Influence of Dexamethasone, Progesterone, Gonadotropin-Releasing Hormone, and Testosterone on Estrous Behavior of Estradiol-Treated Ovariectomized Heifers


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ABSTRACT

In Experiment 1, 12 ovariectomized heifers were assigned to receive weekly hormone treatments in a replicated 6 x 6 Latin square design. Hormonal treatments were given as two simultaneous injections i.m. and consisted of: 1) 2 ml propylene glycol and 2 ml propylene glycol; 2) .5 mg estradiol benzoate and 2 ml propylene glycol; 3) .5 mg estradiol benzoate and 4 mg dexamethasone; 4) .5 mg estradiol benzoate and 10 mg progesterone; 5) .5 mg estradiol benzoate and .4 mg GnRH; and 6) .5 mg estradiol benzoate and 12.5 mg testosterone propionate. The .5 mg estradiol benzoate and 4 mg dexamethasone treatment reduced the percentage of heifers in estrus compared with the .5 mg estradiol benzoate and 2 ml propylene glycol treatment. In Experiment 2, 16 ovariectomized heifers were used in four replicates of a 4 x 4 Latin square design to determine if pretreatment with progesterone potentiated the actions of estradiol. Hormonal treatments i.m. consisted of: 1) 0 mg progesterone and .2 mg estradiol benzoate; 2) 50 mg progesterone and .2 mg estradiol benzoate; 3) 0 mg progesterone and .5 mg estradiol benzoate; and 4) 50 mg progesterone and .5 mg estradiol benzoate. Progesterone pretreatment, at either dosage of estradiol benzoate, did not increase the percentage of heifers in estrus. Based on these observations, we conclude that: 1) dexamethasone inhibited estrus in estradiol-treated ovariectomized heifers and 2) progesterone pretreatment did not potentiate the actions of estradiol in ovariectomized heifers.

INTRODUCTION

The neuroendocrine mechanisms responsible for the induction and modulation of estrous behavior in cattle are complex. It is thought that estradiol, produced by the preovulatory follicle, induces estrus by acting at specific brain loci. Ovariectomy results in the complete absence of estrous behavior, whereas estradiol treatment of ovariectomized (OVX) cattle will induce estrus (1, 3, 9).

There are many potential hormonal candidates that may either attenuate, inhibit, or even facilitate the behavioral actions of estradiol in cattle. Administration of the glucocorticoid, cortisol, during proestrus inhibited the preovulatory surge of LH, ovulation, and estrus in intact heifers (10). However, when cortisol was given to estradiol-treated OVX heifers and cows, estrus was not inhibited. Dexamethasone (Dex), a long-acting synthetic glucocorticoid, inhibited estrus in the same experiment (4). Treatment with progesterone (P4) facilitates (7) and inhibits (2, 5) estrous behavior in estradiol-treated OVX cattle. Numerous studies have reported that GnRH facilitates the behavioral actions of estradiol in rodents (11) but when gonadotropin-releasing hormone (GnRH) was administered 10 h after a suboptimal dose of estradiol in OVX cows and heifers (3), the percentage of animals in estrus and the intensity of estrous behavior was not increased. Testosterone (T), but not androstenedione or dihy-
ditestosterone, when given alone was able to induce estrous behavior in OVX heifers (6). However, the estrous behavior induced by T resulted in fewer behavioral interactions than that induced by estradiol.

The objective of the experiments was to determine if Dex, P₄, GnRH, and T had modulating influences on estrous behavior in estradiol-treated OVX heifers.

MATERIALS AND METHODS

General

In Experiments 1 and 2, heifers were confirmed to be undergoing regular estrous cycles by observation of standing estrus. In addition, serum concentrations of P₄ were monitored thrice weekly for 60 d to verify cyclic ovarian function. Heifers were then subjected to bilateral ovariectomy (using local anesthesia) with an ecraseur through a single incision in the paralumbar fossa. Animals were allowed at least 2 wk for recovery. Thereafter, cattle were moved to a dirt lot equipped with light fixtures to facilitate nocturnal observations. Heifers were identified by large painted numbers and ear tags.

