# Evaluation of transrectal real-time ultrasound for use in identifying sources of reproductive failure in weaned sows

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## Summary

Real-time ultrasound (RTU) may aid in identifying sources of reproductive failure. In the month prior to observation, a commercial 2500-sow unit experienced an increase in the wean-to-estrus interval and reduced conception rates. A subpopulation of 52 sows was examined using RTU once daily on days 4, 5, and 6 postweaning. Transrectal RTU of the ovaries and uterus, performed following estrus detection, required 3.5 minutes per sow. To identify sources of reproductive failure, measures of follicle size, cysts, and time of ovulation were analyzed with sow records. Only 38 of the 52 sows expressed estrus within 7 days of weaning (73%), and only 29 sows ovulated (56%). Nine of the 23 sows that failed to ovulate (24%) were detected standing. Cystic ovaries were observed in four sows that failed to ovulate (17%) and in two sows that ovulated (7%). Of the 14 sows not detected in estrus, none ovulated (0%). The average estrus-to-ovulation interval, which was 39 hours, was influenced by the wean-to-estrus interval. Characterization of the reproductive tract may be used to evaluate the adequacy of estrus detection and artificial insemination procedures and the incidence of pathological conditions.


Poor reproductive performance in sows may be attributed in part to high numbers of nonproductive days, which may arise either from failure of sows to express a fertile estrus within 7 days of weaning or from failure of management to detect estrus and inseminate fertile females at the proper time. Although the reasons for occurrence of these two problems are quite different, herd-specific factors may contribute to both.

Failure of sows to express estrus within a week of weaning may be due to lack of ovarian activity or presence of ovarian cysts or corpora lutea. Reasons for failure to detect estrus and poor timing of artificial insemination (AI) may include variations in wean-to-estrus interval, duration of estrus, and estrus-to-ovulation interval. Variations in these traits may reduce the accuracy of estrus detection and effectiveness of standardized AI times and scheduled labor availability. It has been shown that inseminating sows within 24 hours before ovulation is the key to increased farrowing rate and litter size.[1] Unfortunately, the estrus-to-ovulation interval is variable[2] and is influenced by the wean-to-estrus interval.[3] The wean-to-estrus interval varies with parity, lactation length, and even season,[4] and differs among herds.[5]

When reproductive performance is less than optimal, limited diagnostic methods are available to determine the source of the problem. Real-time ultrasound (RTU) has been used to evaluate the ovarian and uterine status of sows[2, 6] and might provide information on the sources of reproductive failure and enhance the decision-making process for improved management practices.

Characterization of the reproductive tract may be used to evaluate the adequacy of estrus detection and AI procedures and the incidence of pathological conditions. In this article, we describe how transrectal RTU was performed with a minimal investment of time to evaluate the sources of reproductive failure in a representative group of sows. These females were from a herd that used common management practices in a modern swine facility.


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**This article is available online at http://www.aasv.org/shap.html.**

Knox RV, Probst-Miller S. Evaluation of transrectal real-time ultrasound for use in identifying sources of reproductive failure in weaned sows. *J Swine Health Prod.* 2004;12(2):71-74.


## Study sows

Observation was performed in August 2001 on a subpopulation of 52 PIC C-22 females in a herd with an average parity of 4.2 ± 0.5 (representing parities 1 to 11) in a commercial 2500-sow unit in Illinois. The study sows had an average lactation length of 14.9 ± 0.1 days (range 14 to 18 days). Herd management allowed altered weaning procedures, ie, more than a single weaning event. In seven litters that were split-weaned, one to four of the larger pigs were weaned 1 to 4 days before the rest, always leaving at least seven pigs in the litter. Three sows were used as nurse sows. The first litters of these females were removed after a normal lactation (14 to 16 days), and each sow was then given a second litter to nurse for an additional 1 to 14 days.

