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Effects of prostaglandin administration on ovarian follicular dynamics, conception, prolificacy, and fecundity in sheep

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Abstract

Two experiments were conducted to determine the effects of prostaglandin administration on ovarian follicular dynamics, conception, prolificacy, and fecundity in sheep. During the breeding season, multiparous Corriedale ewes were randomly allocated to two groups: 1) PG group (n = 15 and n = 135 in Experiments I and II, respectively): synchronized with two injections of DL-Cloprostenol (125 μg) given 7 d apart, and inseminated at a fixed time (Day 0), 48 h after the second injection; and 2) Control group (n = 15 and n = 73 in Experiments I and II): ewes in spontaneous estrus inseminated at detected estrus. Ewes received 100×10^6 sperm by intrauterine AI. Ultrasonography was used to evaluate growth of the ovulatory follicle, ovulation rate (OR), conception rate, and prolificacy on Days 30 and 60. Ewes from the group PG had a larger (4.8 ± 0.5 mm, mean ± SEM; $P < 0.05$) ovulatory follicle that grew faster (1.2 ± 0.3 mm/d, $P = 0.08$), and a lower OR (1.37 ± 0.1, $P < 0.05$), compared to ewes from the Control group (3.9 ± 0.2 mm, 0.7 ± 0.2 mm/d, and 1.61 ± 0.1 respectively). Plasma progesterone concentrations from Days −6 to 1 were lower in the PG group ($P < 0.05$), but plasma estradiol concentrations were similar between groups ($P > 0.05$). Progesterone concentrations were similar between groups during the early luteal phase and on Days 12 and 17 ($P > 0.05$). The embryo recovery rate (Day 7) tended to be lower in the PG group (39 vs 64%, $P = 0.08$), but embryo quality did not differ between groups. Conception, prolificacy and fecundity, were lower in the PG than in the Control group ($P < 0.05$). Cumulative reproductive losses were similar between groups, but more twins were lost in the PG group ($P < 0.05$). We concluded that in ewes synchronized with $PGF_{2\alpha}$ given twice, 7 d apart, lower reproductive performance was associated with an environment dominated by lower progesterone concentrations that stimulated the preovulatory follicle to grow faster and become larger; this was associated with lower rates of ovulation, conception, prolificacy, and fecundity.

Keywords: Ovulatory follicle; Timed artificial insemination; Embryo loss; Reproductive performance; Ewe

1. Introduction

Timed artificial insemination (TAI) is a practical tool in genetic programs, but requires hormonal treatments to ensure synchronized ovulation and acceptable pregnancy rates. Until the development of a synchronization protocol that included two injections of prostaglandin ($PGF_{2\alpha}$) 7 d apart (Synchrovine®), TAI of ewes with $PGF_{2\alpha}$ protocols was not viable [1,2]. Although this protocol induced good synchrony of estrus and ovulation, fertility was poor [3]. Despite substantial research to identify reproductive losses in ewes syn-

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chronized with $PGF_{2\alpha}$, the cause and timing of loss remained unclear [4–8]. The poor fertility in $PGF_{2\alpha}$-synchronized ewes was associated with alterations in the steroidogenic capacity of the ovulatory follicle [9]. Steroids prepare the oviducts and uterus for fertilization and embryo transport, inducing appropriate muscular contractions to improve fertility [10,11].

Follicles induced to ovulate following $PGF_{2\alpha}$ treatment developed into a CL that secreted less progesterone (P4) [9], which may be insufficient to stimulate embryo development and interferon tau production, thereby compromising maternal recognition of pregnancy [12]. Conception and fertilization rates were often decreased in ewes synchronized with $PGF_{2\alpha}$, compared to the classical protocol of progestagens plus eCG [4,5,13,14]; however, in other studies, fertilization rates were not affected [15,16]. Data on the number of embryos recovered and their quality were contradictory. Mutiga and Baker [13] and Gonzalez-Bulnes et al [16] reported similar recovery rates, conversely Schiewe et al [17] reported reduced recovery rates in $PGF_{2\alpha}$-treated ewes. Hawk [15] found no differences in embryo quality (number of cells), whereas Gonzalez Bulnes et al [16] reported a tendency for better viability when ewes were synchronized with cloprostenol compared to progestagens. It is noteworthy that consumers worldwide are beginning to demand products that are "clean, green and ethical" [18]; due to its rapid metabolism, $PGF_{2\alpha}$ represented a better option than P4-impregnated sponges for reproductive management of sheep [19]. To promote its use, it is important to determine the causes of poor reproductive performance when $PGF_{2\alpha}$ is used in TAI programs.

In the present study, we tested the hypothesis that synchronization with a $PGF_{2\alpha}$ analogue affects the steroidogenic capacity of the ovulatory follicle, inducing the development of a CL with reduced capacity to produce P4. Decreased P4 during the early luteal phase would reduce embryo quality and conception rate. Therefore, the objective of this study was to evaluate the effects of prostaglandin administration on ovarian follicular dynamics, conception, prolificacy, and fecundity in sheep.

2. Materials and methods

Two experiments were carried out at Escuela Agraria La Carolina, Flores, Uruguay (33 S-57 W), during the breeding season (March to April, 2009). These experiments were approved by the Animal Ethics Committee of the Faculty of Veterinary Medicine.

2.1. Animals

Multiparous Corriedale ewes (> 2.5 y), in moderate body condition (3.1 ± 0.06 and 3.2 ± 0.02, Experiments I and II respectively; scale 1 to 5 [20]) and weighing 45.7 ± 0.9 and 47 ± 0.3 kg were used in Experiments I and II, respectively.

2.2. Management

In both experiments, ewes grazed natural pastures with > 1,000 kg dry matter available per hectare (8% CP and 8.5 MJ ME/Kg dry matter). In Experiment I, ewes were housed indoors at night with water available *ad libitum*, to allow for a fasting period before collecting the blood samples, thus avoiding the decrease in circulating progesterone concentrations induced by feed intake [21], which could have varied among animals, depending on their grazing patterns.

2.3. Experimental design

Two experiments were conducted. In Experiment I, with the objective to determine reproductive losses from the beginning of the Synchrovine® protocol to Day 7 (Day 0 = day of AI; Fig. 1), plasma P4 concentrations (from Days −6 to 6), plasma estradiol concentrations (E2; 48 h before to the beginning of estrus), ovulation rate (OR), and embryo quality (Day 7) were assessed. Experiment II evaluated reproductive losses between Day 0 and Day 60 of pregnancy (Fig. 1) by measuring: plasma progesterone concentrations until Day 17, OR, conception, prolificacy, and fecundity at Days 30 and 60. In both experiments, ewes were randomly assigned to a Control group (n = 15 in Experiment I and n = 73 in Experiment II) and a prostaglandin group (n = 15 in Experiment I and n = 135 in Experiment II). In the Control group, ewes were presynchronized with two injections of DL–Cloprostenol im (125 μg each; Sincron®, Laboratorio, Uruguay S.A, Montevideo, Uruguay), given 8 d apart, starting 27 d before AI (Fig. 1), with the objective to increase the number of ewes in spontaneous estrus at Day 0. In the prostaglandin group (PG), ewes were synchronized with two injections of DL–Cloprostenol im (125 μg each), given 7 d apart (Synchrovine® protocol), starting on Day −9 (Fig. 1).

Estrus was detected in all ewes every 12 h, using Corriedale androgenized wethers (given 100 mg cyclopentylpropionate, on three occasions, 7 d apart; Testosterona Ultra Fuerte®, Laboratorio Dispert S.A, Montevideo, Uruguay), with marker paint, at a rate of six wethers/100 ewes.