Induced Ovulation and Synchronized Breeding of Prepuberal Gilts

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INTRODUCTION

A hormonal combination consisting of 400 IU of pregnant mare serum gonadotrophin (PMSG) and 200 IU of human chorionic gonadotrophin (HCG) has recently become available for commercial use in Europe. Treatment of anestrous sows and gilts with this compound led to a standing estrus response in 70 to 78% of treated animals and pregnancy rates from 58 to 80% of bred animals (1). Regular 21 day cycles were induced in 86% of prepuberal Swedish Landrace gilts treated at five to five and one-half months of age and a similar response was obtained in 90 to 100% of German Landrace gilts treated at 180 days of age (2, 3).

This treatment would be of considerable economic value to commercial swine operations as a means of controlling the onset of puberty and obtaining a synchronized first breeding of young gilts. Therefore a series of experiments was initiated to test the efficiency of single and multiple administrations of this hormonal combination in Canadian gilts.

MATERIALS AND METHODS

The experimental animals were prepuberal, purebred Yorkshire, Duroc or crossbred Yorkshire x Duroc gilts. All gilts were weaned at three to four weeks of age and maintained in a feeder barn or on a pasture area equipped with shelters. Immediately prior to treatment, groups of gilts were moved to breeding pens adjacent to the boar stud barn. The weight range of the gilts at the time of breeding was 65 to 80 kg (135 to 180 days of age). Unless otherwise indicated treatment for induction of puberty consisted of a single intramuscular injection of the hormonal combination.

Estrus detection was facilitated by placing a vasectomized boar with the gilts, in a pen adjacent to the gilts' pen or by moving the gilts daily into the boar barn. When placed in the boar barn, the gilts were allowed to wander freely between the boar pens to receive stimulation from sight, sound and smell of the boars. Standing estrous behaviour was confirmed by means of the back pressure test or by allowing a boar to mount the females.

The gilts were inseminated artificially with fresh semen from boars of proven fertility. The semen was collected and extended with skim milk, glucose and antibiotics on each day of breeding.

Experiment 1 – Ovulation rate

Five Yorkshire and eight Yorkshire x Duroc gilts were induced to ovulate at 140 days of age with 400 IU of PMSG combined with 200 IU of HCG1 administered as an intramuscular injection. This single injection will subsequently be referred to as the hormonal combination. The gilts were slaughtered approximately 30 hours postestrus and the corpora hemorrhagica were counted to determine the ovulation rate.

Experiment 2 – Estrus response and farrowing rates

A total of 75 prepuberal animals in four groups of Yorkshire or Duroc gilts were induced to ovulate as follows. Group 1 gilts were given an injection of 1000 IU of PMSG2 followed by a second injection of 500 IU of HCG3 72 hours later. The other groups were treated with the hormonal combination as described in experiment 1. Group 1 gilts were inseminated 24 hours after the injection of HCG whether or not they demonstrated standing estrus behaviour. In the other groups, only gilts demonstrating standing estrus behaviour, were inseminated on each day estrus was observed. Litter sizes and birth weights were recorded at farrowing.

Experiment 3 – Synchronization of breeding dates at the second estrus

Group 1, consisting of 12 Yorkshire gilts, received the hormonal combination at 155 days of age. They were allowed to complete one estrual cycle and were inseminated at the next observed estrus, i.e. about three weeks after treatment. Group 2 contained 11 similar aged gilts that were given the hormonal combination at 155 days of age and again at 176 days of age. Gilts demonstrating estrus following the second injection were inseminated. Both groups were pregnancy checked with an ultrasonic instrument. All animals that conceived were allowed to complete gestation and farrow.

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TABLE I
ESTRUS RESPONSE AND OVULATION RATE RECORDED FOR PREPUBERAL GILTS TREATED WITH A COMBINATION OF PMSG/HCG

<table>
<thead>
<tr>
<th>Breed</th>
<th>No. of gilts</th>
<th>Age in days</th>
<th>No. in estrus</th>
<th>Ovulationsa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yorkshire</td>
<td>5</td>
<td>150</td>
<td>4</td>
<td>12.25±4.6</td>
</tr>
<tr>
<td>York. × Duroc</td>
<td>8</td>
<td>135</td>
<td>7</td>
<td>13.9 ± 6.6</td>
</tr>
</tbody>
</table>

aMean ± standard deviation.

