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Theriogenology 78 (2012) 1578–1582

Theriogenology

www.theriojournal.com

Prostaglandin F2α promotes ovulation in prepubertal heifers

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Received 29 February 2012; received in revised form 27 June 2012; accepted 28 June 2012

Abstract

The objective was to determine the effects of exogenous prostaglandin $F_{2\alpha}$ (PGF), with or without progesterone treatment, on first ovulation in prepubertal heifers. We tested the hypothesis that PGF has a luteolysis-independent ovulatory effect in cattle. Crossbred Angus heifers (12 to 14 mo old, 250 kg body weight, and an average body condition score of 3 out of 5) were examined by transrectal ultrasonography on two occasions, 11 days apart. Heifers in which a CL was not detected at either examination were considered prepubertal. Heifers were assigned randomly to three experimental groups: (1) PG group (N = 14); heifers were treated with a PGF analog (500 μg cloprostenol im) 5 days after the emergence of a spontaneous (i.e., naturally occurring, noninduced) follicular wave; (2) PPG group (N = 12); heifers were given an intravaginal progesterone-releasing insert (CIDR; Pfizer Animal Health, Montreal, QC, Canada), and a follicular wave was induced with 50 mg of progesterone + 2 mg of estradiol benzoate im, and a PGF analog was given at the time of CIDR removal, on Day 5 of the follicular wave (on average, 8.6 ± 0.5 days after CIDR insertion); and (3) control group heifers were given no treatment (N = 14). Heifers were examined daily by transrectal ultrasonography from the start of the experiment to confirmation that ovulation had occurred, or to 5 days after PGF injection (PG and PPG groups) or until dominant follicles of the next follicular wave reached 8 mm (control group). The percentage of heifers that ovulated within 10 days after wave emergence was higher in PPG (10/12; 83.3%) and PG (11/14; 78.5%) groups than in control (1/14; 7.1%; $P < 0.0001$). Ovulations occurred 69.6 ± 6 h and 93.8 ± 5 h after PGF treatment in PPG and in PG groups, respectively, whereas only one heifer in the control group ovulated 96 h after Day 5 of follicular wave ($P = 0.13$). In summary, PGF treatment was associated with ovulation in prepubertal heifers whether or not exogenous progesterone was used as a pretreatment. The hypothesis that PGF will induce ovulation by a luteolysis-independent mechanism was supported.

Keywords: Prostaglandin $F_{2\alpha}$; Follicular development; Progesterone; *Bos taurus*; Ovulation

1. Introduction

In beef cattle production systems, heifers that reach puberty early are more likely to become pregnant in their first breeding season [1,2], and have a higher lifetime productivity. Therefore, early puberty increases the profitability of cattle production. In that regard, onset of puberty can be hastened with exogenous progestins that modulate LH pulse frequency [3]. Exogenous progesterone acts by decreasing the number of hypothalamic estradiol receptors, resulting in increased LH pulse frequency after cessation of progesterone treatment [3,4]. In association with progesterone, most estrus synchronization hormonal

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0093-691X/$ – see front matter © 2012 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.theriogenology.2012.06.030

treatment protocols in cattle use prostaglandin $F_{2\alpha}$ (PGF) to regress the functional CL.

Prostaglandin $F_{2\alpha}$ is a biologically potent substance with multiple applications in the control of reproduction. In cattle, the most common uses are based on its luteolytic properties (i.e., estrus synchronization, regression of persistent CL, and induction of abortion or parturition) [5]. Although PGF (and its analogues) are primarily used as luteolysins, they have also been reported to affect ovulation, implantation, pregnancy maintenance, and postpartum physiology [6]. One possible mechanism of ovulation induction by PGF is by increasing pituitary responsiveness to GnRH, thereby increasing LH release in postpartum cows and prepubertal heifers [7]. Furthermore, experimental evidence in cattle indicates that during the periovulatory period, intrafollicular prostaglandin is essential for the process of ovulation [8]. Although the ovulatory effect of PGF in association with progesterone treatment or follicular aspiration has been demonstrated [9], apparently no studies have been published demonstrating whether PGF per se can induce ovulation in prepubertal heifers.

The present investigation was designed to determine if it is possible to induce ovulation in prepubertal heifers (in the absence of a functional CL) with an injection of exogenous PGF, with or without pretreatment with exogenous progesterone. We tested the hypothesis that treatment with PGF near the end of the growing phase of the dominant follicle induces ovulation by a luteolysis-independent mechanism in prepubertal heifers.

2. Materials and methods

The Committee for Ethics in Animal Experimentation from the Universidade Federal de Santa Maria approved all procedures performed in this experiment.

2.1. Animal treatments and ultrasonographic examinations

Forty prepubertal beef heifers (*Bos taurus*; Red Angus crosses) were used. The heifers were 12 to 14 mo of age, 240 to 270 kg body weight, average body condition score of 3 out of 5, and were maintained at 30° 08'27''S and 53° 21'04'' W on native pasture with free access to water and mineralized salt.

Before the beginning of the experiment, ovaries of the heifers were examined by transrectal ultrasonography on two occasions, 11 days apart, to confirm that the heifers were prepubertal (i.e., absence of CL at both examinations).

Prepubertal heifers were assigned randomly among three groups: (1) PG group (N = 14): 500 μg of PGF analogue (cloprostenol; Ciosin, Schering-Plough Animal Health Ind. Com., Ltda., Campinas, SP, Brazil) was given im 5 days after emergence (Day 0) of a spontaneous follicular wave (i.e., heifers were monitored daily by ultrasonography and treatment was given on Day 5 of a naturally occurring follicular wave); (2) PPG group (N = 12): an intravaginal progesterone-releasing device (CIDR, 1.9 g progesterone; Pfizer Animal Health, Montreal, QC, Canada) was placed in the vagina, 50 mg progesterone (Progesterona Rio de Janeiro, Laboratório Allignani Hnos SRL, Santa Fé, Argentina) and 2 mg of estradiol benzoate (Estrogin, Farmavet, São Paulo, SP, Brasil) were administered im at the same time to induce emergence of a new follicular wave (Day 0); 500 μg PGF im was given at the time of CIDR removal, on Day 5 of the follicular wave; and (3) control group (N = 14): no treatment was given, but heifers were monitored daily by transrectal ultrasonography as in the other two groups. Ultrasonographic examinations were conducted daily from the beginning of the experiment to ovulation (all groups) or, in the absence of ovulation, up to 5 days after the PGF injection (PG and PPG groups), or until detection of a dominant follicle > 8 mm in diameter of the subsequent follicular wave in the control group. In heifers that ovulated, three ultrasonographic examinations were performed (7, 10, and 14 days after ovulation) to determine CL diameter.

2.2. Definitions

Heifers were examined daily by transrectal ultrasonography with a Honda HS-1500V (Toyohashi, Aichi, Japan) B-mode scanner with a 7.5 MHz linear-array transducer. At each examination, the diameter and location of all follicles > 4 mm in diameter were recorded. The day of wave emergence, defined as the day when the dominant follicle of a wave was first recorded (4 to 5 mm in diameter) with a concurrent increase in 4 mm follicles, was determined retrospectively and designated as Day 0. Ovulation was defined as the disappearance of a previously identified follicle > 8 mm in diameter [10]. On average, heifers were examined ultrasonographically for 8.6 ± 0.5 days to detect Day 5 of the follicular wave, coinciding with the period that CIDRs were kept in the vagina in PPG group.

2.3. Statistical analyses

Proportions with dichotomus outcomes, such as ovulation (yes/no) and the presence of CL at 7, 10, and