Concentrations of Insulin-Like Growth Factor-I and Steroids in Dominant Follicles during Postpartum Anestrus and after the Onset of Estrus

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Story in Brief

Concentrations of insulin-like growth factor-I (IGF-I) and steroids in dominant follicles were evaluated in Angus x Hereford cows during postpartum anestrus and after the onset of estrus. Cows were evaluated daily by ultrasonography commencing at either 26±1 or 46±1 d postpartum until the dominant follicle grew less than 1 mm per day. Follicular fluid was aspirated, and time of collection classified as > 35 d before the first estrus, < 35 d before the first estrus, or proestrus (second or greater postpartum cycle). Concentrations of IGF-I and steroids in follicular fluid of anestrous cows were not different in follicles aspirated 30±1 or 47±1 d postpartum. Proestrous dominant follicles had greater concentrations of estradiol and androstenedione than dominant follicles > 35 d and < 35 d before the first estrus. Concentrations of progesterone in dominant follicles at proestrus and < 35 d before the first estrus were similar. Dominant follicles < 35 d before the first estrus had greater concentrations of progesterone and tended to have greater concentrations of androstenedione than dominant follicles > 35 d before the first estrus. We conclude that inadequate concentrations of androstenedione in dominant follicles of anestrous cows may be a limiting factor for maximal estradiol synthesis.

Key Words: Beef Cow, IGF-I, Postpartum Anestrus, Estradiol, Follicles

Introduction

Reproductive failure is one of the major factors contributing to economic loss of beef producers. Reproductive disease and suboptimal reproduction cost the beef industry between $441 and 502 million annually, and the major factor causing this loss is the inability of cows to become pregnant during the breeding season (Bellows et al., 2002). Inefficiency of nonpregnant and late calving cows had a significant economic impact on 47% of beef producers (NAHMS, 1998). Infertility of beef cows is a major loss to producers, thus the mechanisms controlling postpartum anestrus need to be determined to increase reproductive performance.

The ovaries of postpartum anestrous cows have follicular waves, and a dominant follicle can be identified on the ovary as early as 10 d after calving. However, only 11% of beef cows ovulated the first dominant follicle detected during the postpartum period (Murphy et al., 1990). Beef cows had an average of seven follicular waves before the first postpartum ovulation (Stagg et al., 1995). Postpartum anestrus is regulated by factors that influence the ovary, hypothalamus, and/or pituitary. While the hypothalamus and pituitary have been extensively studied, research is limited on ovarian intra follicular changes during the transition from anestrus to normal estrous cycles. Objectives of this study were to evaluate concentrations of IGF-I and steroids in follicular fluid of dominant follicles during the postpartum anestrous period, as well as in preovulatory dominant follicles of cyclic cows.

Materials and Methods

Ovaries of Angus x Hereford cows were evaluated by ultrasonography beginning at either 26±1 or 46±1 d postpartum. Follicles were classified as dominant if they were > 9 mm in diameter and increased in diameter by at least 1 mm per day. When the dominant follicle grew less than 1 mm per day, follicular fluid was collected by transvaginal ultrasound guided aspiration. Time of follicular aspiration was classified as either > 35 d before the first estrus or < 35 d before the first estrus. The first ovulatory estrus was determined by electronic mount detectors (HeatWatch) and concentrations of progesterone in plasma. Follicular fluid was also collected from dominant follicles of cycling proestrous cows. Concentration of estradiol, androstenedione, progesterone, and IGF-I in follicular fluid was determined by radioimmunoassay.

The effects of stage postpartum (> 35 d before the first estrus, < 35 d before the first estrus, and proestrus) on concentrations of steroids and IGF-I in follicular fluid were analyzed with Proc Mixed (SAS, 1990). Homogeneity of variance for traits were determined with Levene's test (SAS, 1990). Log transformation was used for concentrations of estradiol and androstenedione, and the actual means and standard errors are presented.

Results and Discussion

Size of follicles and concentrations of IGF-I and steroids in follicular fluid of anestrous cows were not different in follicles aspirated 30±1 or 47±1 d postpartum (P>0.1), and days until the first estrus were not different for dominant follicles aspirated 30 or 47 d after calving (P>0.1; 34.0±9.5 and 34.4±8.0 d, respectively). Size of dominant follicles at aspiration was not different for proestrous and postpartum anestrous cows (Table 1; P>0.1). However, others have observed an increase in maximum size of dominant follicles with successive follicular waves during the postpartum interval (Murphy et al., 1990; Stagg et al., 1995).

