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Effect of Calcium Ion Supplementation on Swine Parturition

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ABSTRACT

The purpose of this study was to determine the effect of calcium ion supplementation on swine parturition. The focus of this trial was to determine if increased cytostolic calcium levels would reduce the inter-pig birth interval and reduce the number of Type II stillbirths. Thirty-four females were divided into either a control group (n = 17) or a treatment group (n = 17). The treatment group received 70 g of a calcium-chloride supplement, top dressed daily, for five days pre-farrowing. Results showed a reduction in inter-pig birth interval and reduction in Type II stillbirths for the treatment group as compared to the control group (P < 0.05).

KEY WORDS: birth interval, calcium, parturition, stillbirth, swine

INTRODUCTION

Fetal losses (mummified fetuses and stillborns) are one of the most fundamental causes for loss in commercial swine herds (Borges et al. 2005). According to González-Lozano, Rosales-Tores, et al. (2009) "Type II stillbirth" (intra-partum) deaths occur in over 30% of swine litters, with almost 8% of individual piglets being born Type II stillborn. While several factors have been associated with Type II stillbirth, e.g. infectious diseases, gestation length, parity, litter size, farrowing length, birth weight, birth interval, and dystocia (Borges et al. 2005), the primary foci of this study are the issues of litter size, farrowing length, and birth interval.

Curtis (1974) and Hurnik (1985) showed that that the interval of delivery before Type II stillbirths is greater than the interval before live births and that over 70% of Type II stillbirths occur in the last third of the birth order. Oxytocin has been definitively shown to shorten the length of farrowing, but at the same time the improper application of oxytocin has been shown to increase the incidences of birth mortality and dystocia (González-Lozano, Ramírez-Necoechel, et al. 2009).

Parkington et al. (1999) demonstrated cytostolic Calcium 2+ ions (Ca^{2+}) to be of great importance to the contractibility of smooth muscle in the uterine system. Continued Ca^{2+} dependent contractions can be induced by an increase in the cytostolic Ca^{2+} concentrations beyond normal fatigue levels (Uehata et al. 1997). In addition, the transient regenerative current of uterine smooth muscle was directly dependent on the level of cytostolic Ca^{2+} (Anderson et al. 1971).

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The purpose of this study was to determine whether an increased cytostolic Ca2+ ion concentration in swine would: (1) reduce the inter-pig birth interval, (2) reduce the total farrow length, and (3) reduce the number of Type II stillbirths.

MATERIALS AND METHODS

Thirty-four sows and gilts of similar breed-type (Yorkshire and Hampshire Cross) from Tarleton State University's Agricultural Center and Elrod's Show Pigs were randomly assigned to one of two treatment groups. In addition, sows versus gilts were distributed across testing groups to eliminate bias. Mean parity was 2.06 for the control group and 2.29 for the treatment group, which was not different ($P > 0.05$). All sows farrowed between July and September, 2011.

Group One (n = 17; sows = eight, gilts = nine) was the control group, and did not receive any calcium chloride (CaCl) supplement. Group Two (n = 17; sows = 10, gilts = seven) was the treatment group that received CaCl supplement (Table 1) at the rate of 70 grams top-dressed over a daily feed ration. The supplementation for the treatment group began at day 109 of gestation, five days prior to the expected farrowing date. The farrowing date was based upon 114 days of gestation with day 1 of gestation considered to be 24 hours after first Artificial Insemination service. The supplementation continued until the day of farrowing.

Table 1. Calcium chloride supplement composition.

Item	%
Guaranteed Analysis	
Crude protein	Min. 4.0 %
Lysine	Min. 0.1 %
Crude Fat	Min. 9.0 %
Crude Fiber	Max. 2.0 %
Calcium	Min. 16.6 %
Calcium	Max. 19.9 %
Phosphorus	Min. 0.14 %

Prior to the beginning of supplementation, on day 108 of gestation, urine was collected from each female and the pH was determined and recorded. The urine pH readings were determined and recorded again on day 113 of gestation. Earlier research by DeRouchey et al. (2003) showed that decreasing the dietary Electrolyte Balance (dEB) (mEq/kg of diet for Na+K-Cl) by increasing the amount of CaCl in the feed supply is characterized by increased cytostolic Ca2+ blood percentages and decreased urinary pH. The rationale behind comparing the urinary pH is to verify that cytostolic Ca2+ ion concentrations were being increased in response to CaCl supplementation in the sow as indicated by a reduced urinary pH.

Prior to farrowing, on day 108 of gestation, the sow Body Condition Score (BCS) was determined for all sows. BCSs were determined by a three-member expert committee. Scores were assigned by all three members independently and subsequently averaged to determine a final BCS for each female. The scoring system was recorded in accordance with the National Pork Board Body Condition Scoring System. A score of (1) represented emaciated while a score of (5) was obese; a score of (3) was ideal and preferred (Karriker 2006). The body condition score was not limited to a single integer number. It was recorded to the nearest 0.25 of a point to ensure specificity. This was done in order to ensure that BCS was not a contributing factor to an increased risk of Type II stillbirth.

During the period of parturition for all females, the following data was obtained: litter size, number born alive, number of Type II stillbirths, farrowing length, and inter-pig birth interval. Farrow length was recorded as the time interval starting at the beginning of Stage II of labor, defined as the time of first amniotic discharge (Hurnik 1985), and ending with the expulsion of the last fetus. Inter-pig birth interval was the time between each delivered fetus. Furthermore, individual birth weights were also recorded after all piglets had been born for that litter.

