Uterine contraction patterns and fertility in early postpartum ewes

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Abstract

Three experiments were conducted to determine: (1) the direction of uterine contractions in Days 32 and 52 postpartum ewes (Experiment 1); (2) the effect of PGF2α on direction of uterine contractions (Experiment 2); and (3) the effect of PGF2α on fertility rates in Day 32 postpartum ewes (Experiment 3). In Experiment 1, non-lambing (>90 days postpartum) and lambing ewes (day of lambing = Day 0) received medroxyprogesterone acetate (MAP) vaginal sponges for 8 days and 500 IU of eCG at sponge withdrawal (Days 30 or 50 postpartum). At the time of eCG injection, ewes were divided into the following groups: (1) non-lambing (control; n=29); (2) Day 32 postpartum dry (n=15) and lactating (n=16); and (3) Day 52 postpartum dry (n=14) and lactating (n=16). At estrus or 60 h post-eCG, the uterus was exteriorized through a mid-ventral incision, and the origin and direction of uterine contractions were recorded for 10 min. In Experiment 2, ewes received MAP sponges on Day 16 postpartum followed by 500 IU of eCG on day of sponge removal (Day 30). At estrus, the ewes were divided into the following treatments: (1) two injections of saline 4 h apart (n=10) and (2) 12.5 mg of PGF2α followed by another 12.5 mg 4 h later (n=7). After the second injection, ewes were laparotomized and uterine contractions were counted. In Experiment 3, estrus was induced in postpartum ewes, and ewes were mated to two rams, then received the same two treatments as described in Experiment 2 (ram+saline; n=32 and ram+PGF2α; n=28). Two days following mating, ewes were laparotomized and the oviducts flushed for recovery of ova. In Experiment 1, lactational status had no effect, therefore, the data were pooled. Control ewes had a greater percentage (p<0.05) of uterine contractions (69%) moving towards the oviducts than did Day 32 (8%) or Day 52 (43%) ewes. In Experiment 2, PGF2α treatment increased the proportion of contractions (p<0.05) moving toward the oviducts (controls 16%, PGF2α 42%). Number of PGF2α-treated ewes (Experiment 3) with fertilized ova were not significantly different from the control ewes (5/32 versus 2/28, respectively). In conclusion, it can be said that the direction of uterine contractions moving toward the oviducts increased as the postpartum interval progressed or if they received PGF2α injection. PGF2α treatment did not improve fertility rates in Day 32 postpartum ewes. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

In an estrous ewe the majority of uterine contractions originate from the caudal part of the uterine horn and move cranially (Hawk, 1973; Hawk and Echternkamp, 1973). This contraction pattern has been associated with the rapid transport of sperm to the oviducts (Hawk, 1983). It is not known if the direction of uterine contractions are the same in ewes at an induced
estrous during the early postpartum period. Ewes bred at an induced estrus 32 days after lambing have poor fertility (10%). Fertility improves as lambing to breeding interval increases with an 80% conception rate on Day 52 postpartum (Warren et al., 1989). The low fertility observed in ewes during the early postpartum period has been associated with poor sperm transport (Warren et al., 1989).

In rabbits, prostaglandin F$_2$α (PGF$_2$α) injected near the time of insemination increased the sperm numbers in the oviducts of the reproductive tract 2–3 h later (Hawk et al., 1982). In cycling ewes, injections of PGF$_2$α increased both frequency and strength of uterine contractions as measured by a physiograph (Hawk and Conley, 1985). Edquist et al. (1975) and Gustafsson (1978) injected PGF$_2$α into ewes at the time of insemination and found more sperm in the oviducts of treated than of control ewes 16 or 24 h later. Dimov and Georgiev (1977) demonstrated that the addition of PGF$_2$α, and prostaglandin E$_2$ to diluted ram semen increased fertility by more than 15%.

To achieve two lamb crops in 1 year, acceptable fertility rates must be obtained within 30–35 days after lambing. It appears that sperm transport to the site of fertilization is minimal in 32 days postpartum ewes. Therefore, factors that could influence sperm transport such as direction of uterine contractions and the effect of PGF$_2$α on uterine contractions and fertility need to be evaluated. The following experiments were designed to: (1) determine the pattern of uterine contractions of Days 32 and 52 postpartum ewes, compared to non-lambing controls; (2) evaluate the effect of PGF$_2$α on direction of uterine contractions in the postpartum ewe and (3) determine the effect of PGF$_2$α on fertility in Day 32 postpartum ewes bred during the anestrous and estrous seasons.

