Precocious Estrus and Reproductive Ability Induced by PG 600 in Prepuberal Gilts

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ABSTRACT. A total of 29 SPF Large White prepuberal gilts (mean age 152 days at treatment) were examined for estrous and ovulatory responses after PG 600 treatment. After treatment, 85.2% of the gilts showed estrus within 6 days. Whereas the treatment-to-estrus interval and duration were 3.7 and 1.9 days respectively. As ovulation occurred on Day 5 to 6, appropriate timing of artificial insemination would be about 4 days after treatment. Fertility of gilts revealed to be excellent, giving rise to a high percentage of normal embryos, 85.3%. Meanwhile, development and growth of fetuses were mostly normal. Other reproductive performances recorded were: mean litter size 6.8; mean birth weight 1.26 kg; weaning-to-return estrus interval 5 to 8 days. In conclusion, PG 600 was found to be useful in inducing fertile estrus in prepuberal gilts, a result which will be of interest for commercial pig farms.—KEY WORDS: estrus, fertility, ovulation, PG 600, swine (gil).—J. Vet. Med. Sci. 61(1): 7–11, 1998

Pregnant mare serum gonadotropin (PMSG) in combination with either human chorionic gonadotropin (hCG) or gonadotropin releasing hormone (GnRH) has been known to induce estrus and subsequent ovulation in prepuberal gilts successfully, but the results were rather inconsistent especially in cases of poor breeding management [4, 9]. Among these treatments, a single injection of PG600 (a low dose combination of PMSG and hCG) has been claimed to be effect at inducing fertile estrus in prepuberal gilts, thus providing a practical means of facilitating attainment of puberty [15, 16].

Treatment with such exogenous gonadotropic hormones (GTH) in young gilts, however, has never been implemented in Japanese pig farms, as it is widely believed to provoke reproductive failures such as dystocia, lactation trouble and small litter size, etc. Also, some investigators in the late seventies reported rather poor estrus induction rates, as low as about 40%, in prepuberal gilts after simultaneous injections of commercial preparations of PMSG and hCG [10, 12].

This investigation was undertaken in order to reevaluate the usefulness of PG600 in view of estrus and ovulation, to clarify the appropriate timing of artificial insemination, and to evaluate its effects on fertility, conception rate, farrowing rate, litter size and other reproductive performance.

MATERIALS AND METHODS

A total of 54 (29 treated and 25 control) SPF Large White prepuberal gilts were used in the experiments. The gilts were fed with 2.4 kg per day of a grower diet (Zen-noh: 16.3% crude protein, 14.1% digestible crude protein, 4.1% crude fat, 77.2% total digestible nutrients, 0.6% Ca and 0.5% P) and water ad libitum.

Gilts of the treated group (mean age 152 days at treatment) were injected subcutaneously or intramuscularly in the neck behind the ear with 5 ml of a reconstituted solution of PG 600 (PMSG 400 IU + hCG 200 IU/vial, Intervet International B.V., Boxmeer, Holland) in a diluent (phosphate buffer pH 7.0) on Day 0. Whereas the untreated group (phosphate buffer pH 7.0) was treated with a separating interval of 12 hr on the days of displaying standing reflex with a semen containing 9 × 10^9 of sperm gentamycin in 60 ml of Modena extender [19].

Eleven gilts in estrus without insemination were slaughtered on Days 3 to 6 post treatment and examined for ovarian responses. The number of mature follicles and number of corpora lutea (CL) were recorded. An other 7 gilts in estrus and inseminated afterwards were slaughtered on Days 8 to 9 and their reproductive tracts were recovered. Likewise, the number of follicles and the ovulation rate were recorded. Embryos were recovered by flushing with 100 ml of PBS (sterile phosphate buffer) via a sterilized Foly catheter (22 Fr, 30 ml; Cutter, Japan) inserted into the uterine lumen through a small incision made at the site near the uterine body and subjected to microscopic examination for the morphology.

Four anestrous gilts were slaughtered on Day 10 and subjected to examination for the ovarian response to check whether ovulation had occurred.

Three gilts among the artificially inseminated animals were slaughtered on Days 34 and 38 and their reproductive organs were collected. The uterine horns were dissected along the longitudinal direction and the fetuses were recovered.

Twenty-nine gilts including 4 treated and 25 control females in estrus and inseminated subsequently were allowed to farrow in consequence and were examined for litter size, birth weight of piglets born and weaning-to-estrus interval. Statistical comparisons of litter size between treated and control groups were performed using the Mann-Whitney test.

RESULTS

After treatment with PG 600, 86.2% of the gilts exhibited estrous signs characterized by reddening and swelling of the vulva, arched back and erection of ears etc. within 6 days. The estrus induction rate was corrected to 85.2% by excluding 2 gilts slaughtered before coming into standing estrus for examination of ovarian response. The treatment-to-estrus interval and the duration of estrus were 3.7 days and 1.9 days, respectively (Table 1).

