Effects of different regimens of PGF2α treatment during postpartum on reproductive performance in dairy cows

Efeito de diferentes regimes de tratamento pós-parto com PGF2α sobre o desempenho reprodutivo de vacas leiteiras

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Abstract

The aim of this study was to evaluate the effects of early postpartum PGF2α treatment on reproductive performance in dairy cows synchronized with targeted breeding and natural mating after voluntary waiting period. In this experiment ,120 cows were assigned to three groups irrespective of presence or absence of luteal tissue. Cows in PG-14 group were treated with PGF2α from day 14 postpartum, cows in PG-28 group were treated with PGF2α from day 28 postpartum and cows in PG-42 group were not treated with PGF2α until the end of voluntary waiting period (d 42). After day 42 postpartum, cows in three groups were treated with PGF2α within 14-day intervals until natural mating after voluntary waiting period. Recorded reproductive parameters included days to first heat, days to first mating, days open, service per conception, conception rate, percentage of repeat breeder animals and pregnancy loss. Early PGF2α treatment from day 14 postpartum significantly decreased days to first estrus (34.9 ± 0.74, $P < 0.003$), days to first mating (62.35 ± 1.53, $P < 0.04$), days open (117.23 ± 3.1, $P < 0.001$) and service per conception (1.9 ± 0.09, $P < 0.02$); and PG-14 group presented increased conception rate (52.5%, $P < 0.05$). The proportion of repeat breeder syndrome tended to be affected by treatment with PGF2α from day 14 postpartum. In conclusion, treatment of cows with PGF2α from day 14 postpartum improved reproductive performance.

Keywords: PGF2α. Postpartum. Targeted breeding. Natural mating.

Resumo

O objetivo do presente trabalho foi avaliar os efeitos do tratamento pós-parto precoce com PGF2α sobre o desempenho reprodutivo de vacas leiteiras sincronizadas para reprodução controlada por monta natural após o período de espera voluntário. Neste experimento, 120 vacas foram distribuídas em três grupos independentes da presença ou ausência de corpo lúteo. Vacas no grupo PG-14 foram tratadas com PGF2α a partir do 14º dia pós-parto, vacas do grupo PG-28 foram tratadas com PGF2α a partir do 28º dia pós-parto e as vacas do grupo PG-42 não foram tratadas com PGF2α até o final do período de espera voluntário (d42). Após o 42º dia pós-parto as vacas dos três grupos foram tratadas com PGF2α com intervalos de 14 dias até a monta natural após o período de espera voluntário. Os registros dos parâmetros reprodutivos incluíram: dias para o primeiro estro, dias para a primeira cobertura, dias em aberto, serviços por concepção, taxa de concepção, percentagem de animais repetidores de cios e as perdas de gestações. O tratamento precoce com PGF2α, a partir do 14º dia pós-parto reduziu significativamente os dias para o primeiro estro (34,9 ± 0,74, $P < 0,003$), dias para a primeira cobertura (62,35 ± 1,53, $P < 0,04$), dias em aberto (117,23 ± 3,1, $P<0,001$) e o número de serviços por concepção (1,9 ± 0,009, $P < 0,02$); e o grupo PG-14 apresentou um acréscimo na taxa de concepção (52,5%, $P < 0,05$). A proporção da síndrome de vacas repetidoras de cios tendeu a ser afetada pelo tratamento com PGF2α a partir do 14º dia pós-parto. A conclusão obtida foi que o tratamento das vacas com PGF2α a partir do 14º dia pós-parto melhorou o desempenho reprodutivo dos animais.

Palavras-chave: PGF2α. Pós-parto. Reprodução controlada. Monta natural.

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Introduction

The events that must be completed after parturition before a cow is likely to conceive again are uterine involution, regeneration of the endometrium, elimination of bacterial contamination from the uterus, and the return of ovarian cyclical activity (SHELDON et al., 2008). Favorable uterine involution is very important for the next reproductive cycle of postpartum cows, and influences subsequent fertility (THATCHER et al., 2006). Most postpartum dairy cows are invaded by opportunistic and pathogenic bacteria within the first 21 days postpartum (THATCHER et al., 2006; SHELDON et al., 2008). In most instances, cows eliminate these bacteria from the uterus by approximately three weeks postpartum; however, some do not, and the presence of these bacteria predisposes these cows to reduced reproductive performance (HENDRICKS et al., 2006).

