Effect of administration of human chorionic gonadotropin after artificial insemination on concentrations of progesterone and conception rates in beef heifers[1,2]

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ABSTRACT: The objective of this study was to determine whether administration of hCG approximately 5 d after AI would increase plasma progesterone concentrations and conception rates in beef heifers. Heifers from two locations (Location 1: n = 347, BW = 367 ± 1.72 kg; Location 2: n = 246, BW = 408 ± 2.35 kg) received melengestrol acetate (0.5 mg·heifer^{-1}·d^{-1}) for 14 d and an injection of $PGF_{2\alpha}$ (25 mg i.m.) 19 d later. Heifers were observed for estrus continuously during daylight from d 0 to 4.5 after $PGF_{2\alpha}$ and artificially inseminated approximately 12 h after the onset of estrus. Half of the heifers inseminated at Location 1 were assigned randomly to receive an injection of hCG (3,333 IU i.m.) 8 d after $PGF_{2\alpha}$, and a blood sample was collected from all heifers 14 d after $PGF_{2\alpha}$ for progesterone analysis. Half of the heifers inseminated at Location 2 were administered hCG on d 9 after $PGF_{2\alpha}$, and a blood sample was collected from all heifers 17 d after $PGF_{2\alpha}$. Heifers at Location 1 had a 94% synchronization rate, exhibited estrus 2.45 ± 0.03 d after $PGF_{2\alpha}$, and received hCG 5.55 ± 0.03 d after AI. Heifers at Location 2 had an 85% synchronization rate, exhibited estrus 2.69 ± 0.03 d after $PGF_{2\alpha}$, and received hCG 6.31 ± 0.03 d after AI. Progesterone concentrations were greater ($P < 0.01$) for hCG-treated heifers than for controls at both locations (8.6 vs. 4.6 ng/mL for treatment vs. control at Location 1, and 11.2 vs. 5.6 ng/mL for treatment vs. control at Location 2). Pregnancy status was determined by ultrasound approximately 50 d after AI. Conception rates (65 vs. 70% for treatment vs. control, respectively) did not differ at Location 1. Conception rates tended ($P = 0.10$) to be increased with hCG treatment at Location 2 (61 vs. 50% for treatment vs. control, respectively). A second experiment was conducted with 180 heifers at a third location to determine the effects of hCG administration 6 d after timed insemination at approximately 60 h after $PGF_{2\alpha}$ in heifers synchronized as in Exp. 1. Pregnancy rate to timed AI did not differ between hCG-treated (62%) and control heifers (59%). Final pregnancy rate after timed AI and bull exposure (92%) was not affected by treatment. In summary, administration of hCG 5 to 6 d after AI did not improve conception or pregnancy rates at two out of three locations evaluated, suggesting insufficient progesterone is not a major factor contributing to early pregnancy failure in beef heifers.

Key Words: Beef Heifers, Human Chorionic Gonadotropin, Progesterone

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Introduction

Early embryonic mortality can lower overall pregnancy rates in a limited breeding season, resulting in calves being born later in the calving season that have lighter BW at weaning. Early embryonic mortality may be as high as 30%, with a majority of losses occurring between d 8 and 16 of gestation (Binelli et al., 2001). Establishment and maintenance of pregnancy are complex processes that require precise communication and synchrony between conceptus and dam. The role of progesterone is critical in these processes, and insufficient luteal activity has been associated with infertility in

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cattle (Wiebold, 1998). Low progesterone concentrations during early pregnancy may affect embryonic development and maternal recognition of pregnancy (Mann et al., 1999). Therefore, several strategies have been used to increase progesterone concentration after breeding (Binelli et al., 2001). Administration of hCG during the early luteal phase induces ovulation of the dominant follicle from the first follicular wave and results in the formation of an accessory corpus luteum (**CL**; Schmitt et al., 1996). The most dramatic effects of hCG administration on conception rates have been observed in dairy herds of low fertility (Santos et al., 2001). Our objective was to evaluate effects of administering hCG to beef heifers approximately 5 d after AI on plasma concentrations of progesterone and conception rates.