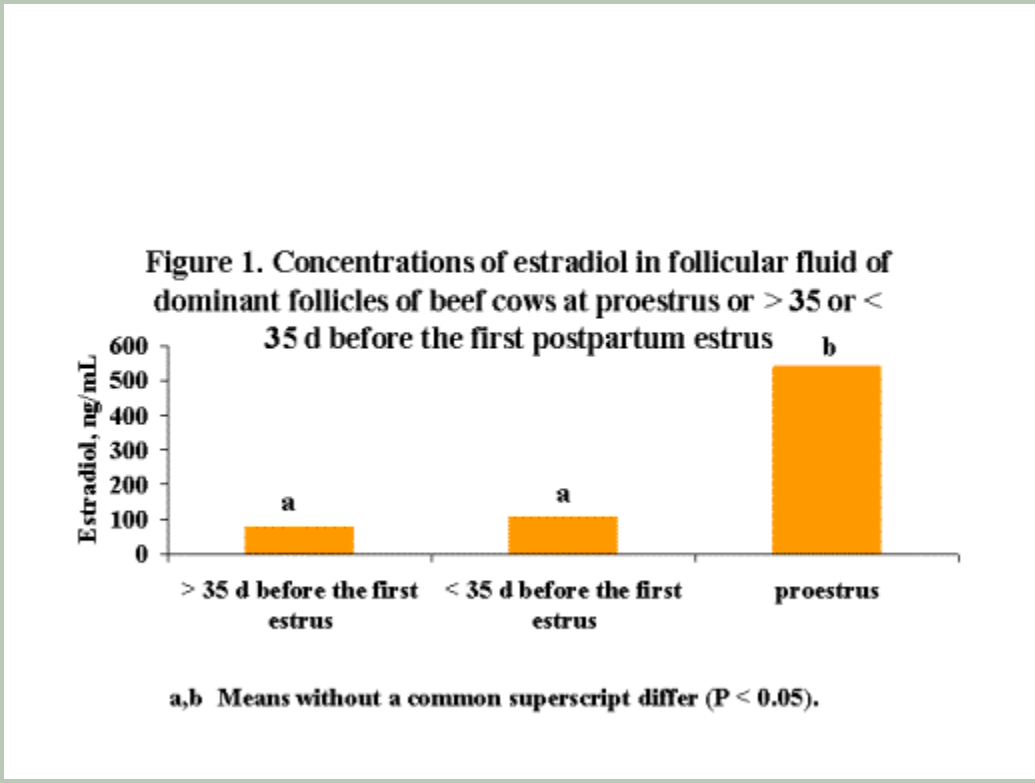
Table 1. Effects of stage postpartum on size of dominant follicle and concentrations of IGF-I in follicular fluid

	Stage Postpartum		
	> 35 d before the first estrus	< 35 d before the first estrus	proestrus
Cows, no	7	9	4
Days postpartum at aspiration, d	39 ± 4	41 ± 3	49 ± 5
Aspiration to estrus, d	56 ± 6[a]	20 ± 6[b]	-
Size of dominant follicle, mm	12.5 ± 0.6	13.4 ± 0.6	13.8 ± 0.8
Concentrations of IGF-I in follicular fluid, ng/mL	24.2 ± 4.0	24.6 ± 3.8	29.7 ± 5.7

[a,b] Means in a row without a common superscript differ (P<0.01).

