ENDOCRINE PATTERNS IN THE POSTPARTUM BEEF COW ASSOCIATED WITH WEANING: A COMPARISON OF THE SHORT AND SUBSEQUENT NORMAL CYCLES

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Summary

Levels of luteinizing hormone (LH), follicle stimulating hormone (FSH), progesterone and estradiol-17β were measured in five Polled Hereford cows. Blood samples were collected once or twice daily for 5 d, then every 6 h from 1 d before weaning (d 28 to 38 postpartum) until 10 d after the second postweaning estrus. Blood samples were again collected at daily intervals until the third postweaning estrus. All cows exhibited estrus within 4 d after weaning, a second estrus 8 to 10 d after the first and a third estrus 16 to 23 d after the second. All cows had peaks in serum concentrations of LH during the first (22.6 to 81.7 ng/ml) and second (4.4 to 149.0 ng/ml) postweaning estrus. Mean levels of LH in serum during the peak and the area under the LH curve during the first and second postweaning estrus did not differ. Serum levels of LH and FSH during the first 4 d of the short cycle did not differ from LH and FSH levels the first 4 d of the subsequent normal cycle. Levels of LH in serum for 4 d before the first LH surge, associated with the first postweaning estrus, did not differ from levels of LH found 4 d before the second LH surge, associated with the second postweaning estrus. However, serum levels of FSH during the 4 d before the first ovulatory LH surge were lower (P = .05) than those observed during the 4-d period before the second ovulatory surge of LH. Progesterone levels were similar the first 6 d after the first and second estrous periods, but were lower after d 6 of the first (short) cycle than after d 6 of the second (normal) cycle. Estradiol peaks of 1.2 to 2.8 pg/ml were detected during the first postweaning estrus and 1.4 to 12.5 pg/ml during the second postweaning estrus, but due to the variability among cows mean levels of estradiol during first estrus did not differ from second estrus. These data agree with previous reports that postpartum anestrous cows had short cycles if they exhibit estrus in response to weaning. The early decline of progesterone after the first estrus apparently did not stem from lack of LH in serum, but the lower levels of FSH observed before this first ovulation may have been an important factor contributing to the reduced life span of the subsequent corpus luteum.

(Key Words: Beef Cows, Luteinizing Hormone, Follicle Stimulating Hormone, Progesterone, Estradiol-17β, Postpartum.)

Introduction

Estrous cycles of reduced length have been reported in cows after the first postpartum estrus (Macmillan and Watson, 1971; Hansen and Hauser, 1980, Odde et al., 1980; Ramirez-Godinez et al., 1980, 1981). Approximately 80% of the postpartum anestrous cows that exhibited estrus within 10 d after weaning their calves had estrous cycles of 7 to 12 d in length with a short serum progesterone rise after the first estrus (Ward et al., 1979; Odde et al., 1980; Ramirez-Godinez et al., 1981). Other researchers have reported that levels of progesterone in serum rise before the first postpartum...
estrus (Kiracofe, 1980; Wettemann, 1980). The pre-estrus serum progesterone rise may result from an ovulation in the absence of an observable estrus and may represent the same short luteal phase as observed in the short cycle studies.

Most anestrous cows that exhibit short cycles after weaning do not have elevated progesterone levels in serum before the first detected postweaning estrus, but those that have a normal cycle do have elevated levels of progesterone pre-estrus (Ramirez-Godinez et al., 1981). In the same study, a 9-d progestogen (Norgestomet) implant given before or at weaning reduced the incidence of short cycles in previously anestrous cows after weaning their calves. These data suggest increased levels of progesterone in serum before the first postpartum estrus are essential for normal luteal function. It has been suggested that the corpora lutea associated with the short cycle in the cow have a short life span due to: 1) lack of luteotropic support, 2) failure of the luteal tissue to recognize a luteotropin or 3) enhanced secretion of a luteolytic agent (Odde et al., 1980). A decreased size and number of granulosa cells in the dominant follicle of the monkey at midcycle was thought to be the cause of defective luteal function after ovulation (Channing et al., 1981). However, a complete study of the endocrine changes that occur during the short cycle in postpartum cows has not been conducted. The purpose of the present study was to measure serum levels of follicle stimulating hormone (FSH) and luteinizing hormone (LH), progesterone and estradiol-17\(
\beta\) during the first and second cycles which occurred after weaning calves from anestrous beef cows.

