Effect of subcutaneous vs intramuscular administration of P.G. 600 on estrual and ovulatory responses of prepubertal gilts1

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ABSTRACT: The effects of s.c. and i.m. administration of P.G. 600 on estrual and ovulatory responses of prepubertal gilts were investigated. One hundred eighty-four crossbred gilts between 159 and 174 d of age were assigned to receive P.G. 600 s.c. (s.c. P.G. 600) in the flank, P.G. 600 i.m. in the neck (i.m. P.G. 600), or no treatment (control). At the beginning of the study (d 0), animals were selected from a modified, open-front barn, regrouped, relocated to new pens, and exposed once daily to a mature boar to check for estrus. On d 17, ovaries were collected from all gilts and analyzed for the presence of corpora lutea (CL), cystic follicles, and cystic CL. A higher proportion of gilts expressed estrus with s.c. P.G. 600 (76%) than with i.m. P.G. 600 (52%, \( P < .01 \)) or controls (15%, \( P < .01 \)). The interval from initiation of treatment on d 0 to estrus was reduced (\( P < .01 \)) by P.G. 600 (4.6 d) compared to controls (5.9 d), but there was no significant difference between P.G. 600 treatments. Both s.c. P.G. 600 (86%) and i.m. P.G. 600 (77%) induced more gilts to ovulate (\( P < .01 \)) than controls (18%), but there was no significant difference between P.G. 600 treatments. No significant effect of treatment was detected on number of CL (17.9), number of cystic follicles (1.5), or number of cystic CL (2.1). Proportions of gilts that developed cystic follicles or cystic CL were not influenced by treatment. Results of this study indicated that s.c. ministration of P.G. 600 significantly improved the induction of estrus in prepubertal gilts compared to i.m. administration.

Key Words: Chorionic Gonadotropin, Estrus, Gilts, Intramuscular Injection, Ovulation, Subcutaneous Injection

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Introduction

The compound P.G. 600 (Intervet, Millsboro, DE) is a commercially available hormone preparation that contains 400 IU eCG and 200 IU hCG and has been approved for induction of estrus in swine. Early research (Schilling and Cerne, 1972) indicated that a combined injection of eCG and hCG could induce > 90% of prepubertal gilts to express estrus within 3 to 7 d, with high percentages conceiving (80%) and farrowing (78%). Subsequent research with P.G. 600 has produced variable results with respect to both estrus and ovulation in prepubertal gilts. However, in general, induction of estrus and ovulation seem to have resulted more frequently in experiments in which the hormone was administered s.c. (Schilling and Cerne, 1972; Baker and Rajamahendran, 1973; Patterson and Martin, 1981) rather than i.m. (Britt et al., 1989; Tilton et al., 1995; Knox and Tudor, 1999).

Separate injections of eCG and hCG have also been used for inducing follicle growth, estrus, and ovulation in swine. Although the drugs have been administered both i.m. and s.c., comparisons of effect on estrual response have not been made within experiments. Differences in results between experiments may have occurred due to differences in dosage, source, and preparation or ratio of FSH to LH biological activity (Gonzalez-Mencio et al., 1978; Aggarwal et al., 1980; Murphy et al., 1984).

Available evidence suggests that s.c. administration of P.G. 600 may improve reproductive efficiency relative to i.m. administration. The objective for this study was to determine whether the estrual and ovulatory responses of prepubertal gilts to P.G. 600 were influenced by the mode of administration.
Materials and Methods

Experiment

The experiment was conducted on seven different occasions between 1997 and 1999 at the Illinois State University swine facility. The data were collected during the months of January, February, March, June, August, November, and December. Crossbred terminal line Hampshire × Pietrain × Landrace × Large White prepubertal gilts (n = 184) were blocked by age, weight, and litter and randomly assigned to receive 1) P.G. 600 (400 IU of eCG and 200 IU of hCG in 5 mL of physiological saline) by s.c. injection in the flank (s.c. P.G. 600; n = 78); 2) P.G. 600 by i.m. injection in the neck (i.m. P.G. 600; n = 71); or 3) no P.G. 600 (control; n = 35). Each treatment was applied to 9 to 10 gilts in any 1 mo with the exception of the trial conducted in March, which contained three to four gilts per treatment.