Among the gilts in estrus without insemination, none of the gilts had ovulated on Day 3. The mean of mature follicles was 12.0 but no CL were found in the ovaries and they were thus referred to as being in the pre-ovulatory stage. On Day 4, there were no CL in 2 gilts in the pre-ovulatory stage but in another gilt there were 6 CL in addition to some mature follicles. This gilt was referred to as being in the ovulatory stage. On Day 5, three gilts had ovulated with 12.7 CL per gilt but they had no mature follicles; they were referred to as being in the post-ovulatory stage. Meanwhile, another gilt still remained in the pre-ovulatory stage with 9 mature follicles but no CL. The single gilt slaughtered on Day 6 was found to be in the post-ovulatory stage, having 13 CL and no mature follicles (Table 2).

All 7 gilts inseminated and slaughtered on Days 8 and 9 ovulated with a mean ovulation rate of 12.2 CL. Seventy-five embryos were recovered from all the gilts, among which 64 were normal. Thus the fertilization rate and the embryo survival rate were calculated as 87.2% and 85.3% (Table 3). The stage of development of the embryos recovered from these 7 gilts ranged from 2 cells to morulae with 11 degenerated embryos observed at slaughter (Table 4).

Judging from one of the 4 anestrous gilts slaughtered on Day 10 having 13 CL, a silent heat had been induced by administration of PG 600.

Among the 3 gilts slaughtered on Days 34 and 38, two gilts inseminated on Days 4 to 4.5 had a high fetus/CL ratio, as high as 81.8 and 100.0 %, whereas the fetus/CL ratio in the other gilt inseminated on Day 2 after treatment was low at 41.2 % (Table 5).

Four gilts treated at ages of 151 to 170 days with PG 600 gave excellent conception and farrowing rates, as high as 100%, though they yielded rather small total litter size and...
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litter size born alive i.e., 6.8 and 6.3 piglets per litter, respectively. Nevertheless the average birth weight (1.26 kg) and mean weaning-to-estrus interval (6.0 days) seemed to be normal (Table 6).

The reproductive performances observed in the four gilts mentioned above were then compared with those recorded for the 25 untreated control gilts likewise inseminated at various ages ranging from 171 to 240 days when spontaneous puberty was being attained. The control gilts exhibited estrus at least 20 days later and yielded larger total and live litter sizes (10.3 and 9.3 piglets per litter) in comparison with the treated group (Table 7).

DISCUSSION

Many reports suggest that gilts normally attain spontaneous puberty at approximately 180 days of age [1, 7, 14, 18]. Our results obtained in the present trial agreed well with previous findings with no control gilts being found in estrus before 171 days of age. In contrast, estrus in the gilts receiving PG 600 began at 151 to 170 days of age and lasted for about 1.9 days. The duration of estrus thus obtained was also consistent with the documentation by Eliasson [8] that the duration of the estrus at puberty was considerably shorter than subsequent estrus (1.8 vs. 2.1 days). As to synchrony of the induced estrus, we were able to substantiate the results obtained by Burnett and Walkers [5] that PG 600 was effective at inducing well synchronized estrus. The gilts receiving the low dose combination of GTH exhibited signs of standing reflex within 6 days after treatment, in contrast to the untreated control gilts which attained spontaneous puberty and came into estrus at a great variability of age as mentioned above. Karalus et al. [13] investigated the maintenance of estrous cycles and pregnancy in prepuberal gilts treated with PMSG and hCG and demonstrated that onset of puberty occurred at 179.6 days of ages.

Hanada et al. [10] and Iwamoto et al. [12] confirmed that estrus could be induced in prepuberal gilts by treatment with a low dose combination of GTH comprising 400 IU of PMSG and 200 IU of hCG. However, the estrus induction rates achieved by them were low, 30% and 44%, in contrast to the 87.1% observed in our study. Such discrepancies in the results might have arisen from the difference in the

Table 4. Morphology of embryos from gilts inseminated after treatment

<table>
<thead>
<tr>
<th>Days to Slaughter</th>
<th>Day to Estrus</th>
<th>No. of Gilts</th>
<th>No. of Embryos at Various Cell Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>4.0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>4.5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>–</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

Mean 4.3

Table 5. Ovulation rate and No. of fetuses from gilts inseminated after treatment

| Gilt No. | Days to Slaughter | Body Wt. at Slaughter (kg) | Days to Estrus | CL | No. of Fetuses | Fetus/CL Ratio (%)
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34</td>
<td>110</td>
<td>4.0</td>
<td>11</td>
<td>9</td>
<td>81.8</td>
</tr>
<tr>
<td>2</td>
<td>34</td>
<td>114</td>
<td>4.5</td>
<td>13</td>
<td>13</td>
<td>100.0</td>
</tr>
<tr>
<td>3</td>
<td>38</td>
<td>126</td>
<td>2.0</td>
<td>17</td>
<td>7</td>
<td>41.2</td>
</tr>
</tbody>
</table>

