Influence of Equine Chorionic Gonadotropin on Weaning-to-Estrus Interval and Estrus Duration in Early-Weaned, Primiparous, Female Swine[1]

Thomaz Lucia, Jr.[2], Marcio N. Corrêa, João C. Deschamps, Ivan A. Peruzzo, Jairo E. M. Matheus, and José A. G. Aleixo

Faculdade de Veterinária, Centro de Biotecnologia, Universidade Federal de Pelotas, Pelotas-RS, Brazil

ABSTRACT: The weaning-to-estrus interval (WEI) influences the total nonproductive days (NPD) accumulated by the breeding herd and affects herd productivity. Short lactation lengths (LL) are commonly followed by prolonged WEI, which are also associated with short estrus duration (ED). Equine chorionic gonadotropin treatment is a tool that has been used to reduce WEI, especially for low-parity females. The objectives for this study were to evaluate the effect of LL on the association between WEI and ED and to estimate the effects of postweaning eCG administration on WEI and ED for early-weaned females. Two treatments (TREAT) consisting of 750 IU of eCG (n = 96) or control (n = 77) were applied 1 d after weaning to first-parity, weaned females. The study was conducted on a commercial farm having a target LL of 18 d. Estrus detection was conducted three times daily, and estrus duration was determined as the interval between the first and the last positive response to back pressure. Analyses of variance were conducted to estimate the effects of LL and TREAT on WEI and the effects of TREAT and WEI on estrus duration. Mean LL was 17.9 ± 1.7 d, mean WEI was 106.6 ± 29.2 h, and mean estrus duration was 55.9 ± 15.5 h. Even though the frequency of short WEI tended to increase with longer LL, mean WEI was shortest for females weaned after 18 d and longest for those weaned after 20 d ($P < .05$). The WEI for females receiving eCG (98.7 ± 2.7 h) was shorter ($P = .0001$) than that for control females (121.5 ± 3.3 h). The WEI was also affected by a LL × TREAT interaction ($P = .0014$), indicating that the interval was longer ($P < .05$) for control females weaned after 17 and 20+ d than for other females. The LL and TREAT did not affect estrus duration ($P = .20$ and $P = .157$, respectively). However, estrus duration was reduced as the WEI increased ($P = .0001$), and it was also influenced by a WEI × TREAT interaction ($P = .024$). A linear regression model estimated that the association between WEI and estrus duration was stronger in the eCG group than in the control group ($R^2 = .51$ and .15, respectively; both $P < .001$). In conclusion, the use of eCG postweaning was associated with more precise prediction of estrus duration as a function of the WEI and allows optimization of breeding management in early-weaned, primiparous females.

Key Words: Weaning-to-Estrus Interval, Lactation Length, Estrus Duration, eCG, Female Swine

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Introduction

Reproductive efficiency in swine herds is measured by the number of pigs weaned·female^{-1}·yr^{-1} (Wilson et al., 1986; Dial et al., 1992a). Nonproductive days (**NPD**) occur when breeding females are neither gestating nor lactating and affect reproductive efficiency. The accumulation of NPD can be minimized by reducing the weaning-to-estrus interval (**WEI**) by administrating equine chorionic gonadotropin (**eCG**) after weaning (Sechin et al., 1999).

The WEI is highly influenced by the lactation length (**LL**). Short LL can prolong WEI and lower farrowing rate (Xue et al., 1992; Koketsu et al., 1996a, 1997). However, at the herd level, the effects of a short LL can be compensated by an increase in the number of litters weaned·female^{-1}·yr^{-1} (Xue et al., 1992).

Estrus duration (**ED**) is commonly shorter for females having longer WEI (Weitze et al., 1994; Kemp and Soede, 1996). As a result, the interval between estrus detection and ovulation would be shorter, and synchronizing AI to the time of ovulation would be difficult.

Because the LL is associated with the WEI, LL could potentially influence the ED. The association between WEI and ED has not been characterized in sows under early weaning management. Also, the effects of hormonal therapy on the WEI under short LL need to be

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[2]To whom correspondence should be addressed. Current address: Centro de Biotecnologia, Universidade Federal de Pelotas, Caixa Postal 354, CEP 96010-900, Pelotas-RS-Brazil.

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investigated, considering the increasing popularity of early weaning systems (Dial et al., 1992b). The objectives for this study were 1) to evaluate the effect of eCG on WEI and ED in early-weaned, primiparous females and 2) to estimate potential effects of LL on the association between WEI and ED.

