Luteal function and oestrus in gilts treated with a synthetic analogue of prostaglandin F-2 α (ICI 79,939) at various times during the oestrous cycle*

H. D. Guthrie† and C. Polge

*A.R.C. Unit of Reproductive Physiology and Biochemistry, Animal Research Station,
307 Huntingdon Road, Cambridge CB3 0JQ, U.K.*

Treatment of cattle with various doses of prostaglandin (PG) F-2 α by subcutaneous injection (Lauderdale, 1972) or by nonsurgical intrauterine injection (Rowson, Tervit & Brand, 1972; Liehr, Marion & Olson, 1972; Louis, Hafs & Morrow, 1972) induces luteal regression and allows oestrus to occur if initiated after Days 3 or 4 of the oestrous cycle. The oestrous cycle of the mare can also be shortened by administration of PGF-2 α (Douglas & Ginther, 1972). Because the presence of the uterus is required for normal cyclic function in the pig (Anderson, Bland & Melampy, 1969), the effects of a synthetic analogue of PGF-2 α , ICI 79,939, on luteal function and oestrus in gilts was investigated.

In Exp. 1, 46 mature gilts were each given a single i.m. injection of ICI 79,939 in 0.9% (w/v) NaCl solution on one day between Days 7 and 12 of the cycle (Day 0 = day of oestrus). Blood was collected a few minutes before and 24 and 48 hr after the injection from gilts treated on Days 10, 11 or 12 and plasma progesterone was measured to monitor luteal function by a competitive protein-binding assay as described by Henricks, Guthrie & Handlin (1972) and Seamark, Moor & McIntosh (1974). The gilts were exposed to a vasectomized boar once daily to check for the occurrence of oestrus. The proportion of animals exhibiting a positive oestrous response in the various treatment groups was assessed by χ^2 analysis (Steel & Torrie, 1960). Plasma progesterone concentrations were subjected to analysis of variance as a split plot over time or a multivariate analysis (Steel & Torrie, 1960; Gill & Hafs, 1971). A probability of $\leq 5\%$ was considered significant.

A positive oestrous response was defined as oestrus occurring 5–7 days after the first injection of ICI 79,939. As shown in Table 1, none of the gilts injected before Day 11 of the cycle gave a positive oestrous response, but treatment with doses of 0.25 or 0.5 mg on Day 12 had a significant effect in about 34% of the gilts. A significant decline in plasma progesterone concentration occurred by 24 hr after the injection, but the single dose was not adequate in most cases to cause complete luteal regression.

In Exp. 2, 57 gilts were used in a 3 $\times$ 3 factorial experiment consisting of three injection schedules designed to vary the period of treatment with ICI 79,939 and starting on Days 8, 10 or 12 of the oestrous cycle (Table 2). Each injection consisted of 0.5 mg ICI 79,939. Blood samples were collected as shown in Table 2.

The timing of the treatment significantly affected the number of positive responses, which were 0, 27.8 and 94.4% for the Day-8, -10 and -12 groups, respectively. In the Day-10 group, extension of treatment to Day 11 by 4 injections of ICI 79,939 significantly increased the proportion of animals exhibiting a positive response.

Plasma progesterone concentrations after ICI 79,939 treatment are shown in Table 2. Concentrations had decreased significantly in each of the Day-8, -10 and -12 treatment groups by 12 hr after the first injection. In all three Day-8 groups the concentrations had increased by 24 hr and remained high in spite of continued injections of ICI 79,939.

In the Day-10 groups luteal function was partly restored by 24 hr when ICI 79,939 was not injected at 12 hr, but the second injection at 24 hr caused another decline in plasma progesterone

* Reprint requests to Dr C. Polge.

† Present address: U.S.D.A., A.R.S., Beltsville Agricultural Research Center, Beltsville, Maryland 20705, U.S.A.

Table 1. The return of gilts to oestrus after a single injection of ICI 79,939 during the luteal phase of the oestrous cycle

Day of treatment	Dose of ICI 79,939 (mg)	No. of gilts			
		Treated	Oestrous response		
			Positive†	Normal cycle	Delayed‡
7-9	0.5-1.0	4*	0	3	0
10	0.5	4	0	4	0
11	0.5	4	2	2	0
12	nil	8	1	7	0
12	0.125	6	0	4	2
12	0.25	6	2	4	0
12	0.5	12*	4	5	2
12	1.0	2	2	0	0

* One gilt died, data excluded.

† 5-7 days after treatment.

‡ 25 or more days after last oestrus.

