Luteal Function and Reproductive Response in Suckled Beef Cows After Metestrus Administration of a Norgestomet Implant and Injection of Estradiol Valerate with Various Dosages of Injectable Norgestomet

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ABSTRACT: In an experiment replicated over 2 yr, 149 suckled beef cows were administered Syncro-Mate-B (SMB), a 6-mg Norgestomet (NOR) ear implant (in situ 9 d) in conjunction with an i.m. injection of 5 mg of estradiol valerate (EV), and either 3.0, 4.5, or 6.0 mg of NOR, 2 d after estrus. All cows were artificially inseminated at 48 h (timed insemination; TI) after implant removal (IR) and cows were reinseminated at any estrus subsequent to 24 h of TI through 30 d. Blood samples collected before treatment, every 3 d through IR, and at TI were assayed for progesterone (P4). At TI, 44, 39, and 12% of cows treated with 3.0, 4.5, or 6.0 mg of NOR, respectively, had serum concentrations of P4 > 1 ng/mL (3.0 and 4.5 mg vs 6.0 mg, P < .01). Fifty-eight, 63, and 84% of cows treated with 3.0, 4.5, or 6.0 mg of NOR, respectively, exhibited a synchronized (within 5 d of IR) estrus (3.0 and 4.5 mg vs 6.0 mg, P < .05). Pregnancy rates for the 5-d synchronized period were 38, 45, and 66% for cows treated with 3.0, 4.5, or 6.0 mg of NOR, respectively (3.0 and 4.5 mg vs 6.0 mg, P < .05). First-service pregnancy rates were 66, 71, and 79% for cows treated with 3.0, 4.5, or 6.0 mg of NOR, respectively (P > .10). Syncro-Mate-B with 6.0 mg of injectable NOR resulted in fewer cows with functional CL (i.e., P4 > 1 ng/mL at TI), more cows exhibiting estrus within 5 d of IR, and a higher 5-d pregnancy rate compared with SMB with 3.0 or 4.5 mg of injectable NOR.

Key Words: Beef Cows, Estrus Synchronization, Norgestomet

Introduction

Syncro-Mate-B (SMB; Ceva Laboratories, Overland Park, KS) has been used to synchronize estrus in heifers (Miksch et al., 1978; Spitzer et al., 1978; Brown et al., 1988) and suckled beef cows (Miksch et al., 1978; Kiser et al., 1980). However, decreased efficacy has been reported when SMB was administered during metestrus (Peters, 1984; McVey and Williams, 1989; Pratt et al., 1991). Standard Syncro-Mate-B consists of a 6-mg Norgestomet (NOR) ear implant (in situ 9 d) and i.m. injection of 3 mg of NOR and 5 mg of estradiol valerate (EV) at implant insertion.

Pratt et al. (1991) have shown corpus luteum (CL) regression to be 100% when SMB was administered to cows during diestrus (d 9) but only 48% when administered to cows during metestrus (d 3). Because luteolysis after estrogen administration is mediated through prostaglandin F2α (PGF2α; Hixon et al., 1983), and administration of PGF2α before d 5 of an estrous cycle is not effective for inhibition of luteal development (Lauderdale, 1972; Inskeep, 1973), injectable Norgestomet (Roussel Corp., Englewood Cliffs, NJ) may be essential to inhibit CL formation. Injections of progesterone

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after ovulation resulted in formation of CL that were poorly developed (Loy et al., 1980; Woody et al., 1967).

Our hypothesis for decreased effectiveness of SMB administered during metestrus is that a standard 3-mg dosage of injectable NOR is insufficient to inhibit CL formation and/or function. Objectives of this study were to determine whether increasing dosage of injectable NOR, administered during metestrus, would inhibit CL development and improve estrous and pregnancy responses.

**Materials and Methods**

Beginning 12 d before the breeding season (April 18), cows were observed for estrus at dawn and dusk for a minimum of 30 min and randomly assigned to treatment after estrus was detected. The experiment was replicated over 2 yr and 149 suckled Angus, Brangus, or Polled Hereford cows were used. Cows were stratified by breed, body condition score (Richards et al., 1986; Spitzer, 1986), BW, calving date (December 28 to March 26), and age (2 to 11 yr old) and were randomized to equally represent those variables among treatments. Two days after estrus (estrus = d 1), individual cows received a 6-mg NOR ear implant and an i.m. injection of 5 mg of EV in conjunction with various dosages (3.0, 4.5, or 6.0 mg) of NOR. Nine days after treatment, NOR implants were removed and cows were separated from calves for 48 h. Observations for estrus were again conducted at dawn and dusk for a minimum of 30 min. A synchronized estrous response was defined as a cow standing to be mounted within 5 d after implant removal (IR).