**Materials and Methods**

The calves were weaned from five Polled Hereford cows that had not been detected in estrus since calving, did not have a palpable corpus luteum and did not have levels of progesterone in serum exceeding 1 ng/ml. Cows ranged from 28 to 38 d postpartum at the time the calves were weaned. Two 15-ml blood samples were collected at designated intervals from each cow by jugular venipuncture from 6 d before weaning until the third postweaning estrus. Samples were collected daily the first 3 d, twice daily the next 2 d, every 6 h (0000, 0600, 1200 and 1800) from 1 d before weaning until 10 d after the second postweaning estrus and then daily until the third postweaning estrus. Blood was collected in evacuated tubes, immediately refrigerated, allowed to clot and then centrifuged. Serum was collected and stored at -20 C until assayed for LH, FSH, progesterone and estradiol-17\(\beta\).

Cows were observed every 6 h for signs of estrus until the third postweaning estrus. After calving and throughout the experiment, all cows were fed diets to meet the NRC (1976) requirements for mature beef cows nursing calves.

Progesterone, LH and FSH were measured with a double-antibody radioimmunoassay as described by Niswender (1973), Niswender et al. (1969) and Akbar et al. (1974), respectively. Progesterone was only measured in blood samples collected daily at 1800 h. Estradiol-17\(\beta\) was measured in blood samples collected around each estrous period by radioimmunoassay as described by Gonzales-Padilla et al. (1975).

Data regarding serum levels of LH, FSH, progesterone and estradiol-17\(\beta\) were analyzed by the paired comparison t-test as described by Steel and Torrie (1960). Serum LH and FSH values were centered on the time of LH peaks coinciding with the first and second postweaning estrus. Data from a period on each side of the LH surge associated with the first and second postweaning estrus were selected to avoid including hormone values twice in the comparison between periods.

Total LH and FSH for 4 d before and for 4 d after LH surges associated with the first and second postweaning estrus was calculated by adding the means of every two consecutive 6-h values. Yates (1981) described and reviewed a similar procedure.

**Results and Discussion**

_Estrus._ All cows exhibited their first postweaning estrus within 4 d (range 1 to 4 d) after weaning and exhibited a second estrus 8 to 10 d after the first. The average number of times cows were detected in standing estrus, observing every 6 h, was 1.0 ± 0.2 and 2.2 ± 0.37 at the first and second postweaning estrus, respectively. Both the first and second estrus was preceded

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5 Norgestomet (17α acetoxy-11\(\alpha\) methyl-19 norpreg-4-ene-3, 20-dione), G. D. Searle and Co., Chicago, IL 60680.
by an elevation in serum LH within 12 h of standing estrus. The second postweaning estrous cycle ranged from 16 to 23 d. The estrous response of anestrous cows to weaning and the occurrence of short cycles after weaning was similar to those previously reported by Odde et al. (1980) and Ramirez-Godinez et al. (1981).

Serum LH. Serum concentrations of LH before weaning reached 3 ng/ml in all cows and one had an LH peak of 9 ng/ml, but none of the peaks was associated with estrous activity. Others have reported frequent elevations in serum levels of LH before initiation of ovarian activity postpartum (Echternkamp and Hansel, 1973; Arije et al., 1974; Schams et al., 1978). Serum concentrations of LH increased in all cows during the first postweaning estrus with preovulatory peaks ranging from 22.6 to 81.7 ng/ml. Concentrations of LH in serum also rose from 4.4 to 149.0 ng/ml in all cows at the second postweaning estrus. Mean LH peaks (average of the highest LH value for all cows) between the first and second postweaning estrus (figure 1) did not differ, nor did areas under the curve during the LH surge. Others have reported elevations in serum concentrations of LH before the first rise of progesterone (Tribble et al., 1973; Dobson, 1978; Stevenson and Britt, 1979; Rawlings et al., 1980; Lofstedt et al., 1981) and before ovulations which were not associated with estrus (Hackett et al., 1973).

The total quantity of LH in serum calculated for four consecutive days before and 4 d after the LH surge did not differ between the first and second postweaning estrus (table 1). The amount of LH produced before, during, and after the first postweaning estrus did not differ from that for the same period associated with the second estrus, so it does not appear that short cycles can be attributed to a lack of LH in

![Figure 1. Mean serum LH and FSH for 4 d before and 4 d after the LH peaks associated with the first and second postweaning estrus.](image-url)
TABLE 1. TOTAL QUANTITIES OF FSH AND LH (NG/ML, MEAN ± SE) BEFORE AND AFTER THE FIRST AND SECOND POSTWEANING LH SURGES

<table>
<thead>
<tr>
<th>Hormone</th>
<th>First estrous cycle</th>
<th></th>
<th>Second estrous cycle</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 d before</td>
<td>4 d after</td>
<td>4 d before</td>
<td>4 d after</td>
</tr>
<tr>
<td>LH</td>
<td>52.1 ± 28.3</td>
<td>14.3 ± 2.2</td>
<td>22.8 ± 6.7</td>
<td>12.6 ± 1.3</td>
</tr>
<tr>
<td>FSH</td>
<td>113.1 ± 23.6d</td>
<td>143.1 ± 23.5</td>
<td>184.6 ± 13.9</td>
<td>171.9 ± 24.3</td>
</tr>
</tbody>
</table>

aLH surges associated with the first and second postweaning estrus.

bCycles ranged for 8 to 10 d.