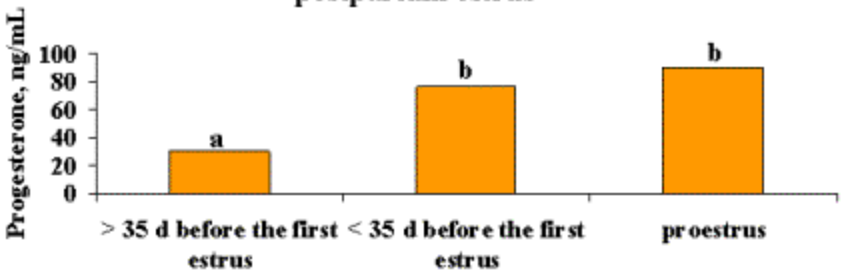
The similar intervals from aspiration until estrus for follicles aspirated on d 30 and 47 after calving could be the reason concentrations of hormones were similar in the follicles. Proestrous dominant follicles had fivefold greater concentration of estradiol in follicular fluid than follicles aspirated > 35 d or < 35 d before the first estrus (Figure 1; P<0.01). Similarly, large follicles recovered from cows at exsanguination had a fourfold increase in concentrations of estradiol from d 14 to 28 postpartum (Spicer et al., 1986). Estradiol causes the LH surge and ovulation of the dominant follicle. During anestrus, minimal estradiol synthesis from dominant follicles may not initiate an LH surge and ovulation. Insulin-like growth factor-I can regulate steroidogenesis

(see review by Spicer and Echternkamp, 1995), but dominant follicles from proestrous and anestrous cows had similar concentrations of IGF-I in follicular fluid (Table 1; P>0.1).



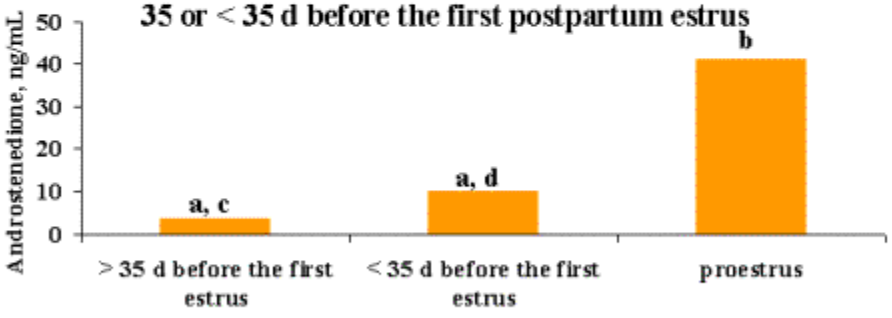
Progesterone and androstenedione are precursors for estradiol synthesis, and limited concentrations of these steroids may reduce estradiol in dominant follicles of anestrous cows. Dominant follicles < 35 d before the first estrus had greater concentrations of progesterone in follicular fluid (Figure 2; P<0.01) and tended to have greater concentrations of androstenedione (Figure 3; P=0.08) than follicles > 35 d before the first estrus. Dominant follicles < 35 d before the first estrus and at proestrus had similar concentrations of progesterone (Figure 2; P>0.1); however, concentrations of androstenedione were greatest at proestrus (Figure 3; P<0.01). Previously, Spicer et al. (1986) indicated that follicles had a threefold increase in concentration of progesterone from d 7 to 14, but no change in follicular fluid androstenedione from d 7 to 56 postpartum. In our study, ovaries were evaluated daily to identify the dominant follicle and ensure follicular fluid was collected at similar stages of follicle growth for all treatments; however, the previous report was conducted before ultrasound technology was available. An increase in progesterone production may be necessary before increased androstenedione production by the dominant follicle can be realized.

Figure 2. Concentrations of progesterone in follicular fluid of dominant follicles of beef cows at proestrus or > 35 or < 35 d before the first postpartum estrus



a,b Means without a common superscript differ (P < 0.05).

Figure 3. Concentrations of androstenedione in follicular fluid of dominant follicles of beef cows at proestrus or > 35 or < 35 d before the first postpartum estrus



a,b Means without a common superscript differ (P < 0.05).

c,d Means without a common superscript tended to differ (P = 0.08).

In conclusion, inadequate concentrations of androstenedione in dominant follicles of anestrous cows may limit estradiol synthesis. Only dominant follicles < 35 d before estrus had concentrations of progesterone in follicular fluid similar to proestrous follicles.

A better understanding of the mechanisms causing postpartum anestrus may allow the development of treatments and management decisions to decrease the length of the interval from calving to conception. Dominant follicles from anestrous cows had less estradiol, which could be due to less synthesis of precursor steroids including androstenedione. Cows that calve with a good body condition score have decreased postpartum anestrous intervals. Additional research is needed to determine if nutrition decreases the postpartum anestrous interval by altering steroid synthesis of dominant follicles.

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