Table 2. Oestrous response and plasma progesterone concentrations (mean $\pm$ S.E.M.) after treatment of gilts with ICI 79,939 starting on Days 8, 10, or 12 of the oestrous cycle

Day treatment started	Time of injection (hr)	No. of gilts			Plasma progesterone (ng/ml)					
		Treated	In oestrus within 5-7 days	Oestrus delayed†	0 hr	12 hr	24 hr	36 hr	48 hr	72 hr
8	0, 12	6	0	0	18.4	12.8	14.2		20.9	
					± 1.7	± 1.5	± 2.0		± 1.6	
	0, 24	7*	0	1	20.6	13.1	18.1	18.2	19.9	25.5
					± 2.2	± 1.0	± 2.2	± 2.0	± 2.0	± 2.2
	0, 12, 24, 36	7*	0	0	17.9	13.2	16.2	16.3	18.2	21.6
10					± 2.4	± 1.6	± 1.0	± 2.2	± 2.7	± 4.2
	Combined	18	0	1	18.9	13.1	16.1	17.2	19.7	23.5
	0, 12	6	0	2	24.4	16.4	14.0		17.6	
					± 2.4	± 1.8	± 2.7		± 3.7	
	0, 24	6	1	0	30.3	14.1	19.3	10.7	12.1	12.8
12					± 4.2	± 2.0	± 2.0	± 3.2	± 3.3	± 3.0
	0, 12, 24, 36	6	4	0	27.6	19.0	16.3	14.2	9.8	8.8
					± 3.9	± 2.9	± 4.9	± 5.8	± 5.8	± 5.4
	Combined	18	5	2	27.4	16.5	16.5	12.4	13.1	10.8
	0, 12	7*	5	1	30.7	11.7	4.6		2.7	
12					± 2.1	± 1.8	± 1.5		± 2.0	
	0, 24	6	6	0	29.7	8.7	6.8	2.0	0.8	0.5
					± 3.1	± 1.4	± 2.0	± 0.4	± 0.1	± 0.1
	0, 12, 24, 36	6	6	0	30.4	9.7	2.8	1.5	0.9	0.6
					± 4.0	± 2.9	± 0.8	± 0.3	± 0.1	± 0.1
12	Combined	18	17	1	30.3	10.0	5.0	1.7	1.5	0.5

* One gilt died during treatment, data excluded.

† 3 or more days longer than control cycle.

concentration, although only one gilt exhibited complete luteal regression and a positive oestrous response. Four injections at 12 hr intervals caused plasma progesterone concentrations to decline to 2.5 ng/ml or less by 48 hr in 4 of 6 gilts. Plasma progesterone concentrations remained high in the other 2 gilts with 15.0 and 36.5 ng/ml at 48 hr and the gilts had oestrous cycles of 20 and 21 days.

Very low progesterone concentrations were found in 17 gilts at 48 hr in the Day-12 group; the one gilt that did not respond had a progesterone concentration of 12.8 ng/ml at 48 hr and an oestrous cycle of 28 days.

The age of the corpora lutea (CL) when the analogue was injected appeared to be the critical factor in determining whether luteal regression would occur; maximum sensitivity seemed to be achieved when the CL were about 10 days old. In gilts in which complete luteal regression was induced, the onset of oestrus occurred 5–7 days after the initiation of treatment. This interval is similar to that observed between the onset of luteal regression and oestrus in the normal oestrous cycle (Stabenfeldt, Akins, Ewing & Morrisette, 1969; Henricks *et al.*, 1972), after luteal enucleation (Anderson, Dyck & Rathmaker, 1966) or after the cessation of methallibure treatment (Polge, 1965). In the cow (Lauderdale, 1972; Rowson *et al.*, 1972) and the mare (Allen & Rowson, 1973) oestrus occurs 2–4 days after PGF-2 α treatment.

The natural process of luteolysis may be a gradual one culminated by a surge of luteolytic substance late in the oestrous cycle. Gleeson & Thorburn (1973) reported that PGF-2 α levels in the uterine veins of 3 sows increased from Days 11–14 of the cycle, preceding the decline in progesterone secretion, but morphological changes in the CL have been reported as early as Day 8 (Cavazos *et al.*, 1969).

In practical terms, the use of prostaglandins alone for oestrous synchronization of gilts at various stages of the cycle seems severely limited because of the relatively short period of luteal sensitivity. The importance of luteal age in PGF-2 α mediated regression suggests that extension of the luteal phase followed by PGF-2 α treatment should be investigated as a method of oestrous synchronization in the pig.

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