The early postpartum uterus produces large amounts of the F-series prostaglandins (GUILBAULT et al., 1984), as reflected by high peripheral concentrations of 13, 14-dihydro-15-keto-prostaglandin F-metabolite (PGFM). The concentration of PGFM increases in plasma prior to parturition, due to the release of prostaglandin F2 alpha (PGF2α). Secretion of PGF2α leads, in most cows, to a decrease in progesterone 1–2 days before parturition and to the final regression of the CL. A major increase in PGFM in blood plasma occurs 1–4 days postpartum, followed by a slow decrease to a basal level by day 15. This decrease has been found to be associated with uterine regression and a reduction in the rate of involution (EDQVIST et al., 1978).

There are conflicting reports on the effectiveness of exogenous PGF2α to increase the rate of uterine involution, cause evacuation of bacterial contamination from the uterus, and subsequently improve conception rate (YOUNG et al., 1984; ETHERINGTON et al., 1988; ARCHBALD et al., 1990; RISCO et al., 1994). These reports examined the use of PGF2α on either one or two occasions between 12 and 40 days postpartum, without regard to the presence of a functional corpus luteum (CL). After PGF2α administration 25–32 days postpartum, improved fertility has been observed in cattle (PANKOWSKI et al., 1995). Peters (1989) concluded that enhancement of the reproductive performance of cows treated with PGF2α after parturition is not due to a direct effect on pituitary ovarian function (PETERS, 1989). The presence of a CL did not influence the outcome of prostaglandin treatment (GLANVILL; DOBSON, 1991) and the effects of PGF2α administered at day 26 postpartum on the uterine involution and reproductive performance is independent of progesterone level at the time of treatment (MCCLARY et al., 1989; BONNETT et al., 1990; RISCO et al., 1994).

It was reported that exogenous PGF2α would be more consistently effective in increasing motility and evacuation of bacterial contamination of the postpartum uterus if it was administered when there is a CL in the ovary (NAKAO et al., 1997; HIRSBRUNNER et al., 2003). Some research has shown no improvement in pregnancy rates (MORTIMER et al., 1984), but other workers have shown significant improvements in the pregnancy rates of cows treated 14–28 days postpartum with a single injection of PGF2α (YOUNG et al., 1984). Benmrad and Stevenson (1986) reported that postpartum administration of prostaglandin F2α reduces the number of services required per conception (BENMRAD; STEVENSON, 1986).

In PGF2α-based breeding programs, often referred to as Target Breeding or Monday Morning Breeding Programs, groups of cows are injected with PGF2α as they reach the voluntary waiting period (VWP) and are bred to detected estrus for the next three to five days (DEJARNETT, 2015). Cows not bred after the first injection are re-treated with PGF2α 14 days later and observed for estrus for another five days. A set-up PGF2α injection 14 days before the first breeding injection will help to improve estrous response at this first breeding opportunity. The hypothesis of the present study was that repeated administration of PGF2α in the immediate postpartum period would increase the reproductive performance after natural mating in postpartum dairy cows synchronized with targeted breeding. Therefore, we aimed to determine the effect of administration of PGF2α in the immediate postpartum period on reproductive performance in dairy cows synchronized with targeted breeding and naturally mated at estrus after a VWP.

Materials and methods

Animals and study farm

The study was conducted from March 2014 to March 2015 on 138 Holstein cows from a commercial dairy herd in suburb of Semnan, Iran. Cows were no seasonal, year-round calvers and milked thrice daily. Cows were housed in free-stall barns and fed a total mixed ration (TMR) three times daily. The TMR was formulated to meet or exceed requirements for lactation. Cows were blocked according to parity and milk production. The VWP was 42 days, and cows detected in estrus were naturally mated. Heat detection was done by visual observation.

Study design

Each animal in each block was randomly assigned to one of the following three groups. PGF2α treatment in PG-14 group (n = 40) started on d 14 postpartum, in PG-28 group (n = 40) started on d 28 postpartum and in PG-42 (n = 40) cows only received PGF2α treatment after the end of VWP (42d). Cows in three groups were treated with PGF2α every 14 days starting on day 14, 28 or 42 and continued until natural mating after VWP. Intramuscular injection of 5 mL prostaglandin F2α (Lutalyse; Pfizer Animal Health, New York, NY, USA, containing 25mg dinoprost) was administered to each cow.