All cows were artificially inseminated 48 h after IR (timed insemination; TI) and cows were reinseminated 12 h after any subsequently observed estrus. Cows were inseminated over a 30-d period by two technicians randomly inseminating cows with semen from numerous bulls randomized among treatments. Fertile clean-up bulls were then joined with cows for an additional 30 d. Pregnancy rates were determined by palpation per rectum 45 d after AI and 55 d after the natural breeding period. First-service pregnancy rates could not be differentiated between TI and repeat insemination immediately subsequent to TI. Therefore, first-service pregnancy rates were defined as the percentage of cows observed in estrus during the 5-d synchronized period that became pregnant from AI.

Blood samples were collected by jugular venipuncture immediately before treatment and every 3 d through IR and at TI. Samples were allowed to clot and centrifuged within 2 h of collection (Breuel et al., 1988) at 2,500 × g at 4°C for 20 min. Serum was harvested and stored at −20°C until progesterone (P4) concentrations were determined using a direct, solid-phase RIA (Coat-A-Count, Progesterone Diagnostic Products, Los Angeles, CA) described by Plata et al. (1990). Percentage of binding of radiolabeled P4 to antibody-coated tubes in absence of unlabeled hormone was 46%. Antibody cross-reactivity was < 1% for NOR, pregnenolone, estradiol, testosterone, cortisol, and six other steroids. Sensitivity of the assay was 0.05 ng/mL and three serum pools had intra- and interassay CV of 3.9 and 15.8%, respectively, across five assays. Serum concentrations of P4 > 1 ng/mL were considered indicative of functional CL.

Effects of dosage of NOR on P4 concentrations were analyzed using ANOVA techniques and changes in P4 concentrations with time-series analysis (Steel and Torrie, 1960). Effects of dosage of NOR on CL function, synchronized estrous response, synchronized estrous distributions and first-service, 5-d synchronized period, and 60-d pregnancy rates were analyzed using chi-square analysis and contingency tables (Grizzle et al., 1969). Semen was from several collections of numerous bulls of various breeds. Preliminary analysis indicated that this source of variation, as well as variation between technicians, was nonsignificant. Thus, variation between technicians and variation among and within bulls was considered random error. All calculations were performed using the GLM and CATMOD® procedures of SAS (1988).

**Results**

Responses to treatment were not affected by breed, body condition, BW, calving date, or age. Mean serum concentrations of P4 before treatment (d 3 of estrous cycle) averaged 2 ng/mL for cows administered 3.0, 4.5, or 6.0 mg of NOR whether they exhibited a synchronized estrus or not (P > .10; Table 1). In nonsynchronized cows administered 3.0 or 4.5 mg of NOR, concentrations of P4 continued to increase (P < .05) through TI. However, concentrations of P4 in nonsynchronized cows administered 6.0 mg of NOR increased through IR (P < .05), then decreased (P < .05) from time of IR to TI. In synchronized cows, regardless of treatment, concentrations of P4 increased (P < .05) until d 3 after treatment, then declined (P < .05) through TI. Concentrations of P4 at TI for cows exhibiting or not exhibiting (P < .01) a synchronized estrus when administered 3.0, 4.5, or 6.0 mg of NOR were .7 and 3.3 ng/mL, .6 and 3.5 ng/mL,
and 3 and 1.9 ng/mL, respectively (Table 1). Concentrations of P₄ were uniformly lower for Replicate 1 than for Replicate 2 (P < .05). However, there was no treatment × replicate interaction (P > .10).

The 6.0-mg dosage of injectable NOR resulted in fewer cows with functional CL, as indicated by serum concentrations of P₄. Serum concentrations of P₄ at IR were > 1 ng/mL in 52, 45, and 24% of cows treated with 3.0, 4.5, or 6.0 mg of NOR, respectively (3.0 and 4.5 mg vs 6.0 mg, P < .05). Even at TI, serum concentrations of P₄ were > 1 ng/mL in 44, 39, and 12% of cows treated with 3.0, 4.5, or 6.0 mg of NOR, respectively (3.0 and 4.5 mg vs 6.0 mg, P < .01).

Twenty-four hours after IR, there were no differences among treatments in percentage of animals exhibiting estrus (P > .10, Figure 1). However, by 48 h after IR, 42, 47, and 66% of cows administered 3.0, 4.5, or 6.0 mg of NOR, respectively, exhibited estrus (3.0 mg vs 6.0 mg, P < .05). By 72 h after IR, 46, 49, and 74% of cows treated with 3.0, 4.5, or 6.0 mg of NOR, respectively, exhibited estrus (3.0 mg vs 6.0 mg, P < .05). By 96 h after IR, 46, 53, and 80% of cows administered 3.0, 4.5, or 6.0 mg of NOR, respectively, exhibited estrus (3.0 and 4.5 mg vs 6.0 mg, P < .05). Cumulative synchronized estrous response (5-d synchronized period [120 h after IR]) for cows treated with 3.0, 4.5, or 6.0 mg of NOR was 58, 63, and 84%, respectively (3.0 and 4.5 mg vs 6.0 mg, P < .05). A majority of cows (37 of 42) treated with 6.0 mg of NOR exhibited a synchronized estrus by 72 h after IR.