TABLE II
BREEDING AND Farrowing RESULTS FOR PREPUBERAL GILTS TREATED WITH PMSG/HCG TO INDUCE A SYNCHRONIZED OVULATION

<table>
<thead>
<tr>
<th>Group no.</th>
<th>1a</th>
<th>2b</th>
<th>3b</th>
<th>4b</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of gilts</td>
<td>10</td>
<td>10</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>Gilts season of birth</td>
<td>Fall</td>
<td>Fall</td>
<td>Spring</td>
<td>Winter</td>
</tr>
<tr>
<td>Breed</td>
<td>Yorkshire</td>
<td>Yorkshire</td>
<td>Duroc</td>
<td>Yorkshire</td>
</tr>
<tr>
<td>Age in days</td>
<td>165-170</td>
<td>165-170</td>
<td>138-149</td>
<td>136-154</td>
</tr>
<tr>
<td>No. in estrus</td>
<td>7</td>
<td>10</td>
<td>22</td>
<td>32</td>
</tr>
<tr>
<td>No. of gilts</td>
<td>10</td>
<td>10</td>
<td>22</td>
<td>32</td>
</tr>
<tr>
<td>No. of gilts</td>
<td>5</td>
<td>6</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Litter sizea</td>
<td>9.2±1.9</td>
<td>7.5±2.1</td>
<td>8.0±2.0</td>
<td>6.7±2.4</td>
</tr>
<tr>
<td>No. still born</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Birth wt. kgc</td>
<td>1.14±0.10</td>
<td>1.16±0.13</td>
<td>1.42±0.25</td>
<td>1.01±2.0</td>
</tr>
</tbody>
</table>

a1000 IU PMSG and 500 IU HCG, separate injections 72 hours apart.
b400 IU PMSG with 200 IU HCG, single injection.
cMean ± standard deviation.

Experiment 4 – Progesterone levels and response in gilts receiving three injections of PMSG/HCG at 21 day intervals

Nine prepuberal Yorkshire gilts at 105 days of age were treated with a series of three injections of the hormonal combination at 21 day intervals. All gilts were observed for standing estrous behaviour for five days following each injection. Gilts that exhibited standing estrus after the third injection were bred. Blood samples were taken at four day intervals commencing just prior to the initial treatment (105 days of age) and continuing until 60 days of gestation. Progesterone content was determined by a competitive protein binding method (4).

Experiment 5 – Response of near puberal animals to one injection of PMSG/HCG and breeding at second estrus

Sixty-four Yorkshire gilts, between the ages of 172 to 181 days, that had not shown signs of previous estrus activity were induced to ovulate with the hormonal combination. These animals were not bred at the induced estrus but allowed to complete one estrual cycle. Half of the gilts demonstrating a second estrus were selected randomly and bred at this estrus and slaughtered 30 days postbreeding to determine the pregnancy rate. Only half of this group were bred since these gilts were part of a separate nutrition trial which required the slaughter of the other half at the second estrus.

RESULTS AND DISCUSSION

A preliminary study involving recovery and gross examination of the reproductive systems from all females between four and eight months of age that were sent for slaughter from the University experimental herd over a one year period was conducted just prior to these experiments. The results, obtained from these animals indicated that 50% of the gilts had their first ovulation by 185 days of age with a range from 140 to 230 days and less than 10% ovulated prior to 160 days of age.

Experiment 1 – Ovulation rate

One purebred and one crossbred gilt did not ovulate in response to the hormonal combination. At slaughter their ovaries showed numerous small follicles and were considered normal for prepuberal gilts. The results listed in Table I from the responding animals show a mean of 12.25 ovulations in the purebred gilts and a mean of 13.9 ovulations in the crossbred gilts. The results from the induced ovulation of prepuberal animals with the hormonal combination in this experiment are comparable with those reported following natural puberty (5).