Animals were excluded or withdrawn from this experiment for any of the following reasons: failure to complete the treatment scheme, animals with retained fetal membrane or dystocia which later experienced metritis and were treated with systemic antibiotics and/or PGF2α, animals that underwent surgery (correction of displaced abomasum), animals placed in the hospital barn that received systemic antibiotic therapy during the study period, animals assigned as controls (PG-42) that were treated with PGF2α during VWP and animals culled from the herd or died during the study period.

Mating, pregnancy diagnosis, pregnancy loss, and reproductive performance

All cows were mated after VWP and examined for pregnancy by ultrasonography on days 32 ± 3 after mating. Detection of an embryonic vesicle with a viable embryo in which heartbeat was visualized, was used as an indicator of pregnancy. Pregnant cows were palpated again per rectum 30 days later (62 ± 3 after mating) for confirmation of pregnancy. Recorded reproductive parameters were days to first estrus, days to first mating, days open, service per conception, conception rate, the percentage of repeat breeder animals and pregnancy loss in each group.

Statistical analysis

At the end of the assay, the data were organized in excel sheets and then parametric variables between three treatments were analyzed using ANOVA test using General Linear Models Procedure (GLM PROC) by SAS (ver: 9.1/ 2005) software. Differences between treatments were tested for significance using the Duncan's Multiple Range test. A P value < 0.05 was considered significant. For non-parametric variables (conception rate and repeat breeder), NONPAR1WAY Procedure was used to compare treatments with Kruskal-Wallis tests.

Results

There were no significant differences between the treatment groups in the distribution of parity and milk yield. The total number of the cows enrolled in the present study was 138. Eighteen cows were excluded from the study for noted reasons. Therefore, 120 cows remained available for data analysis. Data were obtained for 40 cows in PG-14 group, 40 cows in PG-28 group and 40 cows in PG-42 group.

Treatment with PGF2α starting on day 14 postpartum significantly reduced the postpartum interval to first estrus and the number of services per conception (Table 1). Also intervals to first mating and days open were significantly reduced in the cows of the PG-14 group by ~10 days and ~18 days, respectively (Table 1). The prevalence of repeat breeder syndrome was not affected with treatment but it tended to be affected by PG-14 (10% vs. 15% and 17.5%, P = 0.09, PG-14, PG-28 and PG-42, respectively). No pregnancy loss was detected in the experimental groups (Table 2); therefore, pregnancy rates in each group were identical on days 32 and 62 after mating. Conception rate in PG-14 group was 12.5 and 10 incremented compared to PG-28 and PG-42 groups, respectively (P = 0.01; Table 2).

Table 1 – Effect of different regimens of treatment with prostaglandin F2α during postpartum injection on reproductive performance in three experiments – Semnan, Iran – 2015

	Treatments							
	PG-14[1] (n = 40)		PG-28[2] (n = 40)		PG-42[3] (n = 40)		P	sig
Reproductive Parameters	Mean ± SE[4]	CV	Mean ± SE	CV	Mean ± SE	CV		
Days to 1st estrus	$34.9^a \pm 0.74$	13	$37.35^b \pm 0.70$	11	$38.75^b \pm 0.89$	14	0.003	*
Days to 1st mating	$62.35^a \pm 1.53$	15	$72.33^b \pm 3.69$	21	$71.28^b \pm 3.32$	29	0.04	*
Days Open	$117.23^a \pm 3.1$	16	$134.63^b \pm 2.37$	10	$137.93^b \pm 3.24$	14	< 0.001	**
Service per conception	$1.9^a \pm 0.09$	23	$2.5^b \pm 0.14$	30	$2.35^b \pm 0.02$	24	0.02	*

[1] Prostaglandin F2α treatment was started from d 14 postpartum. [2] Prostaglandin F2α treatment was started from d 28 postpartum. [3] There was no treatment during voluntary waiting period (first 42 days postpartum). [4] Standard Error. [a,b] Values within a row with different superscripts are different (P < 0.05). *(P < 0.05), **(P < 0.001)

Table 2 – Effect of three experiments on conception rate, pregnancy loss and repeat breeder – Semnan, Iran – 2015

	Treatments		
Items	PG-14[1] (n = 40)	PG-28[2] (n = 40)	PG-42[3] (n = 40)
Pregnancy/mating at 32 ± 3 d of mating	52.5% (21/40)^a	40% (16/40)^b	42.5% (17/40)^b
Pregnancy/mating at 62 ± 3 d of mating	52.5% (21/40)^a	40% (16/40)^b	42.5% (17/40)^b
Pregnancy loss	0% (0/21)^a	0% (0/16)^a	0% (0/17)^a
Repeat breeder	10% (4/40)^{a*}	15% (6/40)^{a*}	17.5% (7/40)^{a*}