Observations for estrus were conducted continuously by trained observers. During the observation period, heifers were observed for two selected behavioral interactions that increase during estrus. An attempted mount was defined as one heifer attempting to mount another heifer without the recipient standing immobile. A standing mount was defined as one heifer mounting another heifer with the recipient standing immobile. Both the animal initiating and the animal receiving the interaction were recorded as well as the time of day. Onset of estrus was indicated when a heifer first stood immobile when mounted and the end of estrus was indicated as the last time the animal stood immobile when mounted. Total numbers of each interaction, duration of estrus, and the interval from injection of treatment to the onset of estrus were determined for each heifer in both experiments.

In each experiment, two additional heifers were treated chronically with T and housed in the experimental lots to aid in estrous detection. Heifers were provided with a corn and corncob diet and gained an average of .7 ± .1 kg/d during the studies.

Experiment 1

Twelve OVX Holstein heifers (age = 16 mo) were subjected to weekly hormone treatments in a simultaneously replicated 6 × 6 Latin square design. Hormonal treatments were given as two simultaneous injections i.m. and consisted of: 1) 2 ml propylene glycol (PG) and 2 ml PG; 2) .5 mg estradiol benzoate (EB) and 2 ml PG; 3) .5 mg EB and 4 mg Dex; 4) .4 mg EB and 10 mg P₄; 5) .5 mg EB and .4 mg GnRH; and 6) .5 mg EB and 12.5 mg T propionate (TP). Heifers receiving .5 mg EB and .4 mg GnRH were injected i.m. 12 h later with an additional .4 mg GnRH (in 8 ml saline), whereas all other heifers received 8 ml saline i.m. at this time. Observations for estrus were initiated immediately after the injection of treatment and continued without interruption for 48 h.

Experiment 2

Sixteen OVX Holstein heifers (age = 16 mo) were subjected to weekly hormone treatment in four simultaneous replicates of a 4 × 4 Latin square design. Hormonal treatments were given as two injections i.m. and consisted of: 1) 0 mg P₄ and .2 mg EB; 2) 50 mg P₄ and .2 mg EB; 3) 0 mg P₄ and .5 mg EB; and 4) 50 mg P₄ and .5 mg EB. The P₄ injection was given 48 h prior to the EB injection and 1 ml of PG was used as 0 mg P₄. A 40-h continuous period of estrous observation was initiated 9 h after EB administration.

Statistical Analyses

Data were analyzed by analysis of variance with main effect of treatments and weeks as independent variables. The data were normally distributed and there was no heterogeneity of variance detected. A Newman-Keul's test was utilized to separate means when significance was detected. To determine differences among treatments for the proportion of heifers in estrus, a chi-square test was utilized.

RESULTS

Experiment 1

Administration of 2 ml PG and 2 ml PG did not induce estrus or increase any behavioral
interaction and, therefore, data from this treatment were excluded from analysis. Treatment with .5 mg EB and 2 ml PG induced estrus in 91.7% of heifers with all other treatments being similar except .5 mg EB and 4 mg Dex, which induced estrus in a lower (P<.01) percentage of heifers (Table 1). The interval from EB injection to the onset of estrus and the duration of estrus were similar for all treatments (Table 1). In addition, no treatment differences were noted for any of the behavioral interactions when considering only those heifers in which estrus was induced.

Experiment 2

The overall percentage of heifers in estrus after .5 mg EB treatment, with or without prior treatment with P₄, was higher (P<.05) than treatment with .2 mg EB (Table 2). The interval from EB injection to the onset of estrus and the duration of estrus was similar for all treatments (Table 2). Also, no differences due to treatment were detected for any of the behavioral interactions when considering only those heifers in which estrus was induced (Table 2).

DISCUSSION

In the present experiments, one injection of .5 mg EB induced estrus in a high proportion of O VX heifers, which was similar to our previous reports (3, 4). In close agreement, Ray (9) and Carrick and Shelton (2) reported that dosages of .4 mg EB and higher were able to induce estrus in high proportions of O VX cattle. The .2 mg EB treatment was only able to induce estrus in approximately half of the heifers. This result is in contrast to Nessan and King (8), who reported that .25 mg EB failed to induce estrus in cattle. Cook et al. (3) reported previously that .25 mg EB induced estrus in approximately 50% of treated cattle.

In Experiment 1, 4 mg Dex reduced the percentage of estradiol-treated heifers in estrus. The ability of 4 mg Dex to inhibit estrus has been reported previously (3), and this report confirms that observation. However, those heifers induced into estrus after .5 mg EB and 4 mg Dex had behavioral traits similar to those of other heifers in which estrus was induced. Therefore, we infer that estrous inhibition by Dex is an all or none phenomenon.