Following parturition, sows were assigned a Farrowing Ease Score (FES). This score was assigned based on the following criteria: 1 indicated no assistance, 2 indicated little assistance with two or fewer piglets pulled, 3 indicated moderated assistance with three or fewer piglets pulled, 4 indicated extensive assistance with more than three piglets pulled, and 5 indicating surgical intervention such as caesarean section. A three-member expert panel was used to assess a FES. Independent scoring was performed by each member and an average was calculated for reporting.

In order to obtain statistical results that were valid, repeatable, accurate, and true representatives of the population, statistical analysis was conducted using SPSS V 17.0 (SPSS Inc. 2009). Upon consultation from professional bio-statistician Dr. Perdue (2011) and Dr. Lambert (2011) the following tests were performed. Differences in BCS, birth weight, litter size, farrowing length, and inter-pig birth interval between treatment groups were computed by *t*-test. Birth weight was also compared between Type II stillborns and live births to determine differences using the *t*-test. Differences in the pre- and post-treatment urine pH by treatment group were conducted using a Univariate ANOVA test pairing pre- and post-treatment in individuals. The Fisher's Exact Test was used to analyze the differences in the number of stillbirths between treatment groups.

RESULTS AND DISCUSSION

Birth weight (Table 2) was shown to be significant between the treatment groups ($P < 0.05$). However, as this was an increased risk of stillbirth by the treatment group having larger birth weights, it did not affect our analysis of still birth reduction due to treatment. Neither BCS nor litter size (Table 2) were different ($P > 0.05$). It was important to this trial that these factors were not contributing influences because of their increased risk of Type II stillbirth (Borges et al. 2005; Karriker 2006).

In order to demonstrate that cytostolic Ca2+ concentration was indeed being influenced by the CaCl supplementation it was determined that urinary pH levels needed to be observed in agreement with the experimentation by DeRouchey et al. (2003). There was no difference shown ($P = .825$) (7.26 v. 7.29) between treatment groups on day 108 of gestation (Table 3). Sows in the control group did not experience a difference ($P = .754$) (7.26 v. 6.98) in urinary pH from day 108 to day 113 of gestation ($P > 0.05$). However, the treatment group demonstrated a clear difference (7.288 v. 5.65) in urinary pH for the same time period ($P < 0.001$). This indicated an increase in cytostolic Ca2+ levels for treatment sows as a result of supplementation.

Table 2. Initial birth weight, BCS, and litter size by treatment group.

Item	Group	n	Mean	SD	*P*
Birth wt.	Cont	169	2.9896	.75530	
(lbs.)	Trt	178	3.1513	.75749	.047
BCS	Cont	10	3.0250	.75875	
	Trt	10	2.9750	.74954	.884
Litter	Cont	11	9.55	3.236	
Size	Trt	10	10.20	3.425	.659

Table 3. Pre- and post- treatment pH by treatment group.

Item	Group	n	Mean pH	SD	*P*
Pre-treatment	Cont	10	7.2600	.29866	
(day 108)	Trt	10	7.2880	.25939	.825
Post-treatment	Cont	10	6.9800	.43863	.754
(day 113)	Trt	10	5.6500	.69925	.001

When observing the inter-pig birth interval (Table 4) there was a decrease in the amount of time in minutes between each piglet ($P < 0.05$) for the treatment group compared to the control group. The total farrow length (Table 4) was also decreased for the treatment group ($P < 0.05$). Both of these results support the hypothesized effect of an increased Ca2+ diet.

Table 4. Inter-pig birth interval and farrow length by treatment group.

Item	Group	n	Mean	SD	*P*
Interval	Cont	174	25.42	37.915	
(min)	Trt	183	19.81	24.393	.048
Farrow	Cont	17	260.2	131.3	
Length (min)	Trt	17	185.8	120.9	.048

Comparing the number of Type II stillbirths in each treatment group (Table 5); a significant reduction in the number of stillbirths was demonstrated ($P < 0.05$). Furthermore, the results for the control group showed a 5.7% risk for Type II stillbirths which is congruent with results from Borges et al. (2005). In the treatment group there was a 1.6% risk of Type II stillbirths. The cross-tabulated probability of the treatment group indicated a 73% risk reduction for Type II stillbirth as compared to the control group on an individual piglet basis.

Comparing the FES of each treatment group (Table 6); there was a significant reduction in the difficulty of labor for the treatment group ($P < 0.05$) as indicated by the lower FES. This coincided with a shorter time period for inter-pig birth interval and farrow length.

In order to further eliminate bias, birth weights were compared according to delivery type as this had been shown to influence the probability of being stillborn (Borges et al. 2005). Between the two delivery types, live birth and stillborn (Table 7), there was no difference ($P > 0.05$).

Table 5. Type II stillbirths by treatment group.

Item	Group	n Live born	n Stillborn	% Stillborn	*P*
Stillbirths	Cont	164	10	5.7%	
	Trt	180	3	1.6%	.035

Table 6. Farrowing ease score by treatment group.

Item	Group	n	Mean (score)	SD	*P*
FES	Cont	17	2.3529	1.0572	
	Trt	17	1.7059	.84887	.029

Table 7. Birth weight by delivery type.

Item	Delivery type	n	Mean (lbs.)	SD	*P*
Birth weight	Live born	334	3.0713	.76837	
	Stillborn	13	3.1046	.50437	.877

CONCLUSION

In conclusion, there was a reduced inter-pig birth interval, farrow length, and the number of Type II stillbirths associated with the treatment group in this trial ($P < 0.05$). These results supported the hypothesized effect of calcium ion supplementation on swine parturition.

The original intent of observing the FES was to determine if individual sows should be eliminated from the study due to anatomical defects resulting in dystocia (*i.e.* those sows with a FES of 4 or more). While the study did report a significant reduction in FES for the treatment group, it was felt that the sow sample size would need to be increased in order to accurately determine that the reduction of FES was the result of treatment.

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