All gilts were moved through chutes and weighed, but only gilts that were to receive an injection of P.G. 600 were snared. The gilts averaged 167.2 ± 3.3 kg at the start of the trial. Gilts assigned to s.c. P.G. 600 were injected between the fat and muscle layers in the flank, lateral to the teats just forward of the rear leg, using a 38-mm, 20-gauge needle. Gilts assigned to i.m. P.G. 600 were injected in the neck muscle immediately behind the ear using a 38-mm, 20-gauge needle. Immediately after P.G. 600 was administered (d 0), all animals, including controls, were regrouped and assigned to one of two new pens in a modified, open-front confinement facility. Each treatment was allocated equally across the two pens with approximately 12 to 15 gilts per pen. Gilts were given ad libitum access to 14% CP corn-soybean meal diet. To account for the effects of regrouping, relocation, management, and boar exposure on the various reproductive traits considered, control gilts were included in the January, February, June, and November trials.

All animals were checked for estrus one time daily for 15 min using fence-line contact with a mature boar. Estrus detection continued for 17 d after initiation of the experiment, and on d 17 all animals were slaughtered and reproductive tracts were recovered. Ovaries were examined for the presence of corpora lutea (CL), cystic follicles (> 12 mm), and cystic CL (uncharacteristic luteal structures with fluid-filled compartments).

Statistical Analysis

The response variables considered were days from treatment to estrus (given that the gilt expressed estrus), number of CL (given that the gilt had at least one CL), number of cystic follicles (given that the gilt had at least one cystic follicle), number of cystic CL (given that the gilt had at least one cystic CL), frequency of estrus expression, frequency of ovulation, frequency of ovulation conditional on estrus expression, frequency of cystic follicles, and frequency of cystic CL. These variables were modeled using a mixed effects model, \( y_{ijk} = \mu + b_i + t_j + e_{ijk} \), where \( y_{ijk} \) represents the observation from the kth gilt on the jth treatment and ith block. \( \mu \) is the intercept; \( b_i \) denotes the random effect of the ith block (i = January, February, March, June, August, November, and December), \( t_j \) indicates the fixed effect of the jth treatment (j = s.c. P.G. 600, i.m. P.G. 600, and control), and \( e_{ijk} \) represents the random residuals unique to the ith block, jth treatment, and kth gilt. The random block effects were assumed to be independent and identically distributed with mean zero and variance \( \sigma^2_b \) and the residuals were assumed to be independent and identically distributed with mean zero and variance \( \sigma^2_e \). The covariance between the random effects was assumed to be zero. This model, with treatment and block terms, is recommended by Milliken and Johnson (1992) for the unbalanced incomplete block data structure observed in this study. The mixed model approach provides estimates of treatment effect based on intrablock and interblock information, improving on the fixed-effects models that are based only on intrablock differences (SAS, 1997).

Estrus expression, ovulation, cystic follicles, and cystic CL are binary and were assumed to have a binomial distribution. Days from initiation of treatment to estrus, number of CL, number of cystic follicles, and number of cystic CL are counts and were assumed to have a Poisson distribution. The standard linear mixed model assumptions (normality and homoscedasticity) are violated. Hence, for the first set of variables a logistic model was implemented and for the latter group a Poisson (log-normal) model was used (SAS, 1997). These approaches have statistical properties that are more appropriate to describe categorical variables than those based on normality. For example, percentage estimates range between 0 and 100% and count estimates vary between 0 and infinity. These ranges are consistent with the biological processes being modeled. In addition, due to the nonnormality of the data analyzed, standard errors lack meaningful interpretation. For this reason, reported estimates are least squares means with the associated 95% confidence interval lower and upper limits.

There were no cystic follicle observations in the control group, hence the analysis of number and percentage of gilts with cystic follicles only included observations from gilts receiving s.c. and i.m. P.G. 600 treatments. The weight and age of gilts at initiation of the trial (d 0) were analyzed using a linear mixed effects model (SAS, 1997) to ensure that age and weight were equally distributed across treatment classes. The differences between least squares means of s.c. and i.m. P.G. 600 and between P.G. 600-treated and control gilts were determined using the F statistic test (SAS, 1997).

