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Effect of Method of Estrous Synchronization on Oocyte Quality and Follicular Insulin-Like Growth Factor (IGF-I)

Thomas H. Wise and Ralph R. Maurer

Introduction

Of the two methodologies utilized in the beef industry to synchronize animals to estrus (prostaglandin regression of the corpus luteum or implanting/progestin which results in estrus 48-60 hr after implant removal), conception and fertility are generally lower in progestin synchronization to estrus. Both technologies produce comparable results in relation to estrus and ovulation. Alterations in steroidal hormones of the follicle (progestrone/estradiol) are important in the maturation and quality of oocytes. Insulin-like growth factor (IGF-I) which can regulate follicular progesterone concentrations, may have a role in oocyte maturation and viability. Circulating progesterone concentrations alter luteinizing hormone (LH) pulse frequency and amplitude and possible oocyte maturation as LH is the primary hormonal initiation of the ovulatory process. The objectives of this study were to monitor the difference in oocyte quality and follicular steroids in relation to the two methods of estrous synchronization.

Procedure

Crossbred heifers were synchronized to estrus with three methods consisting of 1) prostaglandin-induced corpora lutea regression (Lutalyse, 25 mg and 10 mg, 6 hr apart, n = 30); 2) silastic progestin implants for 8 days (Norgestomet, days 7-9 of estrous cycle), which upon removal results in estrus (n = 30), and 3) prostaglandin-synchronized animals that were administrated a silastic progestin implant 12 hr prior to prostaglandin injection (n = 25). All animals were superovulated with follicle stimulating hormone (FSH) administered 4, 2, 2, and 2 mg twice daily starting on day 10 of the estrous cycle. Prostaglandins were administered 60 hr after the initial FSH injection. Animals were ovariectomized (n = 5-8/time) at 12, 36, 48, 60, and 72 hr after prostaglandin injection or implant removal. Follicles were measured for size and number on the ovary, follicular fluid collected, and oocytes removed from follicular fluid. Follicular fluid was analyzed for IGF-I, estradiol, and progesterone, and oocytes were evaluated for developmental stage and quality.

Results

Analysis of follicular fluid hormones and oocyte quality (n = 1604) showed differences due to method of estrous synchronization. In Figure 1, the progesterone concentrations in small- (≤ 4 mm diameter), medium- (> 4 and < 8 mm diameter), and large-size follicles (≥ 8 mm diameter) of the three treatments over the estrual period are shown. There are significant differences between the prostaglandin-synchronized animals (Fig. 1a) and progesterin-synchronized animals (Fig. 1b) not only in overall concentrations but also in medium- and large-size follicles in which the prostaglandin synchronized heifers have considerably more follicular progestins (p<.01). In the third treatment in which the LH surge was suppressed with a progestin implant administered 12 hr prior to the prostaglandin, follicular progesterone concentrations remained low until 50-70 hr, indicating luteinization of unovulated follicles. Follicular estradiol changes are depicted in Figure 2. Animals receiving prostaglandin for estrous synchronization had increased estradiol concentrations, particularly at the time of the LH surge (40-60 hr), which initiates the ovulatory process and oocyte maturation (Fig. 2a). Animals that were progestin synchronized (Fig. 2b) or received a progestin implant in conjunction with prostaglandin injections (Fig. 2c) had low and comparable follicular estradiol levels. Low follicular concentrations of follicular estradiol at the time of the LH surge (40-60 hr) indicate some interference with the normal LH stimulation that accompanies follicular development/ovulation in these two treatment groups. Follicular fluid concentrations of IGF-I decreased with an increase in follicular size and time of the estrual period (p<.05). IGF-I concentrations are also increased in progesterin-synchronized animals at 12 hr post prostaglandin as compared to progestin-synchronized animals (Fig. 3a, 3b). Differences in oocyte quality as percent degenerate are depicted in Figure 4. In the progesterin-synchronized animals at 12 hr into the estrual period, 81.6 ± 4.7% of the oocytes were degenerate (Fig. 4b) as compared to progesterin-synchronized treatment in which only 29.9 ± 3.9% were degenerate (Fig. 4a). From 24-60 hr, all treatments were comparable in relation to oocyte viability but by 72 hr both the progestin synchronized and the progesterin synchronized that received a progestin implant had increased degenerate oocytes (28.0 ± 2.3 and 36.8 ± 4.2, respectively; p<.05).

Discussion

Differences in follicular hormonal concentrations and oocyte quality indicate that progestin-synchronized animals are responding differently at the ovarian level to the method of estrous synchronization, which may relate to differences in later fertility. Indications are that LH, a prerequisite for ovarian stimulation, steroidogenesis, and oocyte development, may be altered in progestin-synchronized animals as indicated by the lowered follicular progesterone concentrations (Fig. 1), altered estradiol concentrations (Fig. 2), and the increased numbers of degenerate oocytes detected early and late in the estrual period in progestin-synchronized animals (Fig. 4). Changes in IGF-I in progesterin-synchronized animals indicate an asynchrony of the endocrine events that may also produce oocytes of poor quality and later lowered fertility.

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Figure 1 – Follicular fluid changes in progesterone concentration by follicle size during the estrual period in prostaglandin-synchronized animals (a), SynchroMate B progestin synchronized (b), and prostaglandin-synchronized animals that were administered a progestin implant 12 hr before prostaglandin injection (c).

Figure 2 – Follicular fluid changes in estradiol concentration by follicle size during the estrual period in prostaglandin-synchronized animals (a), SynchroMate B progestin synchronized (b), and prostaglandin-synchronized animals that were administered a progestin implant 12 hr before prostaglandin injection (c).
Figure 3 – Follicular fluid changes in insulin-like growth factor (IGF-I) concentration by follicle size during the estrual period in prostaglandin-synchronized animals (a), SynchroMate B progestin synchronized (b), and prostaglandin-synchronized animals that were administered a progestin implant 12 hr before prostaglandin injection (c).

Figure 4 – Percentage of degenerate oocytes by follicular size during the estrual period in prostaglandin-synchronized animals (a), SynchroMate B progestin synchronized (b), and prostaglandin-synchronized animals that were administered a progestin implant 12 h before prostaglandin injection (c).