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# Embryonic survival and variation in embryonic development on day 11 of gestation

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## EMBRYONIC SURVIVAL AND VARIATION IN EMBRYONIC DEVELOPMENT ON DAY 11 OF GESTATION

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### Summary

The primary objective of this study was to determine if embryo survival in gilts and primiparous sows was related to variations in the periovulatory profiles of estradiol-17 $\beta$ , progesterone, and luteinizing hormone. A secondary objective was to compare embryo development and certain endocrine characteristics in gilts and primiparous sows. Sows (n=6) and gilts (n=6) were catheterized in the jugular vein on the day after weaning and day 14 of the estrous cycle, respectively. Additional females (1 gilt and 7 sows) were examined for characteristics of embryonic development, but blood samples were not collected. Embryo size and volume on day 11.5 to 11.75 of gestation were recorded. Embryo recovery was 71.4% based on the number of corpora lutea. Minimal differences were observed between sows and gilts for endocrine and embryo data. However, endocrine differences were noted for pigs with high embryo survival (> 71% recovery) compared to those with low survival. Peak estradiol-17 $\beta$  occurred closer to the onset of estrus in pigs with high embryo survival than in pigs with low embryo survival, and peak LH occurred later after the onset of estrus for pigs with high embryo survival. Also, pigs with high embryo survival tended to have less variation in embryonic development than those with low embryo survival. These data suggest that increased embryo survival and decreased diversity in development might be associated with a closer synchrony between the onset of estrus and peak concentration of estradiol-17 $\beta$ .

(Key Words: Pig, Embryo Survival, Hor-

mone.)

### Introduction

Embryonic diversity within litter, implicated as a cause of embryo mortality in swine, has been the emphasis of several studies. Morphological and biochemical variations in follicular development have been observed in swine, and it is hypothesized that embryonic diversity and subsequent embryo mortality are the result of variation in the rate of follicular development and ovulation.

Previous research has indicated that primiparous sows have lower percentages of fertilized eggs than multiparous sows. Therefore, anomalies in the periovulatory endocrine environment might be associated with fertilization failure and/or early embryonic death in pigs; however, no data are available currently that examine this possible association. The primary objective of the present study was to determine whether embryonic diversity and the proportion of ovulations represented by embryos on d 11 were associated with periovulatory endocrine events. A secondary objective was to evaluate embryonic diversity and embryo survival in gilts and primiparous sows on d 11 of pregnancy.

### Procedures

Crossbred (Hampshire  $\times$  Chester White  $\times$  Yorkshire  $\times$  Duroc) gilts (n=6) and primiparous sows (n=6) were fitted with jugular catheters on d 14 of the estrous cycle and the day after weaning, respectively. Both catheterized pigs, as well as additional

pigs (1 gilt and 7 sows) not sampled for endocrine data, were examined for differences in embryonic development. Gilts and sows were checked for estrous behavior 3×/d (2:00 a.m., 10:00 a.m., and 6:00 p.m.) with an intact boar but were separated physically from boars at other times. Females were inseminated artificially with mixed semen from two boars at 16, 24, and 32 h after the observed onset of estrus.

Blood samples were collected twice daily (6:00 a.m. and 6:00 p.m.) until day 17.5 of the estrous cycle in gilts and day 3.5 postweaning in sows. Thereafter, frequency of blood sampling was increased to 4-h intervals until 24 h after the onset of estrus. Blood samples were collected subsequently twice daily until d 5 after estrus. Blood samples were stored overnight at 4°C and then serum was collected. Serum was analyzed for estradiol-17 $\beta$  ( $E_2$ ), progesterone ( $P_4$ ), and luteinizing hormone (LH) by radioimmunoassay.

Embryos were recovered surgically from all pigs on day 11.5-11.75 of gestation (d 0 = onset of estrus). The number, size, and volume of individual embryos were recorded after recovery. To determine variations in embryonic development, the average deviation from the mean embryo volume was calculated within litter as a percentage of the mean embryo volume.

## Results

Using the number of CL as an estimate of ovulation rate, mean embryo recovery for all pigs was 71.4%. Therefore, for statistical analyses, pigs with > 71% embryo recovery were defined to have high embryo survival (mean embryo recovery = 86.61%), whereas pigs with < 71% embryo recovery were defined to have low embryo survival (mean embryo recovery = 52.77%).

Differences in the characteristics of the  $E_2$  and LH (but not  $P_4$ ) profiles were evident between pigs with high and low embryo survival (Table 1). Peak  $E_2$  occurred later ( $P<.05$ ) relative to the onset of estrus

in pigs with high embryo survival. On average, peak  $E_2$  occurred after estrus in pigs with high embryo survival and before estrus in pigs with low embryo survival. Furthermore, for all animals, embryo survival increased as the interval from estrus to peak  $E_2$  increased ( $r=.64$ ;  $P<.05$ ). Peak LH occurred later ( $P<.05$ ) after the onset of estrus in pigs with high embryo survival compared to pigs with low embryo survival. This was consistent with a positive association between the length of the interval from estrus to peak LH and embryo survival ( $r=.65$ ;  $P<.05$ ). Peak  $E_2$  tended ( $P=.07$ ) to be higher in pigs with low embryo survival compared to pigs with high embryo survival. The onset of the LH surge differed ( $P<.05$ ) for pigs with high vs low embryo survival and occurred prior to peak  $E_2$  in pigs with high embryo survival but after peak  $E_2$  in pigs with low embryo survival.