Results

The age and weight at initiation of trial (d 0) were not significantly different among treatments, as expected
Table 1. Least squares means for age and weight at initiation of treatment (d 0), and interval from d 0 to estrus (days to estrus)

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>i.m. P.G. 600</th>
<th>s.c. P.G. 600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, kg</td>
<td>100.0^b</td>
<td>99.8</td>
<td>100.5</td>
</tr>
<tr>
<td>(94.1, 105.9)^c</td>
<td>(95.0, 104.7)</td>
<td>(95.7, 105.2)</td>
<td></td>
</tr>
<tr>
<td>Age, d</td>
<td>166.8</td>
<td>166.7</td>
<td>166.7</td>
</tr>
<tr>
<td>(164.1, 169.4)</td>
<td>(164.1, 169.2)</td>
<td>(164.1, 169.2)</td>
<td></td>
</tr>
<tr>
<td>Days to estrus</td>
<td>5.9^y</td>
<td>4.8^z</td>
<td>4.6^z</td>
</tr>
<tr>
<td>(5.1, 6.6)</td>
<td>(4.5, 5.3)</td>
<td>(4.3, 4.9)</td>
<td></td>
</tr>
</tbody>
</table>

^aControl = no P.G. 600; i.m. P.G. 600 = intramuscular administration of P.G. 600; s.c. P.G. 600 = subcutaneous administration of P.G. 600.
^bLeast squares means.
^c95% Confidence interval with lower and upper limits.
^dNumber of observations.
^y,zWithin a row, least squares means with different superscripts differ (P < .01).

(Table 1). In addition, when these variables were included in the model as regressors, they were not associated with significant variations in any of the traits considered and were removed from the model. The number of days from initiation of treatment to estrus was greater for control gilts than for P.G. 600-treated gilts (P < .01), but there was no significant difference between s.c. and i.m. P.G. 600 treatments (Table 1). The number of CL, number of cystic follicles, and number of cystic CL were not significantly influenced by treatment (Table 2).

The proportion of gilts that expressed estrus was higher in the group treated s.c. rather than i.m. with P.G. 600 (Figure 1, P < .01), and a greater proportion of P.G. 600-treated gilts expressed estrus than did controls (P < .0001, Table 3). Greater proportions of P.G. 600-treated gilts ovulated than controls (P < .01), but s.c. and i.m. treatments did not differ from each other (P > .10, Table 3). The number of gilts receiving s.c. P.G. 600 that ovulated tended to be greater than the number in the i.m. P.G. 600-treated group (Table 3). Of the 51 P.G. 600-treated gilts that failed to express estrus within 17 d, 24 ovulated. The least squares means percentage of gilts that ovulated but did not express estrus was 62, 52, and 7% for i.m. P.G. 600, s.c. P.G. 600, and control, respectively. The only significant difference (P < .01) was between P.G. 600-treated and control groups.

There was no significant difference between s.c. and i.m. P.G. 600 treatments in the proportions of gilts with cystic CL (P > .10) or with cystic follicles (P > .10) (Table 3). The least squares means estimate of the percentage of gilts with cystic CL was higher among treated gilts than among controls (P = .04). All gilts that had not ovulated exhibited ovaries with small and medium-sized follicles characteristic of prepubertal gilts. Corpora lutea were at similar stages of development as assessed by size and general appearance of internal structure after bisection.

Discussion

Results of this experiment indicated that s.c. administration of P.G. 600 significantly increased the estimated percentage of females expressing estrus by 46% (from 52 to 76%) compared to i.m. administration. Additionally, although not significant, s.c. P.G. 600 resulted in a 12% (from 77 to 87%) improvement in the number of gilts that ovulated compared to i.m. administration.