Experiment 2 – Estrus response and farrowing rate

The results obtained from the four groups of prepuberal gilts are listed in Table II. Groups 1
and 2 were treated simultaneously to compare the commonly used separate injection schedule of PMSG and HCG with a single injection of PMSG combined with HCG. There was no apparent difference in the number of piglets obtained from each group.

In group 1, treated with the separate injection schedule, three of the gilts did not demonstrate standing estrus behaviour following the last injection whereas all gilts in group 2, treated with the single injection of the hormonal combination, were observed in standing estrus. In groups 3 and 4, only one gilt did not respond to the hormonal combination. This gilt was sacrificed and found to have an infantile reproductive tract. The litter sizes in all groups were similar to or larger than those obtained in previous reports on the induction of pregnancy in prepuberal animals (2, 6, 7, 8).

The gilts in group 4 farrowed at an average weight of 140 kg at 255 days of age. No assistance was required at farrowing and all animals readily accepted their litters. The mammary glands were well developed and at 14 days of age the mean piglet weight was 3.88 kg which indicated an adequate supply of milk for normal piglet growth. In general, the results from all groups indicate that 30 to 60% of prepuberal gilts are physically capable of maintaining successful pregnancies. Fall farrowed gilts are considered to reach natural puberty at an earlier age than animals born in other seasons (9, 10). In this experiment, the farrowing rate of 11 of 20 fall farrowed gilts slightly exceeded the rates obtained with the spring and winter farrowed gilts. However, this may be related to the fact that the fall farrowed animals were three weeks older at the time of induced ovulation. A high degree of synchronized estrus was observed in the gilts treated with the hormonal combination. All of these gilts were inseminated twice in the period from day 3 to day 6 following the hormone treatment. The farrowing dates were synchronized in that the pregnant animals farrowed with a three day period. One of the Duroc gilts in group 3 experienced problems at farrowing and required a caesarian delivery. Two of her piglets had a birth weight in excess of 2 kg.

**Experiment 3 – Synchronization of breeding dates at the second estrus**

Table III lists the results of this experiment. All 23 of the treated gilts were observed in estrus between four and six days following the initial injection of the hormonal combination. The onset of the second estrus for animals in the group which received only the initial injection ranged over a seven day period. Response in the second group, which received a second injection, 21 days after the initial injection, was more precisely controlled with nine of the 11 animals in estrus over a three day period. Two gilts in each group failed to respond to the induction treatment. The seven day range for occurrence of the second estrus, postinduction, in group 1 indicates that the induced cycles were slightly shorter or longer than 21 days in some of the animals. The lower pregnancy rate obtained in the group 2 gilts possibly resulted because the second injection was slightly out of phase with the endogenous cycle.

**Experiment 4 – Progesterone levels**

The number of gilts demonstrating estrous behaviour after the first, second and third injection of the hormonal combination were three, six and five respectively. The five gilts in estrus after the last injection were inseminated on the third and fourth or fourth and fifth day. The four gilts not in estrus were slaughtered and from the condition of the ovaries and uteri, one gilt was designated prepuberal, two had cystic ovaries and one was in the early to mid luteal phase. A pregnancy test at approximately 60 days of gestation indicated that four of the five bred animals were pregnant. The nonpregnant animal was sacrificed and the presence of follicles and corpora albicans on the ovary was indicative of normal cyclic function.

A possible explanation as to why four of the nine gilts did not show estrous behaviour following the third injection is that the initial and second induced cycles may have been slightly shorter or longer than 21 days. Therefore, the second and/or third injection of the hormonal combination may have been out of phase with the induced endogenous cycles, resulting in no response at the expected time. The cystic ovarian condition found in two of the nonresponders supports this contention since it has been reported that an injection of the hormonal combination to an animal in the luteal phase may produce cystic ovaries (11).

Figure 1 illustrates the plasma progesterone profiles observed in these gilts. Figure 1A is typical of gilts that responded to each injection with cyclic activity. It is interesting to note the relatively low maximum levels of progesterone, less than 12 ng/ml, in the first two induced cycles.

