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A comparison of ovulatory gonadotropic surge in two rabbit strains : no evidence for a relationship between LH or FSH surge and factors of prolificacy

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Summary. Plasma levels of LH and FSH before and after ovulation were measured in two rabbit strains (New Zealand A 1077 and Californian A 1066) having a different number of ovulations and rate of embryonic loss. Maximal concentrations and total secreted amounts before ovulation were slightly higher in New Zealand, but the difference was not significant.

No relationship between the number of ovulations and the increase in plasma LH or FSH level was found in either strain. In most cases, there was no relationship between gonadotropic surge and early embryonic loss.

Introduction.

Mating in rabbit causes plasma levels of gonadotropic hormones LH and FSH to increase (Goodman and Neill, 1976), and ovulation occurring 10 to 12 h after mating is followed by a second rise in FSH (Osteen and Mills, 1979).

In two rabbit strains selected by Matheron and Rouvier (1977), New Zealand A 1077 and Californian A 1066, the number of ovulations and the rate of early embryonic loss are different (Hulot and Matheron, 1981). These strains seemed to be good models for studying putative relationships between gonadotropic surges, on the one hand, and ovulatory capacity or embryonic development on the other.

Material and methods.

Nulliparous New Zealand and Californian doe-rabbits, raised under a lighting schedule of 16L:8D, were mated with males of the same strain at 4.5 months of age. Blood was drawn by intracardiac puncture at various times before and after ovulation, using the technique of Moret (1977).

LH and FSH levels were determined by radioimmunoassay in an homologous specific system. Assay sensitivity of LH was 130 pg/100 µl and that of FSH was 25 pg/100 µl (Blanc *et al.,* to be published). To avoid assay variability, all the samples of the same series were assayed for each hormone during the same incubation. Using a Leitz ASM integrator, we measured the total amount of secreted hormone by the surface of the individual curves, taking the lowest concentration as baseline.

Series 1. — Blood samples were taken from 19 Californian and 26 New Zealand does at regular intervals for 6 h after mating. The does were killed 96 ± 5 h after mating. The corpora lutea were counted and the uterine horns perfused to collect the blastocysts which were then counted and measured.

Series 2. — Blood samples were taken from 14 Californian and 14 New Zealand does every hour for the first 16 h after mating, every 3 h from 16 to 31 h, then twice a day until day 7 of pregnancy. The blastocysts and their localization in implantation chambers forming in the uterus were counted during exploratory laparotomy at D7 (Wintenberger-Torrès, 1974) after the does had been anesthetized with fentanyl (Hypnorm, U.V.A.).

Statistical analysis. — The F-test (Fisher-Snedecor) was used to compare means and the χ^2-test to compare percentages.

Results.

LH. — In does that had ovulated (100 % in series 1 and 93 % in series 2), LH concentrations usually begin to rise 30 min after mating, reaching a maximum after 2 h, returning to basal level at 6 h after mating and remaining at that level for the first 7 days of pregnancy (figs. 1a, 2a). Individual variations were noted. In several cases, the maximum was reached at 30 min, 1 h or exceptionally at 3 h. Basal levels before mating were higher in series 1 (6.8 ± 0.2) than in series 2 (2.6 ± 0.4).

The multiplication factor between basal and maximal levels was 11.8 in series 1 and 52.0 in series 2. The basal level and the LH pattern were similar in both series in both strains. The levels reached during the ovulatory peak and the total amount secreted were slightly higher in New Zealand. The only significant differences favoring the New Zealand were recorded in series 1 and concerned the total amount of LH secreted and its peak 2 h after mating.

