Studies on the Sex Hormone Levels in Serum of Puerperal Sow

Kyu Seung Lee* and Chang Sik Park*

Summary

The present study was carried out to study the serum concentration of peptide and steroid hormones in puerperal sow. Eight crossbred sows were used for collection of blood samples from day 20 prepartum to day 20 postpartum. FSH, LH, prolactin, estradiol-17β, progesterone and cortisol were assayed by radioimmunoassay methods.

The mean serum FSH did not vary during the puerperal period and ranged from 8.1±1.8 mIU/ml to 9.0±2.3 mIU/ml. LH concentrations increased from 2.6±0.3 mIU/ml at day 20 prepartum to 3.9±1.1 mIU/ml at the time of parturition, reached 3.2±0.9 mIU/ml by day +2 and remained quite constant thereafter. Prolactin reached a peak mean level of 68.5±9.5 ng/ml at day 0.

Estradiol-17β increased from 205.0±29.5 pg/ml at day 6 prepartum to 425.0±35.0 pg/ml at the time of parturition. Progesterone remained fairly constant (18.4±1.6 to 20.0±2.1 ng/ml) from 20 to 6 days before parturition, began to decline on day -2, reached 0.9±0.3 ng/ml by day +2 and remained quite constant thereafter. Cortisol reached a peak level of 86.5±10.5 ng/ml at the day 0.

Introduction

There is a little information on the changes in the concentration of peptide and steroid hormones in the serum of the sow during the puerperal period.

In earlier studies, the levels of follicle stimulating hormone (FSH) and luteinizing hormone (LH) were determined in pituitaries obtained from pigs during the estrous cycle (Parlow et al., 1964), pregnancy and lactation (Melampy et al., 1966). However, the levels of LH in serum from pigs have been determined only in a large pools of blood from which the LH was extracted and bioassayed by the ovarian ascorbic acid depletion bioassay (Anderson & McShan, 1966). This was a complex procedure and not adaptable to large numbers of samples.

*農科大學 畜産學科 (Dept. of Animal Science, Coll. of Agriculture, Chungnam Natl. Univ., Daejeon, Korea)
The recent development of radioimmunoassay techniques in pigs for LH (Niswender et al., 1970; Rayford et al., 1971; Hallford et al., 1975), for FSH (Rayford et al., 1974), and for prolactin (Brinkley et al., 1972) has made it possible to determine levels of these hormones in small aliquots of blood.

Shearer et al. (1972) have reported a limited amount of information on the levels of progesterone and unconjugated estradiol-17β during the early and the later part of gestation, while Molokwu & Wagner (1973) and Ash et al. (1973) have described changes in plasma concentration of corticoids, progesterone, unconjugated estrone and estradiol-17β over the periods from 8 days before to 8 days after parturition and from 7 to 12 days before parturition to birth respectively. Robertson & King (1974) have described the changes in the plasma levels of progesterone, unconjugated estrone, estradiol-17β and estrone sulphate in the sow at the time of implantation, during gestation and at parturition.

**MATERIALS AND METHODS**

Animals used in this study consisted of 8 sows (Duroc♂×(Large White♀×Landrace♀) F1♀ mating). Every other day blood samples were collected beginning 20 days prior to expected farrowing date (based on 114 days gestation length) and continuing through day 20 postfarrowing.

For blood withdrawal the animals were restrained by a snout rope when in farrowing crates, or in a hog squeeze at other times. Blood samples were obtained by inserting a 21-gauge, hypodermic needle attached to 10 cc syringe through surface veins in the ear. Blood samples were permitted sit at 4°C for 3 hours and then was centrifuged at 500 g at 4°C for 20 minutes. Serum was collected and stored at −20°C until ready for assay.

The concentrations of FSH, LH, prolactin, progesterone, estradiol-17β and cortisol in serum was determined by radioimmunoassay. The principles and basic techniques for developing an RIA have been described (Berson & Yalow, 1964), and these techniques and procedures were followed with minor modification. The technical procedures, i.e., buffers, incubation times, counting techniques etc. have been reported for peptide hormones (Odell et al., 1967; Layford et al., 1971, 1974; Brinkley et al., 1972), and for steroids (Hallford et al., 1975).

