID removal and were less than 1.0 ng/ml on the day following PRID removal. In the remaining two heifers (Nos. 35 and 26), which did not exhibit estrus within 3 days after PRID removal, progesterone concentrations were maintained at a level greater than 2 ng/ml until 3 to 4 days after PRID removal (Fig. 2). The concentrations of progesterone in No. 35 and No. 26 declined to a level less than 1.0 ng/ml on Day 18 and Day 19, respectively. All heifers showed peak

Table 1. The occurrence of estrus after PRID removal

<table>
<thead>
<tr>
<th>Group</th>
<th>Day after PRID removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>P+EB (n=6)</td>
<td>0 2 3 0 1 0 0</td>
</tr>
<tr>
<td>P-EB (n=5)</td>
<td>0 3 1 0 0 0 1</td>
</tr>
<tr>
<td>total</td>
<td>0 5 4 0 1 0 1</td>
</tr>
</tbody>
</table>

1) The number of heifers.
estradiol-17β concentrations on the day of standing estrus.

Conception rate

Conception rate for the first AI during synchronized estrus after PRID removal was 80.0% in the P+EB group heifers (4/5) and 100% in the P-EB group heifers (4/4) exhibiting estrus within 3 days. There was no significant difference in conception rate between the P+EB and P-EB groups. The other two heifers (Nos. 35 and 26) were also pregnant by the first AI after PRID removal.

Discussion

In the present study, the PRID was inserted on Day 2 and then removed on Day 14. Day 14 is the functional stage of CL during the normal estrous cycle in cattle, and the CL has the ability to vigorously secrete progesterone at this stage. However, plasma progesterone concentrations decreased immediately to a level less than 1.0 ng/ml after PRID removal in almost all heifers in both groups (P+EB, 83.3%; P-EB, 80.0%), and then a preovulatory increase in plasma estradiol-17β concentrations occurred. Estrus was detected within 3 days after PRID removal in the heifers, and the conception rate was 80.0% and 100%, respectively. In the clinical field, the convergence of estrus within 3–4 days after treatment is required for the success of estrus synchronization. From a clinical point of view, therefore, the present results suggest that a PRID treatment from Day 2 of the estrous cycle for 12 days has beneficial effects for synchronization of estrus. In contrast to the present findings, Sreenan et al. [2] have reported that progesterone treatment alone did not affect the length of the estrous cycle or function of the corpus luteum, whereas CL development was inhibited when estradiol was given on the day of progesterone treatment. In this regard, further studies are needed to determine the characteristics of ovarian structures as well as the endocrine profiles after PRID treatment in the presence or absence of estrogen treatment.

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References

2. Sreenan JM, Mulvehill P, Gosling JP. The effects of progesterone and oestrogen treatment in heifers on oestrous cycle control and plasma progesterone.