Materials and Methods

Experimental Procedures

This study was conducted at a commercial farm located in the Rio Grande do Sul state (extreme Southern Brazil) during a 8-wk period (January and February 1998). This farm had an inventory of 1,600 breeding females with a target weaning age of 18 d and used AI for all matings.

This study included 173 F_1 (Landrace × Large White) breeding females from the same seedstock supplier. All of the females had finished their first lactation and were housed in a naturally ventilated gestation barn during the postweaning period. Up to the time of mating, weaned females had ad libitum access to an 18% CP lactation diet. One day after pigs were weaned, females were selected randomly from all those available for rebreeding in the same production cycle and allocated to one of two treatment groups. One group of sows (n = 96) received 750 IU of eCG i.m. (PMSG-CAL, Cientistas Associados Produtos Biológicos Ltda., Pelotas, RS, Brazil). The other group (n = 77) received no treatment. The procedures for eCG purification were described by Aleixo et al. (1995).

Estrus detection was conducted at 0830, 1530, and 2230 daily, always using boar stimuli. The beginning of the estrus period was characterized as the midpoint between the time of the first observed positive response to back pressure (immobilization reflex) and the previous period of estrus detection. The end of estrus was the midpoint between the time when a negative response to back pressure was first identified and the previous period of estrus detection. The ED was the interval between the starting and the ending of the estrus period.

Statistical Analysis

Descriptive statistics were calculated for LL, WEI, and ED. Following analysis of the frequency distribution of LL, it was observed that more than 85% of the LL were between 16 and 20 d, whereas very low proportions of LL occurred beyond these limits. Thus, females were grouped by their weaning age into five categories: 14–16 d, 17 d, 18 d, 19 d, and 20 or more. Sows were classified by WEI into one of three groups: Short (< 98 h); Medium (98 to 120 h); and Long (> 120 h). Sows were also classified by ED: Short (< 60 h); Medium (60 to 69 h); and Long (> 69 h). These procedures to estimate ED and to categorize both WEI and ED were based on criteria described by Weitze et al. (1994). Cross-tabulation procedures were applied to obtain the frequency of categorized WEI and ED by category of LL and the frequency of categorized ED by category of WEI. All those analyses were conducted using SAS (1991).

Table 1. The number of females (n) and the weaning-to-estrus interval (WEI) for each lactation length category

Lactation length, d	n	WEI, h
14–16	40	108.5 ± 4.2[ab]
17	32	113.0 ± 4.7[bc]
18	35	100.0 ± 4.5[a]
19	40	103.3 ± 4.2[ab]
20+	26	125.7 ± 6.2[c]

[a,b,c]Within a column, least squares means adjusted for the effects of treatment and the lactation length × treatment interaction differ ($P < .05$).

The effects of LL and treatment group on WEI were estimated with ANOVA, using the following model: $Y_{ijkn} = \mu + LL_i + TREAT_j + LL \times TREAT_k + e_{ijkn}$, where Y_{ijkn} is the weaning-to-estrus interval for a given female; μ is the overall mean; LL_i is the effect of the i^{th} lactation length; $TREAT_j$ is the effect of the j^{th} treatment; $LL \times TREAT_k$ represents the interaction between the two previous independent variables; and e_{ijkn} is the random error term.

An ANOVA was also conducted to evaluate the effects of LL, WEI, and TREAT on ED. The LL was not included in the final model, because preliminary analysis indicated that its effect was not significant ($P = .20$). The final model was as follows: $Y_{ijkn} = \mu + WEI_i + TREAT_j + WEI \times TREAT_k + e_{ijkn}$, where Y_{ijkn} is the estrus duration for a given female; μ is the overall mean; WEI_i is the effect of the i^{th} weaning-to-estrus interval; $TREAT_j$ is the effect of the j^{th} treatment; $WEI \times TREAT_k$ is the interaction between the two previous independent variables; and e_{ijkn} is the random error term.

For both models, each sow was considered as an experimental unit in a completely randomized experimental design. Differences in WEI and ED across categories of independent variables were tested using the Fisher's protected least significant difference test (Steel and Torrie, 1980). The ANOVA were conducted with the GLM procedure of SAS (1991).