Table 2. Least squares means for number of corpora lutea, number of cystic follicles, and number of cystic corpora lutea

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>i.m. P.G. 600</th>
<th>s.c. P.G. 600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corpora lutea</td>
<td>15.7^b</td>
<td>17.5</td>
<td>18.4</td>
</tr>
<tr>
<td>(8.8, 27.9)^c</td>
<td>(14.3, 21.3)</td>
<td>(15.5, 21.8)</td>
<td></td>
</tr>
<tr>
<td>Cystic follicles</td>
<td>NA^e</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>(.8, 2.7)</td>
<td>(.9, 2.5)</td>
<td>.9, 2.5)</td>
<td></td>
</tr>
<tr>
<td>Cystic corpora lutea</td>
<td>3.0</td>
<td>1.8</td>
<td>2.4</td>
</tr>
<tr>
<td>(2.0, 4.0)</td>
<td>(1.4, 4.0)</td>
<td>1.4, 4.0)</td>
<td></td>
</tr>
</tbody>
</table>

^aControl = no P.G. 600; i.m. P.G. 600 = intramuscular administration of P.G. 600; s.c. P.G. 600 = subcutaneous administration of P.G. 600.
^bLeast squares means.
^c95% Confidence interval with lower and upper limits.
^dNumber of observations.
^eNA, not applicable.
Table 3. Least squares means of percentage of 165-d-old prepubertal gilts that expressed estrus, ovulated, and formed cystic follicles and cystic corpora lutea in response to subcutaneous or intramuscular P.G. 600

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>i.m. P.G. 600</th>
<th>s.c. P.G. 600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expressed estrus, %</td>
<td>15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>52&lt;sup&gt;b&lt;/sup&gt;</td>
<td>76&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>(6, 32)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>(35, 68)</td>
<td>(61, 87)</td>
<td></td>
</tr>
<tr>
<td>Ovulated, %</td>
<td>18&lt;sup&gt;a&lt;/sup&gt;</td>
<td>77&lt;sup&gt;b&lt;/sup&gt;</td>
<td>86&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>(8, 36)</td>
<td>(64, 86)</td>
<td>(75, 92)</td>
<td></td>
</tr>
<tr>
<td>Cystic follicles, %</td>
<td>NA&lt;sup&gt;d&lt;/sup&gt;</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>NA</td>
<td>(4, 18)</td>
<td>(7, 23)</td>
<td></td>
</tr>
<tr>
<td>Cystic corpora lutea, %</td>
<td>4</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>(1, 18)</td>
<td>(8, 40)</td>
<td>(5, 28)</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Control = no P.G. 600; i.m. P.G. 600 = intramuscular administration; s.c. P.G. 600 = subcutaneous administration.
<sup>b</sup>95% Confidence interval with lower and upper limits.
<sup>c</sup>Number of observations.
<sup>d</sup>NA, not applicable.
<sup>c</sup><sup>d</sup>Within a row, least squares means with different superscripts differ (<i>P</i> < .01).

Both modes of P.G. 600 administration significantly increased the percentage of prepubertal gilts that expressed estrus and ovulated compared to control gilts under the same management. The s.c. and i.m. P.G. 600 treatments induced an average of 18 follicles to ovulate and form CL, with no significant increase in the numbers or frequency of cystic follicles or number of cystic CL. Thus, s.c. administration of P.G. 600 could prove beneficial for estrus induction in swine. This would benefit swine producers by allowing more precision in scheduling entry of replacement gilts into the breeding herd and would reduce the costs associated with size of the gilt pool, non-productive days, feed costs, and labor for estrus detection.

The most important difference between the s.c. and i.m. P.G. 600 groups was in the percentage of gilts expressing estrus. The estrus induction percentages obtained with s.c. P.G. 600 in the present experiment (76%, Table 3) approached those obtained by others (75 to 100%) who have used s.c. P.G. 600 (Schilling and Cerne, 1972; Baker and Rajamahendran, 1973; Patterson and Martin, 1981). The estimated percentage of i.m. P.G. 600-treated gilts expressing estrus (52%) was consistent with other studies in which i.m. P.G. 600 administration occurred (50 to 70%, Britt et al., 1989; Tilton et al., 1995; Knox and Tudor, 1999). It is notable that only 15% of the untreated gilts in the present study expressed estrus within a 17-d period in response to regrouping, relocation, and boar exposure. This percentage is similar to previous observations in this genetic line (Knox and Tudor, 1999), supporting the hypothesis that this crossbred female population is a sample from a line selected for delayed puberty. Typical estrus induction methods using boar exposure combined with mixing and relocation are reported to induce 40% of crossbred females into estrus within 10 d (Hughes, 1982).