2. Materials and methods

2.1. Animals

Hampshire × Suffolk cross ewes (n=202) ranging in age from 2 to 5 years were maintained in a dry lot with access to a barn with an open southern exposure. Ewes were fed a 12% CP corn–soybean meal ration (0.25 kg per ewe per day) plus orchard/grass hay ad libitum. The experiments were conducted in the Midwestern region of the United States near Jefferson City, MO, located at 38°N latitude, 94°W longitude and at a geographical altitude of 168 m.

2.2. Experiment 1

Ewes from June and July lambing, and non-lambing ewes (controls; at least 90–120 days from last lambing; n=29) were used for the study. Beginning on Days 22 or 42 postpartum (day of lambing=0) ewes received a 40 mg medroxyprogesterone acetate (MAP; Intervet, Holland) impregnated vaginal sponge for 8 days. At sponge removal ewes were injected with 500 IU eCG (Intervet, Holland). Estrus was induced in controls using the same procedure except the time that treatment was initiated was no earlier than 90–120 days postpartum. Ewes were randomly assigned within postpartum days into the following groups: (1) Day 32 postpartum dry (n=15) and postpartum lactating (n=16) and (2) Day 52 postpartum dry (n=14) and postpartum lactating (n=16). Postpartum dry ewes either lost their lambs at birth or had their lambs weaned at Day 10 postpartum. Lactating ewes had their lambs with them throughout the experiment. At estrus or 60 h post-eCG (whichever came first), ewes were anesthetized with 20 mg of pentobarbital sodium, placed in dorsal recumbency on a surgical table, and the uterus exteriorized through a mid-ventral incision. Uterine contractions were observed using the procedure of Hawk (1975). Three minutes after the uterus was exteriorized, the origin and direction of movement of uterine contractions was recorded during a 10 min interval (by an observer for each horn). Contraction were recorded as originating either in the caudal, middle or cranial one-third of the uterine horn. Direction of contraction was recorded as either moving toward the oviduct, toward the cervix, in both directions, or no movement. The uterus was not moistened during the period of observation to prevent stimulus-induced contractions. Drying of the serosa was not observed.

The initial analysis was a 2×2 factorial arrangement with two treatments (Days 32 and 52 postpartum) and two different lactation states (lactating and non-lactating). Dependent variables tested in the model were direction and origin of uterine contractions. There was no effect of lactational status, therefore the data were reanalyzed as a one-way analysis of
variance (ANOVA) with three treatments: controls, Day 32 postpartum and Day 52 postpartum ewes. Least square means were performed to determine differences between specific treatments (SAS, 1988). Percentage of ewes exhibiting estrus, was determined by chi-square (SAS, 1988).

2.3. Experiment 2

Ewes \((n=17)\) which lambed in September and October each received a vaginal MAP sponge on Day 16 postpartum (day of lambing = Day 0) followed by 500 IU of eCG on day of sponge removal (Day 30). At estrus, the ewes were divided into the following treatment groups: (1) controls received two injections of 0.9% saline (2.5 ml each) 4 h apart \((n=10)\) and (2) PGF\(_{2\alpha}\)-treated ewes \((n=7)\) received two injections (each injection 12.5 mg) of PGF\(_{2\alpha}\) 4 h apart (Lutalyse, Pharmacia & UpJohn Co., Kalamazoo, MI, USA).

Immediately following the second injection, ewes were laparotomized and uterine contractions were recorded in each horn for a 10 min period as described in Experiment 1. Differences between treatments in direction of uterine contractions were determined in ANOVA (SAS, 1988).

2.4. Experiment 3

Postpartum ewes \((n=20)\) which lambed in September and October, and postpartum ewes \((n=40)\) which lambed in February and March, received a vaginal MAP sponge on Day 16 postpartum (day of lambing = Day 0) and 750 IU eCG at the time of sponge removal on Day 30 postpartum. Ewes that were 90–120 days since last lambing \((n=15,\) anestrous season; \(n=20,\) estrous season) were mated at an induced estrus (received a MAP sponge for 14 days plus 750 IU eCG at sponge removal) and allowed to lamb to determine fertility of rams. Ewes were checked for estrus twice daily with a vasectomized ram. At estrus, postpartum ewes were randomly assigned to two treatment groups: (1) ram+saline, which were mated by two fertile rams during a 10 min period and given an injection of 2.5 ml of 0.9% saline after mating and an additional 12.5 mg injection 4 h later \((n=32)\). Two days following estrus, postpartum ewes were laparotomized and the oviduct adjacent to the ovary containing the corpus luteum was flushed for ova. Ova were evaluated for cleavage under a phase contrast microscope.