**RESULTS**

The mean serum FSH, LH and prolactin concentrations are shown in table 1 and figure 1. The concentration of FSH levels did not vary during puerperal period and range from 8.1±1.8 to 9.0±2.6 mIU/ml.

The concentrations of LH in serum from 20 days before until the day of parturition ranged between 2.6±0.3 and 3.9±1.1 mIU/ml. The level peaked at 3.9±1.1 mIU/ml on day 0 and then began to decline on day 2 postpartum. The serum levels remained fairly constant at about 2.8±0.7 mIU/ml from day 4 showed similar patterns of change.

The concentrations of prolactin in serum were below 15.5±3.5 ng/ml during late pregnancy. The levels increased from 34.2±4.9 ng/ml 2 days prior to parturition to a peak 68.5±9.5 ng/ml at parturition. The levels varied between 29.5±3.5 ng/ml and 38.5±4.8 ng/ml from the 2 days postpartum until 20 days.

The mean serum estradiol-17β progesterone and cortisol concentrations are shown in table 2 and figure 2. The mean estradiol-17β concentrations started to rise on day 6 prepartum. The levels peaked at 425.0±35.6 pg/ml on day 0 and then decreased as rapidly as it had risen, returning to prefarrowing levels by day+2.

The progesterone concentrations began to
Table 1. Serum peptide hormone levels in sow during the periparturient period (Mean ± S. E.)

<table>
<thead>
<tr>
<th>No. of days to farrowing</th>
<th>FSH (mIU/ml)</th>
<th>LH (mIU/ml)</th>
<th>Prolactin (ng/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 20</td>
<td>8.5 ± 2.5</td>
<td>2.6 ± 0.3</td>
<td>17.0 ± 4.0</td>
</tr>
<tr>
<td>- 6</td>
<td>8.3 ± 2.0</td>
<td>2.3 ± 0.5</td>
<td>15.5 ± 3.5</td>
</tr>
<tr>
<td>- 4</td>
<td>9.0 ± 2.6</td>
<td>2.7 ± 0.6</td>
<td>18.6 ± 5.7</td>
</tr>
<tr>
<td>- 2</td>
<td>8.8 ± 2.4</td>
<td>3.8 ± 0.7</td>
<td>34.2 ± 4.9</td>
</tr>
<tr>
<td>0</td>
<td>9.0 ± 2.0</td>
<td>3.9 ± 1.1</td>
<td>68.5 ± 9.5</td>
</tr>
<tr>
<td>+ 2</td>
<td>8.5 ± 1.9</td>
<td>3.2 ± 0.9</td>
<td>38.0 ± 5.6</td>
</tr>
<tr>
<td>+ 4</td>
<td>8.9 ± 1.5</td>
<td>2.8 ± 0.7</td>
<td>38.5 ± 4.8</td>
</tr>
<tr>
<td>+ 6</td>
<td>8.1 ± 1.8</td>
<td>2.4 ± 0.5</td>
<td>29.5 ± 3.5</td>
</tr>
<tr>
<td>+ 20</td>
<td>9.0 ± 2.3</td>
<td>2.9 ± 0.7</td>
<td>30.0 ± 3.9</td>
</tr>
</tbody>
</table>

Fig.1. Mean FSH(*---*), LH(○---○), prolactin(●---●) and progesterone(←→) levels in sows during the puerperal period.
Table 2. Serum steroid hormone levels in sows during the periparturient period
(Mean ± S. E.)