The frequency of gilts ovulating without estrus was highest in the i.m. group, closely followed by the s.c. P.G. 600 group; but both groups had a significantly higher incidence of ovulation than the control group. This phenomenon has also been observed to occur at a frequency of 16% in untreated, pubertal-age females in production herds (Eliasson, 1991) and even more frequently in prepubertal gilts induced to ovulate with gonadotropins. However, this is the first time the effect of mode of P.G. 600 administration has been shown to affect the percentage of gilts that ovulate without expressing estrus. Inducing both estrus and ovulation in prepubertal gilts may depend on the hormone, dose, and method of administration. When the ratio and amount of eCG/hCG in a single injection is altered, although ovulation occurs over all combinations, estrus expression is observed predominantly in only two of the combinations (Baker and Downey, 1975). Similarly, prepubertal gilts treated only with hCG express estrus only 50% of the time, even though ovulation almost always occurs (Baker and Rajamahendran, 1973; Dricourt et al., 1992).

Differences in expression of estrus but not in ovulation suggest the involvement of estrogen. Guthrie et al. (1997) reported that many prepubertal gilts treated with gonadotropins failed to express estrus even though follicle development was increased. They observed that concentrations of plasma estradiol were generally lower for certain gonadotropin treatments associated with reduced expression of estrus, but that concentrations of follicular estradiol did not differ among treatments. This suggests that the release of estrogen from follicles is somehow dependent on the type of gonadal stimulation. Further, although it is known that higher doses of estrogen frequently induce estrus, Dial et al. (1983) reported that low doses not only fail to induce estrus and an LH surge, but that some gilts ovulate even in the absence of a detectable LH surge. Determining estrogen concentrations in follicles and in the blood in response to treatment may be essential for aiding in understanding the dissociation between estrus and ovulation.

The ability to ovulate and express estrus in response to a given dose of hormone may ultimately depend on the stage of ovarian and hypothalamic maturity. Elsasser (1982) has suggested that the LH surge mechanism is intact and functional prior to puberty and, even though the gilt can respond to estrogen feedback, the ovary may be unable to release an estrogen surge. Therefore, the different responses of gilts at identical chronological ages to the same dose of hormone suggests that as reproductive maturation proceeds in the gilt, the systems for control of ovulation and estrus develop gradually, independently, and at different times.
Evidence to support this hypothesis comes from Deligeorgis et al. (1984), who observed that prepubertal gilts of similar ages showed differential follicle growth and ovulation responses to estrogen treatment. Further, Bolamba et al. (1991) reported that prepubertal gilts at the same chronological age had different numbers of medium- and large-sized follicles (> 5 to 6 mm). Of great importance, however, was the fact that when hCG was administered to these gilts, ovulation occurred in all gilts that had follicles > 5 mm on their ovaries, regardless of absolute numbers of follicles > 5 mm. Driancourt et al. (1992) suggested that the reason prepubertal gilts are induced to estrus 4 to 5 d after gonadotropin treatment is because the hormones act upon the medium- and large-sized follicles that are present at the time of injection. These follicles, if present, are able to mature, produce estrogen, and ovulate, and, if great enough in number, to produce adequate levels estrogen to induce estrus.

Therefore, we hypothesize that in the present experiment the difference in estrus expression between the s.c. and i.m. treatments arose due to the manner in which hCG was administered and in which this affected the gilts that had medium- to large-sized follicles (> 5 to 6 mm) on their ovaries at the time of treatment. One possible scenario is that in the i.m. P.G. 600 treatment group, hCG would tend to show a rapid increase in circulation, which could induce ovulation of any follicles that were large enough to respond. The short time from injection to ovulation could prevent estrogen from reaching concentrations high enough to induce estrus or could fail to induce estrus of normal length (Yang et al., 1987). In contrast, the s.c. injection of eCG/hCG would appear in circulation at a much lower and more sustained level, which would likely cause growth of follicles, allowing more time for estrogen concentrations to increase and induce estrus in 4 to 5 d.