Table 6. Reproductive performance of prepuberal gilts with treatment

<table>
<thead>
<tr>
<th>Gilt No.</th>
<th>Age at Treatment (Days)</th>
<th>Body Wt. at Treatment (kg)</th>
<th>Days to Estrus</th>
<th>Litter Size total</th>
<th>Birth Wt. Mean ± SD (kg)</th>
<th>Weaning to Estrus (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>151</td>
<td>86.4</td>
<td>5.5</td>
<td>2.0</td>
<td>1.3 ± 0.2</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>170</td>
<td>88.8</td>
<td>4.0</td>
<td>1.5</td>
<td>1.2 ± 0.2</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>156</td>
<td>101.4</td>
<td>5.0</td>
<td>1.0</td>
<td>1.2 ± 0.3</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>152</td>
<td>99.8</td>
<td>4.0</td>
<td>2.0</td>
<td>1.4 ± 0.1</td>
<td>5</td>
</tr>
</tbody>
</table>

a) Day 0: Day of treatment.
the present trial. However, this is not surprising since it is such as 6.8 and 6.3 piglets respectively were the results of rate during Days 17 to 41 [6].

by previous documentation concerning the prenatal survival rate of embryos or fetuses as suggested 4.5 in the other cases. Our finding might also be related to comparison with insemination carried out later on Days 4 to Day 2 giving rise to a reduced number of fertilized ova in caused by insemination having been performed too early on quite low fertility. This reduced fertility would have been Whereas a pregnant gilt slaughtered on Day 38 afforded a obtained from the gilts slaughtered on Days 8 and 9.

Litter Size, total 6.8 ± 1.3 – – – – 6.8 ± 1.3**
Litter Size, alive 6.3 ± 1.5 – – – – 6.3 ± 1.5*

** P<0.01, * P<0.05, in comparison with control group.

GTH preparations. Though it would most likely be attributable to the difference in estrus detection methodology applied with or without the presence of mature teaser boars in each case since the boar exposure has been well known as an essential breeding management to induce estrus in females [9, 16].

There were mature follicles found in the gilts slaughtered on Day 3, whereas ovulation started on Day 4 and was completed on Day 5 after treatment. This fact demonstrates that PG 600 stimulated follicular growth and subsequent ovulation in the prepuberal gilts of about 5 months of age. Meanwhile, one of the 4 anestrous gilts was found to be in silent heat, i.e. ovulated without exhibition of estrous signs. This is basically the same phenomenon as gilts attaining spontaneous puberty which can be inferred from the progesterone levels [8, 18]. Since the percentage of ovulated gilts would be higher than the percentage of gilts in estrus, artificial insemination at 96 hr after treatment would be successful without estrus detection [3].

The fertility rate in the present trial from the pregnant gilts inseminated on Day 4 and slaughtered on Days 8 and 9 were similar to those afforded by the gilts attaining spontaneous puberty at 5 to 8 months of age [6]. The pregnant gilts slaughtered on Day 34 afforded a high fertility reflected in the fetus/CL ratio comparable with those obtained from the gilts slaughtered on Days 8 and 9. Whereas a pregnant gilt slaughtered on Day 38 afforded a quite low fertility. This reduced fertility would have been caused by insemination having been performed too early on Day 2 giving rise to a reduced number of fertilized ova in comparison with insemination carried out later on Days 4 to 4.5 in the other cases. Our finding might also be related to the prenatal survival rate of embryos or fetuses as suggested by previous documentation concerning the prenatal survival rate during Days 17 to 41 [6].

Rather small total litter size and litter size born alive such as 6.8 and 6.3 piglets respectively were the results of the present trial. However, this is not surprising since it is plausible that the genital organs of young prepuberal gilts at 5 months of age would not have fully grown. Nevertheless undergoing stimulation by the exogenous GTH, the small sized uterus would accept only a limited number of the fertilized ova resulting in the small litter size, since prenatal survival is known to be correlated with uterine capacity [5, 6]. The control gilts in our trial who were inseminated after attaining spontaneous puberty later at various ages had increased litter sizes born alive progressively ranging from 8.3 to 10.0 piglets bred at 171 to 240 days of age. This was approximately in agreement with the results reported by Isler [11], ranging from 7.13 to 8.19 piglets bred at 24 to 35 weeks (168 to 245 days) of age. Skip mating at first estrus induced by PG 600, breeding at second or third estrus, would seem to improve the litter size since the ovulation rate [2, 7] and uterine length [20] would increase with successive estrous cycles. Furthermore, this would be beneficial to keep longevity of the breeding herd substantiating the conclusion of Schukken et al. [17]. They demonstrated that the optimum economic age for replacement gilts at first breeding would be 200 to 220 days old as a result of an epidemiological evaluation of fertility management in swine herd. In conclusion, PG 600 was found to be useful in inducing fertile estrus in prepuberal gilts, a result which will be of interest for commercial pig farms.

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REFERENCES