<table>
<thead>
<tr>
<th>No. of days to farrowing</th>
<th>Estradiol-17β (pg/ml)</th>
<th>Progesterone (ng/ml)</th>
<th>Cortisol (ng/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 20</td>
<td>48.0 ± 6.1</td>
<td>20.0 ± 2.1</td>
<td>47.0 ± 5.5</td>
</tr>
<tr>
<td>- 6</td>
<td>205.0 ± 29.5</td>
<td>18.4 ± 1.6</td>
<td>36.5 ± 4.7</td>
</tr>
<tr>
<td>- 4</td>
<td>328.5 ± 28.5</td>
<td>19.4 ± 2.4</td>
<td>34.0 ± 5.1</td>
</tr>
<tr>
<td>- 2</td>
<td>344.9 ± 25.7</td>
<td>8.8 ± 1.0</td>
<td>48.8 ± 6.0</td>
</tr>
<tr>
<td>0</td>
<td>425.0 ± 35.6</td>
<td>2.6 ± 0.8</td>
<td>86.5 ± 10.5</td>
</tr>
<tr>
<td>+ 2</td>
<td>59.5 ± 7.8</td>
<td>0.9 ± 0.3</td>
<td>44.0 ± 6.6</td>
</tr>
<tr>
<td>+ 4</td>
<td>56.7 ± 5.7</td>
<td>1.0 ± 0.3</td>
<td>31.5 ± 6.9</td>
</tr>
<tr>
<td>+ 6</td>
<td>28.1 ± 4.2</td>
<td>0.8 ± 0.2</td>
<td>34.0 ± 8.0</td>
</tr>
<tr>
<td>+ 20</td>
<td>12.5 ± 3.4</td>
<td>0.5 ± 0.1</td>
<td>32.5 ± 3.5</td>
</tr>
</tbody>
</table>

Fig. 2. Mean estradiol-17β (---), progesterone(----), and cortisol(---) levels in sows during the puerperal period.

- 67 -
decline on day 6 prepartum. This decline was very rapid from day 2 prepartum (8.8±1.0 ng/ml) to day 0 parturition (2.6±0.8 ng/ml). The serum levels remained fairly constant at about 0.9±0.3 ng/ml from day 2 showed similar patterns of change.

The mean prepartum cortisol concentrations remained consistently between 34.0±5.1 and 48.8±6.0 ng/ml. At around 48 hours before parturition, the mean cortisol concentrations began to rise and peaked at a concentration of 86.5±10.5 ng/ml on day 0 and returned to prepartum levels by 48 hours following parturition.

DISCUSSION

No previous study has been done on serum concentrations of FSH in the puerperal sow, but the pattern of changes observed in this study is similar to that found in the plasma of rat, mouse and dairy cows (Linkie & Niswender, 1972, Murr et al., 1974; Hilary, 1978). We have not observed significant changes in serum FSH during the puerperal period.

The serum LH concentrations varied greatly between and within animals. The pattern of changes in LH levels observed in this study is in general agreement with the patterns noted in the cow (Schams et al., 1972), rat (Linkie & Niswender, 1972), mouse (Murr et al., 1974), gilt (Wetteman et al., 1977), but Ingalls et al. (1973) have not observed significant changes in serum LH around parturition in heifers. It may be concluded that, in the sow the demonstration of a luteotrophic action of LH may occur in certain situations, for instance in the presence of active luteal tissue with a low progesterone synthesis rate, provided that there is no dominance of any possible luteolytic activity. The decline of progesterone near parturition is not due to a lack of LH, so other factors have to be considered to luteolyse and hence to initiate parturition.

An increase in the concentrations of prolactin at the time of parturition has been noted in several species including the sheep and cow (Ingalls et al., 1973; Fell et al., 1972; Lamming et al., 1974). An increase in the levels of prolactin about 2 days before parturition was noted by Ingalls et al. (1973) and Fell et al. (1972). It is tempting to associate this with the rapid rise in free circulating estrogens and the decrease in progesterone that take place at this time (Obst & Seamark, 1972; Chamley et al., 1973; Robertson & Smeaton, 1973), but a careful study of the time sequence of these events is necessary any more definite conclusions can be drawn.

No previous study has been done on serum levels of estradiol-17β in the puerperal sow, but the pattern of changes observed in this study is similar to that found in the plasma of puerperal sow (Molokwu & Wagner, 1973). The changes in serum estradiol-17β also correlate with those found by Robertson & King (1974) in the plasma of sow. Previous studies have demonstrated that estrogen are produced by the placenta in the sow (Bowerman et al., 1964). Fèvre et al. (1968) further showed that urinary estrogen content in the pregnant sow was not affected by ovariotomy or hypophysectomy. Fèvre et al. (1972), using adrenalectomized sows, demonstrated that estrogen synthesis in pregnant sow was independent of the maternal adrenal. Fèvre (1970) reported convincing evidence of fetal involvement in this estrogen production by showing that administration of labeled C-19 steroids into the fetal compartment gave a greater conversion to estrone than when infused into the uterine artery of the dam. Since fetal-placental unit appears to be responsible for estrogen production, this accounts for the abrupt decline when this source is removed at parturition.