Within each treatment group, a linear regression was used (Statistix, 1996) to explain the variation in ED as a function of WEI, because a significant effect of the WEI × TREAT interaction on ED was identified in the ANOVA mentioned above ($P = .024$).

Results

The average LL observed in this study was 17.9 ± 1.7 d (range from 14 to 23 d). Females having LL of 20 d or more represented only 15% of the sample (Table 1), having a mean LL equal to 20.5 ± .86 d. The mean LL for the females in the control group was 17.6 ± 1.5

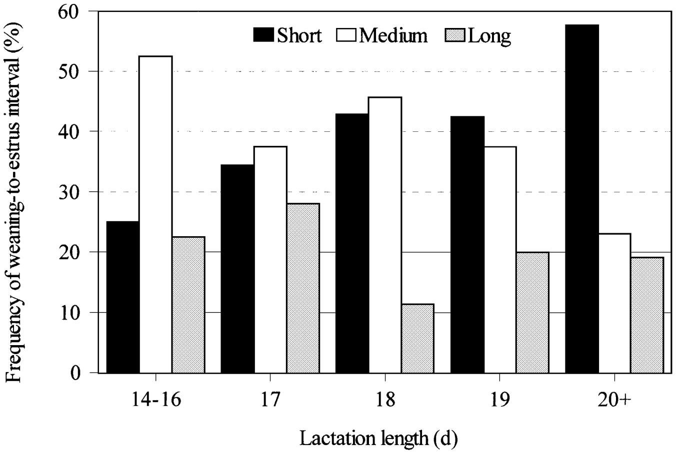

Figure 1. Frequency distribution of weaning-to-estrus interval by lactation length category (n = 173 sows).

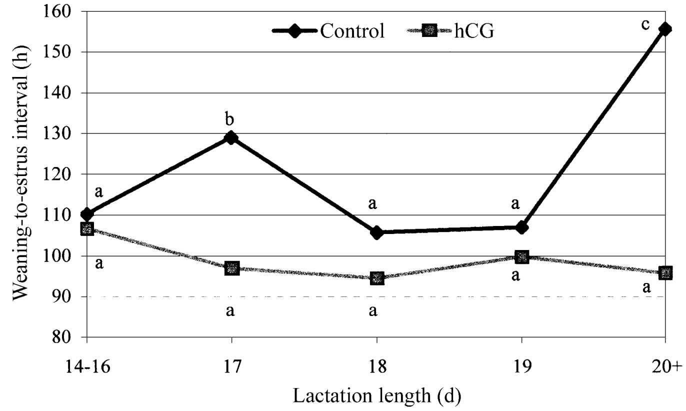

Figure 2. Effect of the interaction between lactation length and treatment group on the weaning-to-estrus interval (WEI) ($P = .024$). [a,b]Mean WEI for sows in the control group weaned after 17 d and 20+ d differ from all other means ($P < .05$). Mean WEI for sows in the control group weaned after 17 d differ from the WEI for sows in the control group weaned after 20+ d ($P = .038$).

d, and the mean LL for the females in the eCG group was 18.0 ± 1.9 d.

The mean WEI was 106.6 ± 29.2 h (range from 69 to 354.5 h). The mean WEI for females having the shortest LL (14 to 16 d) did not differ ($P > .10$) from that observed for those with LL of 17 to 19 d (Table 1) but was shorter in comparison with females having LL of 20 d or more ($P = .023$).

Short (< 98 h) and medium (98 to 120 h) WEI seemed to be more common (39.3 and 40.5%, respectively) than long (> 120 h) WEI (20.2%). Mean WEI were 86.8 ± 4.9 h for short WEI, 106.5 ± 6.0 h for medium WEI, and 145.4 ± 43.3 h for long WEI. Medium WEI tended to be more common for females with LL of 14 to 18 d, whereas short WEI tended to be more common among those with LL of 19 or more days (Figure 1).

The WEI for females that received eCG was 98.7 ± 2.7 h and was shorter ($P = .0001$) than the 121.5 ± 3.3 h observed for those in the control group. The WEI for control females weaned after 17 d and after 20+ d was longer ($P < .05$) than for all other females in both treatment groups (Figure 2). The WEI for control females weaned after 20+ d was longer ($P = .038$) than that observed for control females weaned after 17 d.

