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Ovulation and fertility responses for sows receiving once daily boar exposure after weaning and OvuGel® followed by a single fixed time post cervical artificial insemination

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ABSTRACT

Boar exposure is used to stimulate follicle development and estrus in sows after weaning and also to improve semen uptake and sperm transport with insemination. However, the need and value of boar exposure is uncertain when ovulation induction is used. These studies were designed to determine the effect of daily boar exposure after weaning when used with ovulation induction and fixed time post-cervical artificial insemination (PCAI). In experiment 1, sows were weaned into stalls and assigned to receive 3 min of daily fenceline boar exposure (BE, n = 7) or no boar exposure (NBE, n = 8). All sows received OvuGel at 96 h after weaning and BE or NBE 30 min prior to a single PCAI 24 h after OvuGel. Ovaries were assessed daily for follicle size from weaning until ovulation. Cervical contractions were measured 30 min following BE or NBE and before PCAI, while uterine contractions were measured for 1 h following PCAI. In experiment 2, weaned sows (n = 244) were assigned by parity to receive once daily BE for 1.5 min each day or NBE. OvuGel, PCAI and ultrasound methods were performed similarly as in experiment 1. Results from experiment 1 indicated BE did not significantly influence follicle size or measures of fertility. However, BE did increase the frequency of cervical contractions ($P < 0.05$), but with no effect on the uterus. Results from experiment 2 indicated BE had no effect on catheter passage for PCAI but did increase the proportion of sows ovulating within 48 h after OvuGel (77.7 vs 67.5%, $P = 0.05$), and tended ($P = 0.10$) to increase the proportion of sows inseminated 24 h before ovulation (70.3 vs. 61.0%). However, BE had no effect on adjusted farrowing rate (84.4 vs. 77.4%) or total pigs born (13.2 vs. 12.5) for BE and NBE, respectively. There were treatment and parity interactions for follicle size at time of OvuGel and at time of PCAI ($P < 0.05$) with BE minimizing parity effects on follicle size. Parity effects were also evident on farrowing rate and litter size when inseminations occurred >24 h from ovulation but not when inseminations occurred ≤24 h before ovulation. The results indicate that boar exposure for only minutes each day after weaning had beneficial effects for improving follicle development, ovulation induction, and AI timing, most notably in parity 1 sows, but had no beneficial or detrimental effects on the ability to perform PCAI.

1. Introduction

The ability to make more efficient genetic progress through use of artificial insemination (AI) relies on technologies that enable the number of sperm required per conception to be reduced. Approaches to accomplish this have included reduction in the number of sperm in inseminations, reduced number of in-seminations, and use of post cervical artificial insemination (PCAI) [1,2]. The advantages for PCAI reside in depositing semen into the uterus where distance for transport is less, risk of leakage and trapping in mucus is reduced [3]. For lowering sperm numbers, fertility is affected by boar [4], semen quality [5] and number of sperm inseminated [6,7]. To achieve acceptable fertility with use of

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only a single insemination, ovulation induction has been used [8]. Use of ovulation induction eliminates the need to time inseminations based on estrus and the need to use multiple inseminations to ensure semen is present within the 24 h period before ovulation [9,10]. The combination of the technologies of low sperm numbers, PCAI, and ovulation induction with a single insemination, offers the greatest opportunity to improve the use of the semen from superior sires to aid in global distribution of economically important traits.

Despite the potential for each technology to improve genetic progress, some obstacles impede successful implementation on farm. For example, when using lower numbers of sperm, reduced fertilization, farrowing rates and litter size can occur in relation to AI timing [11,12] and as a result of semen backflow or leakage [6,13]. Use of the PCAI technique requires passage of an intrauterine catheter through the cervix [3] and while highly successful in multiparous sows, is more difficult for parity 1 sows, and seldom used in nulliparous females [14,15]. Another factor suspected in reducing successful passage of the uterine catheter is boar exposure. Exposure of females to a mature boar is required for detection of estrus and may play a role in sperm uptake and transport [16]. However, data on cervical muscle activity in the pig are lacking. Yet in mice, both the frequency and force of cervical contractions are increased at estrus and by oxytocin [17]. In the pig, boar exposure induces oxytocin release, which acts to stimulate myometrial contractions [16]. The dilemma is that while boar exposure is required to detect estrus and aid in sperm transport, it may negatively affect passage of the catheter in a PCAI.