Materials and Methods

Experiment 1

Beef heifers, primarily of British breed composition (BCS = 5 to 6), from two locations (Location 1: n = 347, BW = 367 ± 1.72 kg; Location 2: n = 246, BW = 408 ± 2.35 kg) received melengestrol acetate (**MGA**; 0.5 mg·heifer^{-1}·d^{-1}) for 14 d and an i.m. injection of 25 mg of $PGF_{2\alpha}$ (dinoprost tromethamine [Lutalyse]; Pharmacia Animal Health, Kalamazoo, MI) 19 d later. Heifers were housed in a dry lot and fed MGA in a total mixed diet. Heifers were observed for estrus continuously during daylight from 0 to 4.5 d after $PGF_{2\alpha}$ injection, and artificially inseminated approximately 12 h after the onset of estrus. Approximately half (160 control and 165 hCG) the heifers inseminated at Location 1 were assigned randomly to receive an i.m. injection of 3,333 IU of hCG (Chorulon, Intervet, Inc., Millsboro, DE) 8 d after $PGF_{2\alpha}$, and a blood sample was collected from all heifers at this location 14 d after injection of $PGF_{2\alpha}$ for progesterone analysis. Approximately half (101 control and 109 hCG) the heifers inseminated at Location 2 were administered hCG on d 9 after $PGF_{2\alpha}$, and a blood sample was collected from all heifers 17 d after $PGF_{2\alpha}$ for progesterone analysis. Bulls were placed with heifers 10 d after the last AI and removed approximately 30 d later. Pregnancy status was determined by ultrasound approximately 50 and 80 d after AI to determine pregnancy rate to AI and final pregnancy rate.

An RIA consisting of antibody and I^{125}-labeled progesterone from ICN Pharmaceuticals, Inc. (Costa Mesa, CA), was used to determine circulating concentrations of progesterone in serum collected at 14 or 17 d after $PGF_{2\alpha}$ injection (Roberts and Jenkins, 2002). Two assays were run for samples from Location 1 and one assay was run for samples from Location 2. Average intraassay and interassay CV were 10 and 15%, respectively.

Differences in synchronization rates at each location were evaluated by χ^2. Differences in conception to AI and pregnancy rates (by AI or bull) of heifers that were artificially inseminated, time of estrus, and concentrations of progesterone were determined using GLM procedures (SAS Inst., Inc., Cary, NC). For all dependent variables except time of estrus, the model included treatment, location, and treatment × location. This model was selected because several factors were confounded by location, including AI technician, AI sire, bull, and time of hCG administration. Initial evaluations for differences in conception to AI and pregnancy rates, and concentrations of progesterone included day after PGF_2 injection when AI occurred or day after PGF_2 injection when serum was sampled as a covariate in the model for the respective response variables. These covariate terms did not account for variation in the response variables and were omitted from the final model.

Experiment 2

A second experiment was conducted at a third location to determine the effects of hCG administration 6 d after timed insemination in beef heifers. One hundred eighty beef heifers, approximately 14 mo of age and of primarily Angus breeding, were fed MGA (0.5 mg/d) for 14 d and given 25 mg of $PGF_{2\alpha}$ i.m. (dinoprost tromethamine [Prostamate]; Phoenix Scientific, St. Joseph, MO) 18.5 d later. Heifers were housed in a dry lot and fed MGA in a total mixed diet. All heifers were then time inseminated, beginning approximately 60 h after $PGF_{2\alpha}$, and then given an injection of GnRH (gonadorelin [OvaCyst]; Phoenix Scientific). Six days after AI, half the heifers were assigned randomly to receive 3,333 IU i.m. of hCG. Bulls were placed with heifers 10 d after AI for 45 d, and pregnancy was determined by ultrasound 47 and 85 d after AI.