Cycles ranged from 16 to 23 d.

Different (P = .05) from the total FSH before the LH surge in the second cycle.

Serum. Differences in LH secretory patterns were not measured but could influence luteal function.

Serum FSH. The levels of FSH in serum tended to decrease for 2 d before the preovulatory surge of LH during both estrous periods (figure 1) and minor peaks occurred in serum levels of FSH which coincided with the preovulatory peak of LH. The same trends were seen in the data of Akbar et al. (1974). However, due to the variability among cows, neither of these trends were statistically significant. Schams et al. (1978) also found variable plasma FSH profiles during the postpartum period with no changes associated with either the onset of ovarian activity or the first estrus in postpartum dairy cows.

Total quantities of FSH in serum calculated for four consecutive days before the first LH surge were less (P = .05) than for 4 d before the second LH surge (table 1). Total quantities of FSH in serum calculated for 4 d after the first and second LH surges did not differ (P>1). Dobson (1978) had previously shown that the pituitary gland’s ability to produce FSH increased during the postpartum period, but that plasma FSH decreased after cyclic ovarian activity resumed. The lower quantities of FSH before the short luteal phase (figure 1 and table 1) was particularly interesting in light of data from monkeys (Wilks et al., 1976; Stouffer and Hodgen, 1980) and women (Wentz, 1979) which demonstrated that reduced levels of FSH during the follicular phase of the menstrual cycle resulted in reduced luteal function. Although data from the present study are not conclusive, they certainly indicate that further studies are needed to resolve the role of FSH in luteal function in cows.

Serum Progesterone. Progesterone levels in serum the first 6 d of the first cycle and the first 6 d of the second cycle did not differ, but after d 6, progesterone was lower (P<.05) during the first cycle (figure 2). The second estrus, but not the first, was preceded by a rise in progesterone.

Postpartum cows have either a short progesterone rise before the first observed estrus or a short cycle if the first postpartum ovulation is accompanied by estrus (Lishman et al., 1979; Stevenson and Britt, 1979; Kiracofe, 1980; Odde et al., 1980; LaVoie et al., 1981; Lofstedt et al., 1981; Ramirez-Godinez et al., 1981). Previous observations of an elevation in serum concentration of progesterone before the first observed estrus in postpartum cows nursing calves (Kiracofe, 1980; Wettemann, 1980) could represent the same short luteal phase found after the first postweaning estrus in the present study. The only difference being observation of estrus at the first ovulation after weaning. The life span of corpora lutea induced with gonadotropin-releasing hormone in anestrous cows (Sheffel et al., 1980), as well as those in anestrous cows after weaning a calf (Ramirez-Godinez et al., 1981), is short (8 to 11 d), but can be prolonged by administering exogenous progesterone before gonadotropin-releasing hormone treatment or weaning. Progesterone may be necessary to re-establish normal estrous cycles after parturition.

Serum Estradiol-17β. For lack of serum, only samples collected around the time of estrus (table 2) were assayed for estradiol-17β. Levels of estradiol-17β ranged from 1.2 to 2.8 pg/ml during the first postweaning estrus and from 1.4 to 12.5 pg/ml during the second postweaning estrus. Similar levels of estradiol
before a pre-estrus progesterone rise have been reported in beef cows (Gimenez et al., 1980), but estradiol concentrations during the postpartum period have varied (Echternkamp and Hansel, 1973; Rawlings et al., 1980). Our data suggest that estradiol-17\beta may be somewhat lower at the first estrus (table 2) when estrual activity is less overt and of shorter duration, but there was no significant difference between levels of estradiol-17\beta during the first and second estrous periods due to limited and variable data.

**Conclusion**

The short cycle after weaning in the early postpartum anestrous cow differs from the next cycle by a lack of elevation in serum concentrations of progesterone before estrus, less FSH before estrus and a shorter and less overt expression of estrus. Serum levels of LH did not differ before, during or after the ovulatory surges. Serum progesterone levels did not differ between first and second cycles until the seventh day, then they were lower in the first cycle than in the second one.

**Literature Cited**


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