The initial design was a 2\(\times\)2 factorial arrangement with two treatments (ram+saline and ram+PGF\(_{2\alpha}\)) and two seasons (fall and spring). There was no effect of season, therefore, the data were pooled and reanalyzed as ANOVA with two treatments (ram+saline and ram+PGF\(_{2\alpha}\)) using the General Linear Models Procedure of SAS (SAS, 1988).

3. Results

3.1. Experiment 1

Percentage of ewes exhibiting estrus was similar among controls, Days 32 and 52 ewes (69, 55 and 50%), respectively. Mean number of uterine contractions moving toward the oviducts was greater \((p<0.05)\) for the control ewes than the Days 32 or 52 ewes (Table 1). Day 52 ewes had more contractions \((p<0.05)\) moving towards the oviducts than Day 32 ewes. There were more uterine contractions moving towards the cervix of Day 32 ewes than in Day 52 ewes.

For the control ewes, origin of contractions was equally divided among the caudal, middle and cranial portions of the uterine horn (Table 1). The majority (76%) of the uterine contractions originated from the cranial part of the uterus and moved towards the cervix in Day 32 ewes, whereas only 51% of uterine contractions originated in the cranial part of the uterus and moved toward the cervix in Day 52 ewes (Table 1).

3.2. Experiment 2

Since there were no differences among treatments in number of uterine contractions moving both ways in Experiment 1, only contractions moving towards or away from oviducts were recorded in this experiment. There was no significant difference in the number or direction of contractions between uterine horns, so the data recorded were pooled. Percentage of ewes exhibiting estrus was 100% in both treatment groups.
aPGF2α-treated ewes had more (p<0.05) contractions moving towards the oviducts than did the controls (Table 2). The percentage of contractions moving toward the cervix was 58% (p<0.05) for PGF2α-treated ewes compared to 84% in the controls.

### 3.3. Experiment 3

The percentage of ewes exhibiting estrus was 100% in all treatment groups. The percentage of ewes lambing was 66% for controls (90–120 days since last lambing) indicating normal fertility of rams used in this study. PGF2α treatment of Day 32 postpartum ewes did not improve fertility (Table 3).

### 4. Discussion

Some reports have suggested that the uterus has completed involution in ewes by 30 days after lambing (a review by Kiracofe, 1980). However, histological evaluation of the luminal contents and endometrium at this time revealed that the number of lymphocytes and plasma cells exceeded those found in control ewes (Akinbami, 1989). The amount of uterine debris and leukocytes decreases as the time from lambing increases, with a corresponding increase in contractions moving from the cervix to the oviducts, and an increase in fertility rate.
This is supported by data demonstrating that placement of intrauterine devices (IUD) into the uterine horn of estrous ewes causes contraction patterns similar to Day 32 postpartum ewes. This reversal of direction of contractions with IUD resulted in a reduced number of sperm in the oviducts and is associated with loss of fertility (Hawk, 1967, 1969). Once the device is removed, direction of contractions move from the cervix to the oviduct and fertility is restored.

PGF$_{2\alpha}$ was injected in an attempt to change direction of contractions in Day 32 postpartum ewes. Although PGF$_{2\alpha}$ increased the number of uterine contractions moving towards the oviducts, there was no improvement in fertility. Even with the change in direction of contractions, sperm may not have been transported in large enough numbers to the oviducts for fertilization to take place (Hunter and Nichol, 1983). The effect of changing the direction of uterine contractions on the number of sperm actually reaching the site of fertilization was not determined in the present experiment. It seems unlikely, however, that PGF$_{2\alpha}$ successfully increased the number of sperm at the ampullary-isthmus junction because surgical deposition of semen at this site significantly improved fertility in Day 32 postpartum ewes (Warren et al., 1989). Even if the change in direction of uterine contractions by PGF$_{2\alpha}$ resulted in more sperm moving towards the site of fertilization, they were probably destroyed in the uterus before reaching the site. This is thought possible because of the higher number of leukocytes found in the Day 32 postpartum uterus (Akinbami, 1989) and leukocytes are one of the two major causes for loss of sperm (Bedford, 1965; Mattner, 1968). The adverse uterine environment at this postpartum stage is further illustrated by Akinbami et al. (1996) and Wallace et al. (1989) who demonstrated that embryos migrating into the uterine horn have poor survival rate early postpartum. Future treatments to improve fertility may need to be focused more on improving the uterine environment rather than direction of uterine contractions.

5. Conclusion

The high proportion of uterine contractions originating near the oviducts and moving toward the cervix in Day 32 postpartum ewes could be one cause for the poor fertility in ewes bred during the postpartum period. Although direction of uterine contractions could be reversed with PGF$_{2\alpha}$ injections, there was no improvement in fertility. Evaluating factors that cause low fertility during the early postpartum period may result in methods to improve fertility at this stage.

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References