The mean ED was 55.9 ± 15.5 h (range from 15.5 to 96 h). Mean estrus duration for short, medium, and long ED were 46.0 ± 11.3 h, 63.6 ± .4 h, and 75.8 ± 6.3 h, respectively. Short ED seemed to be more common (59%) than either medium (19.1%) or long (22%) ED. Such a trend was observed across all LL, although the highest frequencies of short ED occurred for females having LL equal to 19 d or longer (Figure 3). Frequencies of distinct ED seemed to be similar when the WEI was short, but short ED tended to be much more frequent at medium and long WEI (Figure 4). The ED for females having short WEI (n = 68) was 64.5 ± 2.0 h, which was longer ($P < .01$) than the ED observed for those having medium (n = 70, 56.3 ± 1.7 h) and long WEI (n = 35, 37.7 ± 2.5 h). The ED for females having medium WEI was longer than that observed for those having long WEI ($P = .0001$).

The effect of WEI on ED was dependent on treatment group ($P < .0001$). A reduction in the WEI resulted in an increase in ED in both treatment groups, but the reduction was greater in females that received eCG than for those in the control group (Figure 5).

Discussion

The mean WEI (4.4 d) reported in this study was much shorter than mean intervals reported in other studies (Xue et al., 1992; Wilson and Dewey, 1993; Koketsu et al., 1996a,b) and also shorter than industry standards (King and Xue, 1996). Females with short LL are expected to have longer WEI than those having longer LL (Xue et al., 1992; Koketsu et al., 1996a,b).

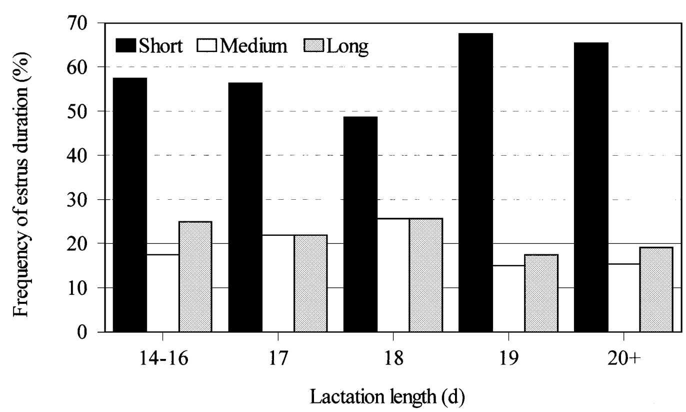

Figure 3. Frequency distribution of short, medium, and long estrus duration by lactation length category (n = 173 sows).

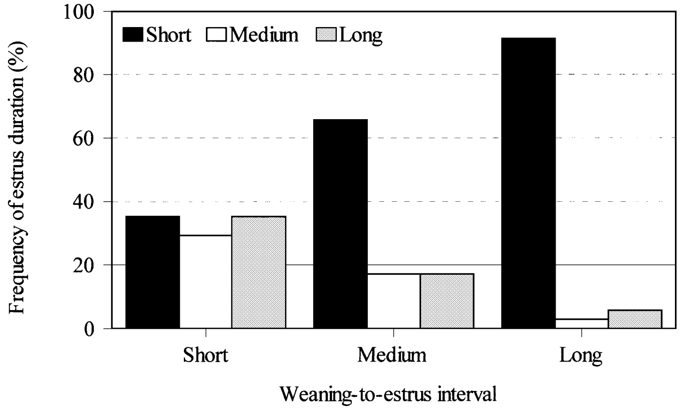

Figure 4. Frequency of short, medium, and long estrus duration according to the weaning-to-estrus interval category (n = 173 sows).

In this study, the proportion of short WEI tended to increase as LL became longer. Also, this study was conducted during summer months, when the probability of occurrence of different types of reproductive failure (such as prolonged WEI) would be greater (Hurtgen and Leman, 1981; Xue et al., 1994). We also used only first-parity females, which are usually more prone to have longer WEI than those at higher parities (Hurtgen and Leman, 1981; Koketsu et al., 1996a,b). Some studies reported differences in WEI across distinct genetics (Koketsu et al., 1996a) and a significant influence of genetics on the length of the WEI (ten Napel et al., 1995; Sterning et al., 1998). The present results were obtained with females from the same genetic source, which seemed to respond to early weaning with above-standard WEI. Another factor that was possibly related to the short WEI observed in this study is that estrus detection was conducted three times daily, which is