[1] Prostaglandin F2α treatment was started from d 14 postpartum. [2] Prostaglandin F2α treatment was started from d 28 postpartum. [3] There was no treatment during 42 days of voluntary waiting period. [a,b] Values within a row with different superscript letters are significantly different (P < 0.01). *Values within a row with different superscript letters tended to be significant different (0.05 > P < 0.1)

Discussion

The objective of this study was to evaluate the effects of immediate postpartum PGF2α treatment on reproductive performance in dairy cows synchronized with targeted breeding program and naturally mated after VWP. In the present study, treatment with PGF2α from day 14 postpartum has shown beneficial effects in cows naturally mating.

The rationale for using PGF2α in the absence of a CL (days 14 postpartum) in our study was based on the results of previous research suggesting that PGF2α has direct effects on the uterus (LINDELL; KINDAHL, 1983; RISCO et al., 1994), and can resolve uterine infections in cows without a CL (DEL VECCHIO et al., 1994). It has been shown that exogenously administered PGF2a can increase uterine PGF2α and luteal leukotriene B4 (LTB4) secretion (HOEDEMAKER et al., 1992), and that LTB4 can enhance chemotaxis and antibody-independent cell-mediated cytotoxicity. It has been reported that PGF2α promotes uterine involution and reduces the risk of uterine infection (SLAMA et al., 1993). Collectively, this information suggested that exogenous PGF2α could have beneficial effects on the postpartum uterus in the absence of a CL. Further, it was considered that administration of PGF2α after the development of a CL would lead to luteolysis, remove the suppressive effect of progesterone on the uterus, enhance uterine defenses and mitigate the immunosuppressive effects of progesterone (LEWIS, 2004).

In the present study, earlier postpartum PGF2α treatment (day 14; PG-14 group) affected the moment of first estrus and first mating. However, PGF2α treatment after day 28 postpartum (PG-28 and PG-42) did not affect these parameters. Longer duration and greater magnitude of postpartum peripheral plasma 13,14-dihydro-15-keto-prostaglandin F-metabolite (PGFM) concentrations have been related to faster uterine involution (LINDELL et al., 1982) and may favor earlier resumption of ovarian activity; and Lindell et al. (1982) speculated that uterine synthesis of PGF2a increases uterine muscle tone, promoting uterine involution and, also, that delayed involution is associated with inadequate synthesis of PGF2a. It seems that earlier first estrus and first mating after PGF2α treatment in PG-14 group was probably due to direct effect of PGF2α on the uterus, and resolving of uterine infection in cows without a CL in early postpartum. Results from this experiment support previous findings that a single intramuscular injection of PGF2α in the early postpartum period (between 7 and 28 days) reduced the postpartum interval to conception (YOUNG et al., 1984; BENMRAD; STEVENSON, 1986) and had a positive effect on reproductive performance (WHITE; DOBSON, 1990; PANKOWSKI et al., 1995; NAKAO et al., 1997; SCHOFIELD et al., 1999). These studies did not compare the effect of earlier PGF2α injection (around day 14 of VWP) and late PGF2α injection (around day 28 of VWP) in VWP but our results showed that earlier PGF2α treatment was better than late PGF2α treatment. The shorter postpartum interval to PGF2α administration was associated with an earlier first postpartum estrus. However, Hendricks et al. (2006) demonstrated that repeated administration of PGF2α on days 7, 14, 22 and 35 in the early postpartum period had no effect on days to first service and the probability of pregnancy at first insemination. Also, Salasel and Mokhtari (2011) reported that treatment with PGF2α had no effect on days to first estrus and days to first artificial insemination at day 20 postpartum (SALASEL; MOKHTARI, 2011). Kindahl et al. (1976) and McClary et al. (1989) found that the time to first ovulation was unaffected by PGF2α treatment, and Young et al. (1984) reported no effect on the postpartum interval to first service. Kasimanickam et al. (2005) reported that PGF2α treatment of cows with subclinical endometritis at 20 to 33 days postpartum did not reduce the median days to first service (KASIMANICKAM et al., 2005). In this regard, unlike our results that achieved from normal postpartum dairy cows, Kasimanickam et al. (2005) reported that there was no benefit in a routine injection of PGF2α to dairy cows with abnormal puerperium in the period 14 to 28 days after calving when rebreeding commenced more than 70 days after calving (GLANVILL; DOBSON, 1991). It is speculated that the different VWP had influenced the time to first artificial insemination in different studies and can be a reason for different results. It seems that in the case of prolonged VWP, such parameters should not be considered while evaluating the use of PGF2α in the early postpartum period. Treatment with PGF2α also affects days to first estrus and mating due to its direct ecbolic effect on the uterus, and positive effect on uterine muscle tone and involution rate (LINDELL; KINDAHL, 1983).