The pattern of changes in progesterone concentrations observed in this study is general
agreement with the patterns noted in the sow by Molokwu & Wagner (1973), Ash et al. (1973), Robertson & King (1974) and First & Bosc (1979). Many studies have indicated that the corpus luteum (CL) remain the main physiological source of progesterone all through pregnancy, and that the ovary is indispensible during gestation in the sow (Molokwu & Wagner, 1973; First & Bosc, 1979). The abrupt postpartum decline of progesterone observed in this study coincides with the rapid degeneration of the CL of pregnancy. Palmer et al. (1965) reported that by day 1 after farrowing the luteal cells were already showing degenerative changes and that immediately after farrowing the luteal cells were much smaller than just prior to parturition. Thus it appears that the changes observed in serum progesterone in the present study would be consistent with the view that the CL are major source of progesterone in the pregnant.

A rise in serum cortisol levels was observed at parturition in the sow and was similar to the report of Smith et al. (1972) in the cow. Adams & Wagner (1970) also observed a rise in corticoids but their results 2 to 4 days prepartum. In the present study the cortisol rise began to 2 days prepartum which was similar to the report of Molokwu & Wagner (1973).

As shown in figure 2, before parturition occurs, the serum estradiol-17β and cortisol levels rise well above the gestation levels, and the progesterone levels show a substantial decline. Minar & Schilling (1970) and Coggins et al. (1977) were able to delay parturition in the sow by oral administration of progestagens or by parenteral administration of progesterone. This evidence would provide support for the "progesterone block" theory of initiation of parturition (Csapo, 1956) for the sow. But a high proportion of stillbirth occurred when parturition was prevented by continued administration of progestogens (First & Staigmiller, 1973; Coggins et al., 1977), by induced corpora lutea (Coggins et al., 1977; Martin et al., 1977) or by inhibition of luteolysis (Nara & First, 1977). First & Bosc (1979) indicates that the sequence of events leading to parturition start with pituitary stimulation of cortisol production by the adrenal glands, followed by cortisol causing stimulation of the production or release of prostaglandin F2α probably by the uterus.

摘 要

豚に於いて 仔分前後 仔豚血清中の peptide 及び steroid hormone 水準の変化を定量す か頃より 8 頜の妊娠豚を 對象に フィエ 20日目より 分娩後 20日まで 血清中の FSH, LH, prolactin, estradiol-17β, progestrone 及び cortisolの濃 度変化を radioimmunoassay 方法に依り測定 した。

血清 FSH 濃度は 分娩前後迄大変変化が少 なく、8.1 ± 1.8 mIU/ml にて 9.0 ± 2.6 mIU/ml の変化が見られた。LH濃度は 分娩前20日間で 2.6 ± 0.3 mIU/ml で分裂するが 分娩日23日間で 3.9 ± 1.1 mIU/ml に増加する、分娩後 2日目は 3.2 ± 0.9 mIU/ml に減少、その後は シーストのある水準を維持する。Prolactinの濃度は 分娩日 に 68.5 ± 9.5 ng/ml に最高水準を呈し、分娩後前後では比較的小さな水準を呈した。

Estradiol-17βは 分娩前 6日目 に 205.0 ± 29.5 pg/ml に増加するが、分娩後 2日目は 425.0 ± 35.6 pg/ml に増加する。分娩後 2日目は 59.5 ± 7.8 pg/ml に減少する。Progestrone濃度は 分娩前 20日目より 6日まで に 18.4 ± 1.6 ～ 20.2 ± 2.1 ng/ml の変化を示し、分娩後 2日目より 減少する。分娩後 2日目より 減少を 始める。分娩日は 2.6 ± 0.8 ng/ml に減少し、分娩後 2日目は 0.9 ± 0.3 ng/ml に減少する。皮疹及び 毛細の湿潤を得た。Cortisolは 分娩日より 86.5 ± 10.5 ng/ml に最高水準を呈した。
LITERATURE CITED