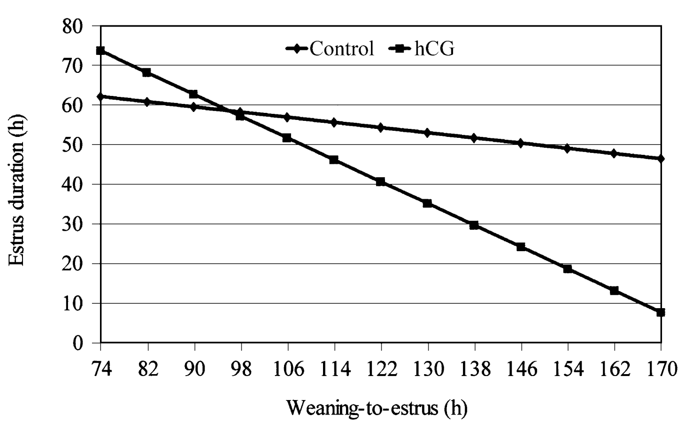

Figure 5. Prediction of estrus duration (ED) according to the weaning-to-estrus interval (WEI) in different treatment groups. The equation for control is ED = 74.20 − .164WEI (n = 77 sows, P = .0004, R^2 = .15). The equation for eCG is ED = 124.63 − .688WEI (n = 96 sows, P < .0001, R^2 = .51).

probably more accurate than detecting estrus once or twice daily, as is commonly done at the farm level.

Sows treated with eCG postweaning had mean WEI equal to 98.7 h (4.1 d), which was nearly 1 d shorter than the WEI for control sows. A reduction of this magnitude would be related to an increase in the ED by approximately 16.5 h. There are reports that females having WEI shorter than 4 to 5 d (Leman, 1990; Vesseur et al., 1994) or shorter than 6 d (Wilson and Dewey, 1993; Xue et al., 1998) would have improved farrowing rates and litter sizes in comparison with those having longer WEI. The suboptimal subsequent performance of females returning to estrus beyond those ranges of WEI could be due to a lack of synchronization between mating and ovulation (Kemp and Soede, 1996). Mating during either late estrus or metestrus is associated with a reduction in farrowing rate and litter size (Rozeboom et al., 1997). Even though the mean WEI observed in this study was already within the desired range mentioned above, the WEI for females treated with eCG tended to be shorter and less variable across all LL than the intervals observed for control females. Therefore, the use of eCG would allow optimization of mating management and reduction of mean NPD, which potentially affects herd reproductive efficiency (Wilson et al., 1986; Dial et al., 1992a).

The negative association between WEI and ED previously reported (Weitze et al., 1994; Kemp and Soede, 1996) was also observed in this study. Short WEI is also associated with long ED under early weaning conditions, even though no effect of LL on ED was observed within the range of weaning ages analyzed in this study. The R^2 for the model for females treated with eCG was higher than the R^2 for the model for control females and also higher than the coefficient of .25 reported by Kemp and Soede (1996), who studied females weaned after 24 d of lactation without eCG treatment. Thus, for females receiving eCG, the association between WEI and ED was stronger and the prediction of ED based on the WEI was more precise than that for females in the control group. However, considering the lack of a significant main effect of eCG and the significant treatment × WEI interaction for the ED, eCG therapy postweaning would have an indirect influence on ED, possibly mediated by the effect of eCG on WEI. Although Weitze et al. (1994) have described that primiparous females treated with eCG showed reduced ED in comparison with untreated females having two or more parities, that study did not use untreated primiparous females as controls and was not conducted under early weaning conditions.

We chose to use 750 IU eCG based on the findings of a recent study (Sechin et al., 1999) that indicates that doses higher than 750 IU would not be necessary to improve WEI, even though doses higher than 750 IU could lead to improvement in subsequent litter size. Additionally, a study that evaluated different eCG doses concluded that doses close to 750 IU (800 IU) would be effective in improving subsequent reproductive performance (Bergfeld et al., 1990).

Implications

Despite its effect on the weaning-to-estrus interval, lactation length did not directly influence the association between weaning-to-estrus interval and estrus duration in this study. The length of the weaning-to-estrus interval can be used to predict estrus duration in early-weaned sows. Administration of 750 IU of equine chorionic gonadotropin after weaning allows this prediction to become more precise, with the advantage of accelerating rebreeding, which leads to longer estrus duration. This practice would permit better synchronization between the timing of artificial insemination and ovulation and improve the efficiency of artificial insemination programs.

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