The interval from parturition to involution of the uterus has been reported as lasting from 26 to 52 days

(MORROW et al., 1969). The length of this interval increases with parity, decreases with an increase in milk production (BUCH et al., 1955). Cows in this experiment were paired for milk yield and parity to minimize these confounding effects. Therefore, it is speculated that days to first estrus and days to first mating are influenced by parity and milk production, which is not similar in all studies.

Our study showed that pregnancy/mating rate on day 32 was improved with PGF2α administration on day 14 postpartum. Other studies showed that conception rate was not influenced with PGF2α treatment before VWP (SCHOFIELD et al., 1999). Conversely, Salasel and Mokhtari (2011) reported that conception rate and pregnancy loss were improved with administration of PGF2α on day 21 postpartum.

In the present study, postpartum treatment with PGF2α from day 14 decreased the mean of days open. Salasel and Mokhtari (2011) showed that days open was decreased (32days) with using PGF2α in day 21 postpartum. However, Schofield et al. (1999) indirectly demonstrated that treatment with PGF2α in early postpartum decreases days open. They reported that treatment of dairy cows with PGF2α at day 21 postpartum reduced the postpartum interval to first service by seven to nine days; therefore, days open was also affected. On the other hand, another study reported that interval to first postpartum insemination of treated cows with PGF2α was like control group (without PG2α treatment in early postpartum) and within a range of 130–134 days postpartum (HENDRICKS et al., 2006). Our result showing improvement of days open may have been mediated through a direct action of PGF2α on uterine smooth muscle causing myometrial contractions of the uterus, in addition to the apparent advancement of ovulation. This may enhance uterine involution as well as cleaning the uterine lumen of residual products resulting from parturition, or subsequently established uterine pathogens.

In this study, mean service per conception in PG-14 group was lower than PG-28 and PG-42 groups (1.9 vs. 2.5 and 2.35, respectively). It is speculated that reduced number of services per conception was the outcome of frequency of estrous cycles before first mating. Other study similarly shown that the mean services per conception were improved (1.64 vs. 2.33) by postpartum treatment with PGF2α on Days 14 to 16 (MCCLARY et al., 1989). Salasel and Mokhtari (2011) also reported that postpartum treatment with PGF2α improved the mean service per conception in cows with calving and puerperal traits. Benmard and Stevenson (1986) showed that administration of PGF2α at 20 to 24 days postpartum reduced services per conception by 26% to 41%, especially in cows with puerperal problems (BENMARD; STEVENSON, 1986).

According to the results obtained in the current study, injections of PGF2α on day 14 postpartum reduced the prevalence of repeat breeder syndrome. In agreement with our results, two injections of PGF2α 8 h apart on day 20 postpartum reduced the prevalence of repeat breeder syndrome in cows with calving and puerperal traits (SALASEL; MOKHTARI, 2011). However, there are some differences in studies which have investigated the use of PGF2α at the postpartum period in dairy cows and there is difference between day of PGF2α injection in studies and different studied did not compare effect of early or late PGF2α injection in VWP on reproductive performance. Also, the type of PGF2α used in these studies, type of animals selected for these studies, protocols used for and the timing of treatment were different. Therefore, some authors reported that PGF2α treatment in postpartum period had no beneficial effect on fertility (ARCHBALD et al., 1990; GLANVILL, DOBSON, 1991; HENDRICKS et al., 2006), but others showed that it improved reproductive performance (YOUNG et al., 1984; MELENDEZ et al., 2004; KASIMANICKAM et al., 2005). Therefore, the difference in the results of these studies is somewhat due to different study designs. According to above mentioned dissimilarities, it is suggested that further consideration should be given to selection and timing of optimum PGF2α treatment protocol for cows with different kinds of abnormalities in the postpartum period.

In conclusion, despite the cost, the administration of PGF2α in the immediate postpartum period improves reproductive performance in dairy cows submitted to target breeding program, only when PGF2α treatments starts earlier on day 14 postpartum compared to days 28 or 42.

Conflict of interest

The authors declare that there is no conflict of interest.

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