FSH. — Plasma FSH concentrations began to increase at 30 min, reaching a maximum at 2 to 3 h after mating, then decreasing up to 8 h (figs. 1b, 2b) ; the concentrations increased again at 10 h after mating, remaining high from 16 to 22 h and then decreasing gradually to reach the basal level 2 days after mating. Some more or less wide fluctuations were observed up to day 7 of pregnancy (fig. 2b). The basic levels before mating were higher in series 2 (1.5 ± 0.1) than in series 1 (0.7 ± 0.07). The multiplication factor between the basal level measured before mating and the maximal level reached before ovulation was 9.7 in series 1 and 3.7 in series 2.

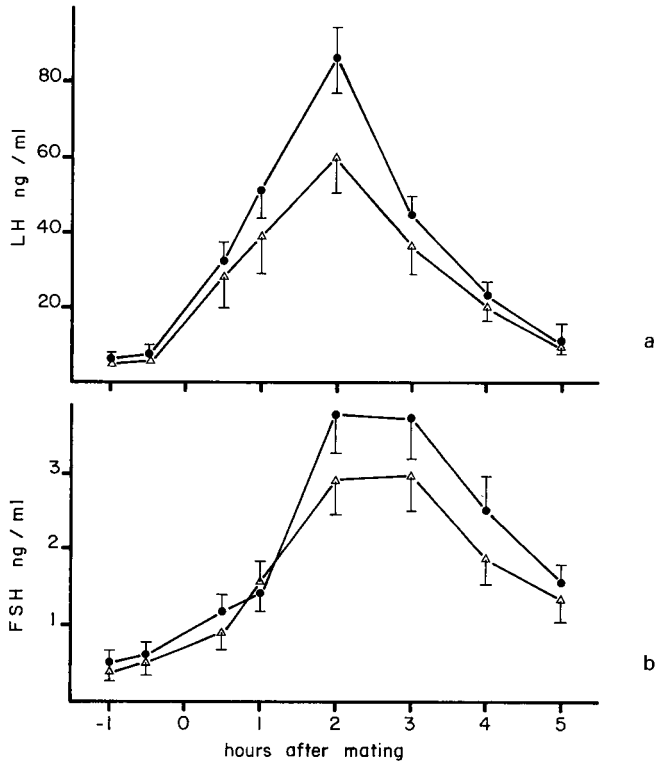

FIG. 1. — *Changes in plasma LH* (a) *and FSH* (b) *concentrations in Californian* (Δ—Δ) *and New Zealand* (•—•) *doe-rabbits after mating.*

The pattern of FSH concentration and its basal level were similar in both series in both strains. The levels reached during preovulatory and postovulatory peaks and the total secreted amount were slightly higher in New Zealand, on the average, but the difference in series 2 was only significant 4 h after mating.

Number of ovulations. — The number of ova produced per female was higher in the Californian, although the difference was only significant in series 1 (tables 1, 2). There was no intra or interstrain relationship between the number of ovulations and the increase in plasma LH or FSH concentrations during preovulatory surge.

Five of the 71 does ovulating showed no increase in LH and FSH, while 6 showed no increase in FSH (table 3). Except for one Californian which had only 6 corpora lutea, the number of ovulations in these females was not different from that of does showing peaks of LH and FSH.

Embryonic loss. — The percentage of does losing their litter before 4 (series 1) or 7 (series 2) days was the same in both strains (tables 1, 2). In the other