<table>
<thead>
<tr>
<th>PMSG/HCG injections</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of gilts</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Mean age at 1st injection (days)</td>
<td>155</td>
<td>155</td>
</tr>
<tr>
<td>No. in estrus and bred</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>No. farrowing</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Litter size*</td>
<td>8.4±2.1</td>
<td>9.0±1.8</td>
</tr>
</tbody>
</table>

*Mean ± standard deviation.
FIGURE 1. Plasma progesterone in individual gilts treated with PMSG/HCG at three week intervals. Treatment was initiated at 105 days of age and gilts were bred as indicated.

when compared to a reported average of 27 ng/ml in normal mature gilts from day 10 to 15 of the estrual cycle (12). The lower level may be a result of the relative immaturity of these animals and/or a reflection of relatively few ovulations following induced estrus during this period. Progesterone levels postbreeding rose above 20 ng/ml and this higher level was maintained during the first 60 days of gestation. All of the sampled gilts that responded and were bred after the third injection demonstrated this higher progesterone level postbreeding whether they maintained pregnancy or not.

Figure 1B illustrates a gilt that was not detected in standing estrus following the first two treatments. The progesterone levels show a limited response in this period. this gilt subsequently responded to the third treatment, conceived and maintained pregnancy.

Figure 1C presents the progesterone levels measured in a gilt that responded to the initial treatment, but not to the following treatments. At slaughter, her uterine development was minimal and the ovaries appeared dormant. This indicates that causing an immature animal to demonstrate behavioural signs of estrus and to ovulate does not invariably cause the female to remain in a postpuberal state or to maintain a successful pregnancy to full term.

Blood samples taken from all nine gilts just prior to the first injection treatment revealed progesterone levels of less than 0.5 ng/ml in all gilts. This is similar to the levels noted at estrus in the induced cycles and is in agreement with previously reported levels (12).

Experiment 5—Response of near puberal animals

Evaluation of the results obtained in experiments 2 and 3 suggested that a satisfactory response might be obtained in gilts that ranged in age from five to six months and who were bred on the estrus immediately after treatment or three weeks later. A group of 64 gilts on an independent nutrition trial, involving normal and high energy rations, were available for attempted puberty induction and it was decided to breed these animals at the second estrus following treatment. Fifty-two gilts (81%) demonstrated a second estrus and 26 randomly selected animals were inseminated over a seven day period. At 30 days gestation the bred gilts were slaughtered and 17 (65%) were found to be pregnant.

Research has shown that pregnancy failure in prepuberal gilts may be a result of insufficient uterine development and/or a lack of sufficient steroidal or luteotrophic support to allow proper implantation and prevent luteolysis (7, 13, 14, 15). Most of this previous work has involved the prepuberal gilt induced to ovulate and bred around 120 days of age. Our experimental results and those of others (2, 3) indicate that some of these problems may be overcome when gilts are induced to ovulate at an older age closer to the time of natural puberty. Many gilts prior to attaining market weight, reach an age when an acceptable estrus response and farrowing rate can be expected to result from breeding at an induced ovulation. Therefore, selection of replacements at this time from gilts that respond to the hormonal combination has the advantages of reducing costs and the convenience of a scheduled, synchronized breeding time. Particularly, when one considers that in some areas as many as 42% of all farrowings are from gilts (16) and 20 to 25% of gilts selected for breeding are culled due to infertility (17). The hormonal combination appears to be an effective method for the induction of puberty in near puberal animals. The results of these experiments indicate that the treatment of gilts between five and six months of age and breeding at the induced estrus or three weeks later may have a potential advantage in advancing the first farrowing and in controlling the breeding time of gilts.

SUMMARY

Prepuberal gilts were treated with 400 IU of pregnant mare serum gonadotrophin combined with 200 IU of human chorionic gonadotrophin given as a single intramuscular injection to induce a synchronized ovulation. Breeding and farrow-
ing data were collected from groups of animals bred at the first or second induced estrus following treatment. Progesterone levels were measured in gilts given three successive injections at three week intervals and bred at the estrus following the third injection. The results indicate that a synchronized induction of puberty in five to six months old gilts that have not shown previous estrual activity may reduce costs associated with replacement animals and provide an advanced, scheduled first farrowing.

ACKNOWLEDGMENTS

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REFERENCES