No differences were evident in  $P_4$  profiles between gilts and sows; however, differences were detected in  $E_2$  and LH profiles (Table 1). Peak LH occurred nearer ( $P<.01$ ) to the onset of estrus in gilts than sows, and the onset of the LH surge occurred earlier ( $P<.05$ ) before estrus in gilts compared to sows. Peak  $E_2$  and peak LH both tended ( $P=.08$  and  $P=.11$ , respectively) to be greater in gilts compared to sows. Other characteristics of the  $E_2$  and LH profiles were similar between gilts and sows; however, gilts tended ( $P=.11$ ) to have a greater interval from peak LH to the end of the LH surge compared to sows.

No differences in ovulation rate and embryo volume were evident between pigs with high and low embryo survival (Table 1); however, pigs with high embryo survival tended ( $P=.10$ ) to have less variation in embryonic development compared to pigs with low embryo survival. Evaluation of the data from all animals supports this association, because a negative correlation within litter occurred between embryo survival and the percent deviation in embryo development ( $r=-.79$ ,  $P=.0001$ ).

## Discussion

In the present study, ovulation rate, embryo diversity, and embryo survival were similar between gilts and sows, indicating that fertility was not reduced in primiparous sows. In contrast, previous studies reported that fertilization rate was lower and litter size declined at the second farrowing. Data from our study indicate that the population of primiparous sows we used had fertility similar to that of gilts.

In our study, differences were noted in the LH and E<sub>2</sub> profiles between pigs with high versus low embryo survival. Previous research has indicated that disparity in the time of ovulation and zygotic maturation might be the result of skewed follicular development, in which the majority of follicles was more developed than the minority at 21-34 h after the onset of estrus. It has been suggested that a small group of follicles on d 18 of the estrous cycle secrete E<sub>2</sub> sooner than other

follicles and induce the ovulatory surge of LH. This series of events would result in the ovulation of follicles at different maturational stages, thus, possibly contributing to diversity in embryonic development. Variation in embryo size in pigs appears to be greatest on days 11 and 12 of gestation, which correspond to the stage of development evaluated in the present study.

In our study, pigs with high embryo survival on d 11.5 to 11.75 of gestation tended to exhibit less variation in embryonic development than pigs with low embryo survival. Embryo losses in our experiment might have been due to fertilization failures or embryo death before day 11. Perhaps both embryo diversity and embryo loss before day 11 result from the same causes.

In conclusion, results of the present study suggest that a closer synchrony among peak E<sub>2</sub>, the onset of the LH surge, and estrus is associated with reduced embryo diversity and higher embryo survival prior to implantation. Perhaps embryo survival could be improved by changing the timing of preovulatory endocrine events.

**Table 1. Periovulatory Endocrine Characteristics (Mean  $\pm$  S.E.M.) and Embryo Development (Day 11.5; Mean  $\pm$  S.E.M.) in Pigs with High (>71%) versus Low (<71%) Embryo Recovery and in Gilts versus Sows**

Characteristic	Embryo Survival		Parity	
	High	Low	Gilt	Sow
<b>Endocrine Traits</b>				
No. of pigs	7	5	6	6
Onset of estrus to:				
Peak E <sub>2</sub> , h	3.33 <sup>c</sup>	-13.00 <sup>d</sup>	-4.67	-5.00
Peak LH, h	11.33 <sup>c</sup>	5.00 <sup>d</sup>	3.33 <sup>e</sup>	13.00 <sup>f</sup>
Peak E <sub>2</sub> , pg/ml	28.17	35.21	35.01	28.37
Peak LH, ng/ml	7.01	6.35	8.36	5.00
Onset of LH surge relative to peak E <sub>2</sub> , h	-5.83 <sup>c</sup>	6.33 <sup>d</sup>	-4.00	4.50
Onset of LH surge relative to estrus, h	-2.50	-6.67	-8.67 <sup>e</sup>	-0.50 <sup>f</sup>
<b>Embryo Traits</b>				
No. of pigs	11	9	7	13
Embryo recovery, %	86.61	52.77	69.26	70.00
Ovulation rate	15.88	17.25	15.88	17.25
Embryo volume, mm <sup>3</sup>	403.04	368.12	414.43	356.72
Average deviation of embryo volume, mm <sup>3</sup> <sup>a</sup>	162.45	189.84	180.13	172.16
Average deviation as % of mean embryo volume <sup>b</sup>	40.76 <sup>g</sup>	59.39	50.14	50.01

<sup>a</sup>The mean conceptus volume was determined for each litter, and the absolute value of the deviation from the mean was determined for each conceptus. The average deviation within each litter was used as a measure of the diversity in size within the litter.

<sup>b</sup>Calculated as in footnote a, except that each deviation was converted to a percent of the mean conceptus volume for the litter.

<sup>c,d</sup>Different superscripts within rows between high versus low embryo survival are significantly (P<.05) different.

<sup>e,f</sup>Different superscripts within rows between gilt versus sow are significantly (P<.05) different.

<sup>g</sup>Tends (P=.10) to be less than for pigs with low embryo survival.