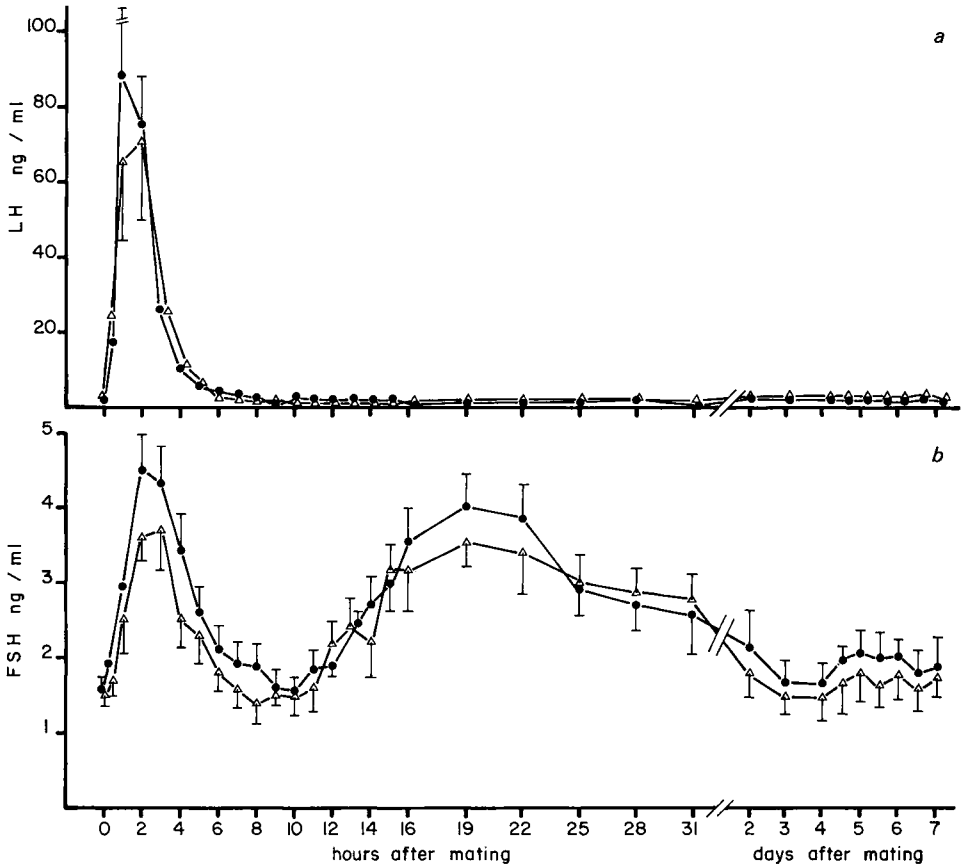

FIG. 2. — *Changes in plasma LH* (a) *and FSH* (b) *concentrations in Californian* (Δ——Δ) and New Zealand (•——•) *doe-rabbits after mating.*

TABLE 1

Number of ovulations and embryonic loss at 96 h after mating.

Strain	Number of ovulations	Does with total embryonic loss	Partial or no embryonic loss			
			Number of ovulations	Number of blastocysts	Loss	Blastocyst diameter (in μm)
Californian	12.0 ± 0.6 n = 19	16 % n = 3	12.3 ± 0.7 n = 16	10.1 ± 0.6 n = 16	18 %	366 ± 9 n = 162
New Zealand	10.0 ± 0.4 n = 26**	12 % n = 3	10.0 ± 0.5 n = 23**	9.0 ± 0.5 n = 23	10 % *	437 ± 9 n = 207***

n = number of does ; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.005$.

TABLE 2

Number of ovulations and embryonic loss at 7 days of pregnancy.

Strain	Number of ovulations	Does with total embryonic loss	Partial or no embryonic loss			
			Number of ovulations	Number of blastocysts	Number of sites	Loss
Californian	11.5 ± 0.7 n = 14	7 % n = 1	12.2 ± 0.7 n = 10	9.7 ± 1.0 n = 10	8.7 ± 1.3 n = 10	30 %
New Zealand	10.3 ± 0.3 n = 12	8 % n = 1	10.4 ± 0.4 n = 8	9.0 ± 0.4 n = 8	8.8 ± 0.5 n = 8	16 % *

n = number of does ; * $P < 0.05$.

TABLE 3

Embryonic loss in does showing no simultaneous preovulatory peaks of LH and FSH.

Number of does	Increase		Embryonic loss (%)
	in LH	in FSH	
5	–	–	100
1	+	–	100
1	+	–	80
1	+	–	50
3	+	–	0-20

does, embryonic loss at 4 or 7 days was higher in Californian than in New Zealand. Blastocyst diameter at 96 h after mating was significantly smaller in the Californian (tables 1, 2).