Results and Discussion

Experiment 1

Heifers at Location 1 had a 94% synchronization rate, exhibited estrus 2.45 ± 0.03 d after $PGF_{2\alpha}$, and received hCG 5.55 ± 0.03 d after AI. Heifers at Location 2 had an 85% synchronization rate, exhibited estrus 2.69 ± 0.03 d after $PGF_{2\alpha}$, and received hCG 6.31 ± 0.03 d after AI. Heifers at Location 2 had a delayed estrous response compared with heifers at Location 1 ($P < 0.01$ for mean time from $PGF_{2\alpha}$ to estrus; Figure 1), and were therefore given hCG 1 d later than originally planned in an effort to target hCG administration 5 d after the peak AI period. Concentrations of progesterone were greater ($P < 0.01$) for hCG-treated heifers at both locations: 8.6 vs. 4.6 ng/mL for treatment vs. control at Location 1; and 11.2 vs. 5.6 ng/mL for treatment vs. control at Location 2. This finding is similar to results of Santos et al. (2001), who reported a 5 ng/mL increase in concentrations of progesterone in dairy cows given hCG 5 d after AI. Santos et al. (2001) collected blood samples 11 to 16 d after AI, which is within the time frame of

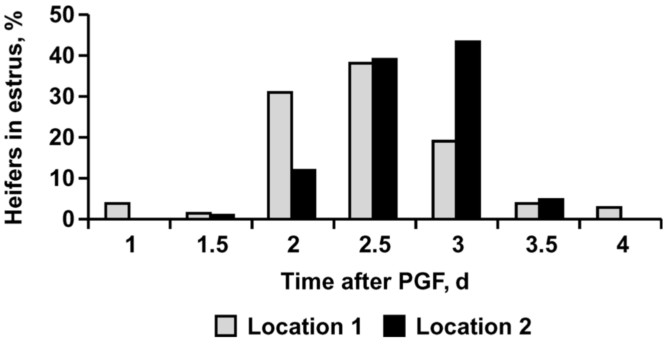

Figure 1. Percentage of heifers in estrus on each day after $PGF_{2\alpha}$ (PGF) injection for heifers exhibiting estrus at Location 1 and Location 2, in Exp. 1. Mean time from $PGF_{2\alpha}$ to estrus differed between locations, $P < 0.01$.

blood sample collection in the present study. Breuel et al. (1989) also reported increased concentrations of progesterone over the first 16 d of the estrous cycle in beef heifers administered hCG on d 4 or 7 of the estrous cycle (0.9 and 0.8 ng/mL, respectively). In a subsequent experiment, administration of hCG on d 4 of the prebreeding estrous cycle increased progesterone concentrations by 0.9 ng/mL over the first 16 d; however, progesterone concentrations were not affected by a second injection of hCG on d 4 after breeding. In the present study, there was no effect of hCG administration in relationship to days after AI on concentrations of progesterone at either location. Pregnancy status (AI or overall) was not affected by progesterone concentrations.

Conception rates were influenced ($P = 0.06$) by the treatment × location interaction. At Location 1, conception rate of hCG treatment (65%) and control (70%) groups did not differ, whereas conception rates at Location 2 tended to be influenced ($P = 0.10$) by hCG treatment (61%) compared with control (50%). Similarly, pregnancy rates of inseminated heifers after bull exposure tended to be influenced ($P = 0.09$) by the treatment × location interaction. At Location 1, pregnancy rate of hCG treatment (80%) and control (77%) groups did not differ, whereas pregnancy rates at Location 2 tended ($P = 0.10$) to be increased with hCG treatment (72%) compared with control (62%). Time of hCG administration in relation to day of AI did not affect conception rates, and the treatment × day interaction was not significant at either location. It has been previously reported that progesterone treatment increased fertility in herds with low fertility (Robinson et al., 1989; Van Cleef et al., 1991), which is generally consistent with the positive effect at the location with lower conception rates (Location 2) in the present study.

Experiment 2

Pregnancy rate to AI did not differ between hCG-treated (62%) and control heifers (59%), and final pregnancy rate (92%) was not affected by treatment. In addition, there were no pregnancy losses from the first to second pregnancy diagnosis for either treatment. It was hypothesized that hCG might be of more benefit in a timed AI protocol because it has been reported that induction of ovulation of follicles ≤12 mm resulted in the formation of luteal tissue with normal luteal life spans but decreased luteal function (Perry et al., 2002). The pregnancy rates in Exp. 2 were acceptable; therefore, it does not seem that decreased luteal function or embryonic mortality was a problem in these heifers.

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