During the month of observation, the herd average wean-to-estrus interval was 6.8 days, an increase from a range of 5.7 to 6.1 days during the previous 6 months, and the percentage of sows bred within 7 days of weaning fell to 84%, compared to the range of 87 to 92% during the previous 6 months. Conception rate was 76% (range for the previous 6 months, 80 to 83%) and farrowing rate was 76% (range for the previous 6 months, 76 to 83%).

## Detection of estrus

All sows were weaned into gestation stalls and were exposed to boars beginning 1 day postweaning (Day 1). Detection of estrus was performed by farm breeding personnel once daily at 8:00 am, with a boar moved to the alleyway at the head of the crate for a 1-minute period. The boar, which was housed >20 meters from the sows and downwind from air currents, was moved to the sow crate against the air current to prevent excessive exposure to boar odor and sound, which may cause refractoriness to boar stimuli and reduce accuracy of estrus detection.[7] Estrus was confirmed in sows by expression of the standing response when back pressure and side rubbing were applied in the presence of the boar. Estrus duration was defined as the number of days that the sow exhibited a standing response.

## Performing real-time ultrasound

Once standing estrus was observed, transrectal RTU was performed at 24-hour intervals to determine the occurrence of ovulation. Ultrasound was performed once daily on the basis of results from a previous study,[6] which showed that the mean time of ovulation was not significantly different whether ultrasound was performed once or twice daily. All sows that did not express estrus by Day 5 were evaluated by RTU examination of the ovaries.

Ovaries were visualized using an Aloka 500V ultrasonics machine (Aloka Co, Tokyo, Japan) fitted with a transrectal 7.5 MHz linear transducer. Transrectal RTU was performed after fitting the transducer to a rigid, fixed-angle PVC adapter.[8] The average size of the largest unovulated, noncystic follicles (≤ 12 mm) was determined. The estrus-to-ovulation interval was calculated from the time when the female was first detected in standing estrus (0 hours) to the time when ovulation was determined to be complete, ie, when there were fewer than four follicles ≥ 6.5 mm remaining on the ovaries and noticeably fewer large follicles relative to previous observations. Cystic ovaries were characterized as having follicles > 12 mm in diameter. This classification was based on physical measurement of ovulatory follicles[9] and on ultrasonographic measurements of the largest ovulatory follicles in pigs.[3]

## Measurement of backfat

Backfat at weaning was measured at the P2 location, 65 mm off midline and parallel to T13 (Renco Lean Meter; Renco Corp, Minneapolis, Minnesota).

## Data analysis

The continuous response variables (largest follicle size, wean-to-estrus interval, estrus-to-ovulation interval, and duration of estrus) were analyzed using linear models procedures (PROC MIXED, SAS; SAS Institute, Cary, North Carolina). Discrete response variables (occurrence of estrus, ovulation, and presence of at least one cyst) were analyzed using the logistical CATMOD program of SAS. The models included the fixed effects of parity (parities 1 and 2: sows having had one or two litters; ≥ parity 3: sows having had three or more litters) and weaning (conventional or altered). The model also included as covariates the effects of lactation length, backfat at weaning, and number of pigs weaned at the last weaning event. All nonsignificant terms ($P > .05$) were removed from the final models, except altered weaning and wean-to-estrus interval. Differences among least squares means for continuous variables were tested using the Scheffe test.

## Diagnostic results

### Herd profile

Study sows had an average backfat at weaning of 14.7 ± 0.2 mm (range 9 to 25 mm) and weaned on average 8.5 ± 0.2 pigs (range 4 to 11).

### Estrus and ovulation observations

Observation using RTU required, on average, 3 to 4 minutes per female, with a range of < 1 minute to 6 minutes. In all sows expressing estrus within 7 days of weaning, the average size of the largest follicle at estrus was 7.2 ± 0.2 mm. Within the observation period, only 38 of the 52 sows expressed estrus within 7 days of weaning (73%), and 29 of these sows ovulated (56%). Of 23 sows that failed to ovulate, nine were detected standing (39%). Cystic ovaries were observed in four sows that failed to ovulate (17%) and in two sows that ovulated (7%). None of the 14 sows not detected in standing estrus ovulated (0%). Failure to express estrus or occurrence of cysts within 7 days of weaning was not associated with parity, lactation length, backfat at weaning, altered weaning, or number of pigs weaned ($P > .05$). The percentage of sows ovulating tended to be influenced by the wean-to-estrus interval (Table 1), but not by parity, lactation length, backfat at weaning, altered weaning, or number of pigs weaned ($P > .05$).