Evidence to support this hypothesis for the effect of the route of the hCG hormone injection comes from a study in human males, in which s.c. hCG caused a delayed time to peak serum concentrations and a more prolonged serum half-life than i.m. hCG administration (Saal et al., 1991). Further, in cattle, ovulation rates are lower when FSH is administered s.c. in the neck than with s.c. injection behind the shoulder (Bo et al., 1994). The authors speculated that the amount of fat at the site of the s.c. injection most likely influenced the response. In the gilt, the amount of fat at the s.c. flank injection site was presumably much greater than in the neck muscle. If this was the case, then it is likely that a delay in the peak levels in circulation and clearance rate were quite different between the s.c and i.m. treatments. Therefore, differences in the ratio of eCG to hCG bioactivity in circulation would be expected over time between the s.c. and i.m. routes, because the biological half-life of eCG has been reported to last for 5 to 6 d (Ladman, 1964; Murphy and Martinuk, 1991). This could explain the estrus expression differences between the studies, because a change in the ratio of eCG to hCG was observed to dramatically influence estrus expression in pigs (Baker and Downey, 1975). It would be of great benefit, therefore, to characterize the pattern and duration of eCG/hCG bioactivity in circulation in order to facilitate improved methods for estrus induction in pigs.

The wide range of successful estrus induction among published research trials using P.G. 600 implicates additional factors besides route of gonadotropin administration. Other variables, including animal age and weight at treatment, environment and boar exposure (Caton et al., 1986; Christenson, 1986), genetic composition, level of nutrition, and season of the year (Hughes, 1982) may all play a role in attainment of puberty. In the present experiment, variation based on age, weight, and breed composition was minimized by design. Despite this, we observed estrus induction and ovulation percentages to vary widely across month (data not shown). However, our observations on the month effect could be confounded with other sources of variation, such as differences in bioactivity from different hormone lots. Further research may be needed to partition the month effect into components, such as season, that are involved in the variability of the estrous response.

The ovulation rate (number of CL) in this experiment did not differ between s.c. and i.m. P.G. 600 treatments. The number of follicles that ovulated and formed CL within P.G. 600-treated gilts seemed to be optimal for inducing estrus and a normal luteal phase. The estimated number of CL we observed in the P.G. 600-treated gilts was higher (16 to 18) than that reported by Baker and Rajamahendran (1973), Patterson and Lindsay (1981), or Patterson and Martin (1981) and slightly higher than treatment means (11 to 17 CL) observed by Tilton et al. (1995). These estimates were slightly lower than the number of CL (21 to 23 CL) reported by Guthrie (1977), Nephew et al. (1994), and Knox and Tudor (1999). It is not apparent why differences in ovulation rate between studies occurred, because the administered dose was identical across all experiments. Other factors could influence this differential response, such as physiological age, differences between hormone batches in biological activity, genetic composition of gilts, and management differences between experiments. Despite the high number of CL in the present study, there was no significant increase in the number of cysts or cystic CL in response to any of the treatments. Tilton et al. (1995) observed that younger females (140 to 150 d of age) induced to ovulate with P.G. 600 showed a significantly higher incidence of cystic follicles.

Further research is needed to determine whether other breeds and age groups of females will respond as well as the gilts in the present experiment. It is also unknown whether additional effort or labor would be required to restrain a gilt in order to properly administer the drug s.c. in a production setting. However, in our hands, the time to snare and administer the drug did not seem to be drastically different between the s.c.
and i.m. routes of administration. It is clear from this experiment that the use of P.G. 600 by s.c. injection could provide producers with a significant advantage for scheduling replacement gilt entry into the breeding herd.

Implications

The results of this experiment indicate that subcutaneous administration of P.G. 600 to 165-d-old prepubertal gilts improves the induction of estrus compared to intramuscular administration. Both routes of administration were associated with significantly higher percentages of gilts expressing estrus and ovulating and significantly earlier time to estrus than controls under the same management. Therefore, this treatment regimen could prove especially beneficial for inducing estrus in females that do not respond adequately to boar exposure, regrouping, or relocation near anticipated age of puberty. The use of this hormone preparation could provide producers with an advantage for scheduling replacement females and for reducing the costs associated with large replacement gilt pools.

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