Lastly, in changing from a multiple insemination system based on estrus detection of estrus to a single insemination approach timed based on the administration of an ovulation induction drug, success depends upon the females having mature follicles at time of treatment [18,19]. The development of follicles after weaning depends upon gonadotropin release by the pituitary and stimulation of the ovary [20] and can be negatively affected by numerous factors [21,22]. However, there is some uncertainty as to what conditions may be required for boar exposure to have a positive effect on follicle development [23–25] or not [26,27].

Collectively, there are important questions that must be answered to advance the use of a single PCAI following ovulation induction. First, it is important to determine whether the success of ovulation induction and subsequent fertility can be improved using boar exposure after weaning. Secondly, it is not clear whether daily boar exposure would affect the success of PCAI. Therefore, the objectives of the present studies were to evaluate the fertility effects of boar exposure following weaning on follicle development and success of ovulation induction when using a single fixed time PCAI.

2. Materials and methods

Two experiments were performed using weaned sows at the University of Illinois (Experiment 1) and at a commercial research farm in Indiana (Experiment 2). The use of animals in these experiments were approved by the Institutional Care and Use Committee of the University of Illinois (#13131).

2.1. Housing and management

Experiment 1 was performed at the University of Illinois swine research farm, a farrow to finish farm that maintains a 220 sow inventory. The main barn housed sows in stalls in environmentally regulated rooms. Inside the barn, three identical experimental rooms were used that each contained 12 gestation stalls/room and were timed to provide 12 h of light and a room temperature of 21 °C. Water was provided *ad libitum* via nipples and sows were fed once daily 2.2 kg of a conventional corn and soybean meal diet that met or exceeded NRC requirements for gestating sows [28] on the floor of the crate in the morning. Animals were maintained in the experimental rooms from weaning until after insemination and were then moved into the main gestation room until time of farrowing.

Experiment 2 was performed at a 1400 sow commercial, breed to wean research farm in Indiana. The environmentally regulated facility was curtain sided, controlled temperature using fans and evaporative cooling, and provided lighting 10 h of light from 0600 to 1600 h. Water was provided *ad libitum* using a trough system and sows were fed 2.4 kg once daily of a diet similar to that used in experiment 1.

2.2. Experimental design

2.2.1. Experiment 1. The effect of boar exposure on cervical and uterine contractions

This experiment was performed in three replicates (2–3 sows/replicate/treatment). Multiparous sows (Genetiporc USA, Alexandria, MN) were weaned and uniformly assigned to groups of evaluation by previous total born, parity, lactation length, and body condition score to receive daily boar exposure (BE, n = 7) following weaning or no boar exposure (NBE, n = 8). Sows assigned to BE were moved into one of the experimental rooms where they received once daily fenceline contact with a mature boar for 3 min from the day after weaning up to the time of insemination without any application of the back-pressure test. Sows assigned to NBE were weaned into stalls into an adjacent experimental room and were provided no boar exposure after weaning and no back-pressure test.

Sows in both treatments received 200 μg of triptorelin acetate (OvuGel®, JBS United Animal Health LLC, Sheridan, IN USA) intravaginally at 96 h after weaning as previously described [19]. The 2 mL dose was deposited approximately 1–2 cm posterior to the cervix using a multi-dose applicator and new disposable outer sheath for each sow. On the day of insemination, boar exposure was performed only for the sows in BE starting at 30 min before PCAI while not provided for sows in NBE. The PCAI procedure was performed by a single trained technician using a foam tip catheter followed by an inner intrauterine catheter (Magaplus S®, Magapor, Zaragoza, Spain). The success for the use of PCAI was qualitatively evaluated for ease of intrauterine catheter passage through the cervix. Three levels of ease of insertion were considered: 0 (easily inserted); 1 (catheter was inserted with some difficulty on the first attempt); and 2 (not possible to insert the catheter through the cervix) [15]. Semen leakage during PCAI or immediately afterwards, and the presence of blood on the catheter or vulva were classified as Yes or No. Insemination was performed using pooled semen doses obtained from a commercial supplier containing 1.5 billion motile sperm in 40 mL of extender and was used within 48 h of day of collection. For sows that could not be inseminated using PCAI, data were excluded for farrowing rate and litter size. Following insemination, sows were moved out of the stalls in the experimental rooms and into individual stalls in the larger gestation barn. The sows remained in their stall until they were moved into farrowing 5 d before their expected day of parturition. Reproductive data related to return to estrus, pregnancy, farrowing and total born pigs were recorded.

2.2.1.1. Measurement of cervical and uterine contractions. Cervical contractions were evaluated starting 30 min before application of BE or NBE. To measures contractions, a foam tip insemination catheter (Magapor, Zaragoza, Spain) was inserted into the cervix and then a pressure transducer (MIKRO-TIP catheter