Inconsistencies were observed between CL function and synchronized estrous response. Of cows administered 3.0 mg of NOR, 28 of 50 cows had concentrations of P₄ < 1 ng/mL at TI. Four of those 28 cows did not exhibit a synchronized estrus. Of the 22 cows administered 3.0 mg of NOR that had concentrations of P₄ > 1 ng/mL at TI, five exhibited a synchronized estrus. Thirty of 49 cows administered 4.5 mg of NOR had concentrations of P₄ < 1 ng/mL at TI. Two of those 30 cows did not exhibit a synchronized estrus. Nineteen cows treated with 4.5 mg of NOR did not exhibit a synchronized estrus. Of those 19 cows, 14 exhibited estrus in some cycling cows seems to be a failure to prevent CL formation and endogenous secretion of P₄ when treatment is administered early in an estrous cycle (d 1 to 5). Pratt et al. (1991) observed that a standard 3.0-mg dosage of injectable NOR with 5 mg of EV and a NOR ear implant was 100%
effective in controlling CL function when administered on d 9 of an estrous cycle, but was only effective in controlling CL function in 48% of cows treated on d 3 of an estrous cycle. The 6.0-mg dosage of injectable NOR seems to enhance the ability of the SMB treatment to control CL function during metestrus.

The percentage of cows treated with 3.0 mg of NOR that had functional CL at time of IR was identical to the data of Pratt et al. (1991), who reported 52% functional CL at IR for cows treated with 3.0 mg of NOR during metestrus. The percentage of cows treated with 3.0 mg of NOR that had functional CL at time of TI was higher than the data of McVey and Williams (1989), who reported 23% functional CL at TI for cows treated with 3.0 mg of NOR early in an estrous cycle.

The 6.0-mg dosage of injectable NOR administered on d 3 of an estrous cycle possibly inhibited LH release (Chien, 1982), resulting in the demise of developing CL and the cessation of endogenous P₄ secretion. The 6.0-mg dosage of injectable NOR resulted in fewer cows with functional CL at IR and TI, which resulted in more cows responding with a synchronized estrus after IR and more cows pregnant to insemination at synchronized estrus.

Concentrations of P₄ in nonsynchronized cows were similar in pattern to those in normally cycling cows observed by Henricks et al. (1971, 1972) and Wettemann et al. (1972), suggesting that, in those cows, treatment was not effective for CL control. Concentrations of P₄ for synchronized cows increased until d 4 of treatment and then declined through TI, indicating that treatment resulted in CL demise and thus decreased P₄ production. Clearly, the 6.0-mg NOR treatment was more effective in decreasing endogenous P₄ than either 3.0 or 4.5 mg of NOR, which is in agreement with the results of others (Loy et al., 1960; Woody et al., 1967) who concluded that higher dosages of progestins were more effective in inhibiting CL function.

Synchronized estrous response was enhanced with the 6.0-mg dosage of injectable NOR. More cows (26 and 21 percentage point advantage) treated with 6.0 mg of NOR exhibited estrus within 5 d of IR than cows treated with 3.0 or 4.5 mg of NOR, respectively. A majority (37 of 42) of animals treated with 6.0 mg of NOR exhibited estrus by 72 h after IR. Synchronized estrous response for cows treated during metestrus with 3.0 mg of NOR was similar to synchronized estrus responses observed by Pratt et al. (1991).

A total of nine cows (3.0 mg = 5; 4.5 mg = 3; 6.0 mg = 1) had concentrations of P₄ > 1 ng/mL at TI and yet were in estrus on d 5 of the 5-d synchronized period. Because all cows were treated on d 3 of an estrous cycle with an implant in situ 9 d, allowing for a 5-d estrous response would place these cows at d 17 of their cycle. Some of these cows may have responded with spontaneous, rather than treatment-induced, estrus. Of these nine cows, all but one cow (3.0 mg of NOR) were pregnant from insemination at exhibited estrus.

Despite these inconsistencies, it is clear that the 6.0-mg dosage of injectable NOR is more effective than lower dosages of injectable NOR in inhibiting CL function. The 6.0-mg dosage of NOR resulted in enhanced 5-d pregnancy rates. This increase in 5-d pregnancy rates occurred as a result of more animals exhibiting estrus within the 5-d period. First-service pregnancy rates and pregnancy rates at the end of the 60-d breeding season were similar among treatments.
Implications

When administered to lactating beef cows during metestrus (2 d after estrus), a 6.0-mg injection of Norgestomet, in conjunction with estradiol valerate and the Norgestomet ear implant, resulted in 28% more synchronized pregnancies than the 3.0-mg injection of Norgestomet, in conjunction with estradiol valerate and the Norgestomet ear implant. This would result in more calves born early in the ensuing calving season, thereby increasing the total weight of calves weaned and increasing lifetime productivity.

Literature Cited