The administration of 10 mg P₄, given concurrently with .5 mg EB, did not alter any estrous trait in Experiment 1. Davidge et al. (5) indicated that pretreatment with P₄ either had no influence on estrous behavior of estradiol-treated cattle or, if given in high dosages, had an inhibitory effect on the estrous response.

TABLE 2. Estrous characteristics of heifers in Experiment 2.1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Treatment2</th>
<th>0 mg P4 and .2 mg EB</th>
<th>50 mg P4 and .2 mg EB</th>
<th>0 mg P4 and .5 mg EB</th>
<th>50 mg P4 and .5 mg EB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heifers in estrus3 %</td>
<td>50.0</td>
<td>43.8</td>
<td>75.0</td>
<td>87.5</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>8/16</td>
<td>7/16</td>
<td>12/16</td>
<td>14/16</td>
<td></td>
</tr>
<tr>
<td>Interval to estrus, h</td>
<td>15.5 .6</td>
<td>16.4 .7</td>
<td>16.3 .9</td>
<td>16.3 .7</td>
<td></td>
</tr>
<tr>
<td>Duration of estrus, h</td>
<td>6.1 .9</td>
<td>9.7 .7</td>
<td>8.9 1.5</td>
<td>9.3 1.2</td>
<td></td>
</tr>
<tr>
<td>Attempted mounts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initiated</td>
<td>15 4</td>
<td>16 4</td>
<td>15 2</td>
<td>16 4</td>
<td></td>
</tr>
<tr>
<td>Received</td>
<td>24 7</td>
<td>27 9</td>
<td>18 5</td>
<td>19 4</td>
<td></td>
</tr>
<tr>
<td>Standing mounts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initiated</td>
<td>17 4</td>
<td>20 4</td>
<td>22 6</td>
<td>21 4</td>
<td></td>
</tr>
<tr>
<td>Received</td>
<td>16 5</td>
<td>36 12</td>
<td>43 13</td>
<td>63 17</td>
<td></td>
</tr>
</tbody>
</table>

1Values only reflect data from heifers in estrus.
2P4 = Progesterone and EB = estradiol benzoate.
3Overall, .5 mg estradiol benzoate induced estrus in a higher proportion of heifers than .2 mg estradiol benzoate (P<.05).

The results of Experiment 2 are in agreement with Davidge et al. (5). Pretreatment with P4 before administration of either .2 mg or .5 mg EB failed to improve the percentage of heifers in estrus and did not alter any estrous trait. Although the number of standing mounts received exhibited a vast range in values across treatments (from 16 to 63), the larger variation associated with these means prevented the detection of significance. We therefore hypothesize that pretreatment with P4, as administered in this experiment, does not facilitate the actions of EB in OVX cattle.

The administration of high dosages of GnRH did not alter the percentage of heifers in estrus after EB treatment, nor was the expression of estrous activity changed by GnRH. We have reported previously (3) that one administration of GnRH did not facilitate the estrous-inducing actions of EB, even when low dosages of EB were given. This result is in contrast to reports in rodents (11). The rodent, therefore, appears to be an inadequate model for the study of estrous behavior in cattle. Along with the difference in response to GnRH, P4 potentiates the actions of estradiol in OVX rodents, whereas P4 clearly has no such effect in OVX cattle.

When TP was given in concert with EB, the percentage of heifers in estrus and other estrous traits were not changed relative to .5 mg EB and 2 ml PG. When T was given alone, estrous behavior was induced in OVX cattle (6, 8). It appears that in Experiment 1, .5 mg EB by itself induced estrus in a high proportion of heifers, and TP was not able to increase further the already high response.

In summary, Dex was able to inhibit estrus in approximately half of estradiol-treated heifers. The inhibitory action of Dex must be acting on the central nervous system in our OVX heifer model. The exact mechanism of action requires further study. The estrous characteristics of the heifers induced into estrus after Dex were equal to the EB-treated heifers. This supports our contention that the induction of estrus is an all or none phenomenon in cattle. Progesterone was unable to potentiate the behavioral actions of estradiol, even when suboptimal dosages of estradiol were administered. This observation is supported by all recent studies that have examined the role of P4 in the induction of estrus in cattle. Finally, GnRH and TP did not alter the expression of estrous traits in estradiol-treated OVX heifers.

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REFERENCES