### Wean-to-estrus interval

The average wean-to-estrus interval was 5.0 ± 0.1 days. This interval was not influenced by parity, lactation length, backfat at weaning, or number of pigs weaned ($P > .05$), but was influenced by altered weaning. The wean-to-estrus interval was longer ($P = .01$) when altered weaning was used (5.5 ± 0.2 days) compared to conventional weaning (4.7 ± 0.1 days).

### Duration of estrus

The duration of estrus was not influenced by altered weaning, but was influenced by wean-to-estrus interval. The duration of estrus decreased with longer wean-to-estrus intervals (Table 1).

### Interval to ovulation

When estrus detection and RTU observation were performed once daily, the average estrus-to-ovulation interval was 39 ± 2.6 hours. However, the estrus-to-ovulation interval was influenced by the wean-to-estrus interval. Estrus-to-ovulation interval decreased with longer wean-to-estrus intervals (Table 1). The wean-to-ovulation interval averaged 158 ± 2.9 hours (6.6 days) and was influenced by altered weaning. The wean-to-ovulation interval (170.4 ± 7.2 hours) was 12 hours longer when altered weaning was used ($P < .05$) than when conventional weaning was used (158.4 ± 2.4 hours).

### Interpretation of the reproductive diagnostics

With the limited numbers of sows evaluated, the failure of 27% of the sows to express estrus within 1 week of weaning during the month of August could not be associated with parity, lactation length, backfat at weaning, altered weaning, or number of pigs weaned. However, RTU evaluation of the ovaries of females failing to express estrus did reveal that these sows showed inadequate follicle growth, and by 4 days after weaning, average follicle size was 2 mm smaller in these sows compared

**Table 1**: Least squares means (± SE) for estrus and ovulatory responses by wean-to-estrus interval in a group of 52 sows weaned in August in a commercial 2500-sow unit experiencing reproductive problems[1]

| Variable | Wean-to-estrus interval (days) | | | P |
|---|---|---|---|---|
| | 4 | 5 | 6 | |
| No. of sows | 10 | 22 | 5 | NA[2] |
| Follicle size at estrus (mm) | 7.1 ± 0.5 | 7.4 ± 0.3 | 8.1 ± 0.5 | > .05 |
| Cysts (%)[3] | 20 ± 13 | 10 ± 8 | 10 ± 11 | > .05 |
| Ovulation (%) | 76 ± 17 | 58 ± 12 | 100 ± 19 | .06 |
| Estrus-to-ovulation interval (hours) | 53.8 ± 4.8[a] | 40.8 ± 4.8[ab] | 24.0 ± 4.8[b] | .01 |
| Duration of estrus (hours) | 74.4 ± 7.2[a] | 57.6 ± 4.8[b] | 48.0 ± 7.2[b] | < .05 |

1 In the sow herd, average parity was 4.2, average lactation length was 14.9 days, average wean-to-estrus interval was 6.8 days, conception rate was 76%, and farrowing rate was 76%. Estrus detection and ultrasound were performed once daily. Follicle size, cystic follicles, and ovulation were determined using a real-time ultrasonics machine (Aloka 500V, Aloka Co, Tokyo, Japan) fitted with a transrectal 7.5 MHz linear transducer.

2 NA = not applicable.

3 Percentage of sows with one or more follicles >12 mm.

ab Within a row, means with no common superscript are different ($P < .05$). A logistical model was used to detect means differences for percentage data, and Scheffe's test was used for continuous data.

to sows that did show estrus. The largest follicle size was 5.2 mm for sows not expressing estrus and 7.6 mm for those expressing estrus. This suggests that ovarian stimulation by gonadotropins was lacking in the sows that did not express estrus, and that exogenous hormones might be beneficial.