Nine (15 %) of the 60 does showing a rise in LH and FSH before ovulation had an embryonic loss of 50 to 100 % at D4 or D7. Eight (73 %) of the 11 does showing no peaks of LH and FSH, or of FSH only, had an embryonic loss of more than 50 % (table 3). The difference between these two groups was significant ($p < 0.005$).

Discussion.

Of the two rabbit strains we used, the Californian had the higher number of ovulations and higher embryonic loss (Hulot and Matheron, 1981). On the average, however, basal level and plasma concentrations of LH and FSH before and after ovulation were comparable, although the LH peaks were slightly higher (but not significantly so) in the strain that ovulated less.

We found no relationship between the elevation of LH before ovulation and the number of ovulations. In the ewe, the preovulatory LH peak is identical, whatever the ovulation rate (Thimonier and Pelletier, 1971 ; Land *et al.*, 1973 ; Quircke *et al.*, 1979).

According to Bindon *et al.* (1979), basal FSH levels are higher before estrus in Ile-de-France ewes (which have a low ovulation rate) than in Romanoff ewes. Such a difference was not found between the two rabbit strains we studied. However, our results on the preovulatory FSH peak agree with those of Bindon *et al.* (1979) and Cahill *et al.* (1981), *i.e.* hormone levels were slightly higher in the strain that ovulated less. The postovulatory peak in ewe (Cahill *et al.*, 1981) was significantly higher ($p < 0.05$) in Romanoff which is the more prolific strain ; our results in rabbit would not agree with this.

Cahill *et al.* (1981) studying ewe, suggested that the ovulation rate in a given cycle depends on the postovulatory FSH level in the previous cycle, determining the number of antral follicles in the ovary. In rabbit it is difficult to imagine the role of the postovulatory peak on an ovulation occurring after mating in the more or less distant future.

The difference in the number of ovulations in the two strains of rabbit we examined would be due to the number of preovulatory follicles (higher in the Californian) (Hulot and Mariana, 1982) and would not depend on successive hormonal surges following mating.

Embryonic loss is lower in New Zealand than in Californian, as shown by the number of implantations. We did notice that when embryonic loss was higher than 50 %, it was almost always associated with the absence of preovulatory peak or with a very short surge of FSH. The postovulatory surge of FSH would induce maturation of a new wave of follicles. The secretion of estrogen by these follicles would maintain the hormonal balance needed for the progression of the blastocysts through the oviduct and for the release, by oviduct epithelial cells, of the mucopolysaccharides surrounding the rabbit blastocyst as it moves through the Fallopian tubes (Greenwald, 1961). However, since the work of Greenwald (1962), we know that the normal development of the blastocyst is related to the thickness of the mucin layer.

A modification in the surge of FSH could therefore change estrogen balance and thus affect the transit of the blastocysts and the thickness of the mucin layer, impairing the normal development of the embryos.

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Résumé. *Comparaison des décharges gonadotropes chez deux souches de lapine, en relation avec le taux d'ovulation et la mortalité embryonnaire.*

Les niveaux plasmatiques de LH et de FSH ont été mesurés avant et après l'ovulation dans deux souches de lapines qui diffèrent par le nombre d'ovulations et la mortalité embryonnaire. Les concentrations maximales et les quantités totales sécrétées avant l'ovulation sont légèrement supérieures dans la souche Néo-Zélandaise, mais la différence n'est pas significative.

Dans les deux souches, aucune relation n'a été trouvée entre le nombre d'ovulations et l'augmentation des niveaux plasmatiques de LH ou de FSH. Dans la majorité des cas, il n'est pas non plus possible d'établir de relation entre l'intensité des décharges gonadotropes et la mortalité embryonnaire précoce.

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