The results of the RTU examination revealed an incidence of cystic follicles of 12% (6 of 52 sows), which should be considered problematic. In this study, we classified follicles >12 mm as cystic. We believe this classification is conservative, since the average size of follicles at the time of ovulation, evaluated by RTU, has been reported to be 7 to 9 mm.[6,10] The causes of abnormal follicle development which resulted in cystic ovaries were not identified through RTU diagnosis. However, previous studies have identified season (and temperature), parity,[6,11,12] and short lactation length [4,6,13] as factors which may delay or reduce follicle development and expression of estrus within 1 week after weaning. Altered weaning did not significantly influence the proportions of sows expressing estrus and ovulating, compared to conventional weaning. Although the study may not have had the power to detect a statistical difference, the proportions of sows expressing estrus and ovulating were numerically lower when altered weaning was used. Further investigation of this management practice as a cause of reproductive failure in sows may be warranted.[14]

The RTU technique also revealed that 17% of sows identified in standing estrus actually failed to ovulate. In most cases, sows had neither cysts nor large follicles. This problem might be related to improper heat detection, ie, breeding herd personnel might not have been stringent enough in their criteria for the signs of estrus. Solutions to this situation should focus on improving the stringency for identifying estrus. From our experience, improvement in estrus detection may be accomplished by controlling the period of nose-to-nose contact with the boar, assessing the standing response only to full (or nearly full) weight of human back pressure (even in a crate), and performing the test twice daily (at 7 to 8 AM and again at 2 to 3 PM). In our experience, twice daily estrus detection eliminates most cases of false estrus, since these females rarely stand for two consecutive detection periods.

Poor timing of AI and late inseminations may reduce reproductive performance.[15] Information on estrus-to-ovulation intervals may be useful for improving AI timing and preventing late inseminations. Establishing the relationship of the wean-to-estrus interval and the estrus-to-ovulation interval for each herd is important, as wean-to-estrus interval is the primary factor influencing estrus-to-ovulation interval. Individual herds are not expected to have the same profiles,[16] and therefore AI timing strategies based on the estrus-to-ovulation intervals in one herd may not work well in another herd.[17] Since inseminations performed within 24 hours of ovulation maximize the potential for high farrowing rates and large litter sizes,[1] the information gained from characterizing a representative sow group may provide the basis for determining the optimal time of insemination. The wean-to-estrus interval for the study group of 52 sows was 5 days and mean estrus duration was 55 hours, with an average estrus-to-ovulation interval of 39 hours. Values for these parameters fall within those previously published for other herds.[5,16,18] Therefore, if RTU is performed on a regular basis, and measures of wean-to-estrus and estrus-to-ovulation intervals vary between examinations, this information might be used to develop methods to improve AI timing. In this study, most sows (59%) had a wean-to-estrus interval of 5 days and a mean estrus-to-ovulation interval of approximately 41 hours (SD 5.0 hours). Assuming a 12- to 24-hour error associated with onset of estrus as a result of once-daily estrus detection, the optimal AI times for these sows would be 12 and 24 hours after onset of estrus. The next largest group (27% of sows) had a wean-to-estrus interval of 4 days, and these females ovulated approximately 53 hours after onset of estrus. Later AI times or a third insemination should be considered for sows such as these, which are still standing on the morning of the third day. The last group (14% of sows) had a wean-to-estrus interval of 6 days. Most had ovulated by 24 hours after onset of estrus; therefore, optimal AI times would be at first detection of estrus (0 hours) and 12 to 24 hours later.

## Implications

- Characterizing the reproductive status of weaned sows using transrectal RTU on days 4 to 6 postweaning required 3 to 4 minutes per examination per sow.
- RTU provided reproductive information on follicles and their size, incidence of cysts, and characterization of wean-to-estrus and estrus-to-ovulation intervals.
- Obtaining ovarian measures with RTU may aid in assessing estrus detection techniques and effectiveness of AI timing, and may be used to identify sources of reproductive problems in the herd.

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