Risk Factors and the Economic Impact of Ovarian Cysts on Reproductive Performance of Dairy Cows in Korea

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Abstract. The objectives of this study were to determine the risk factors for development of postpartum ovarian cysts by evaluating several reproductive factors in individual cows, and to determine the economic impact of ovarian cysts on subsequent reproductive performance in dairy herds in Korea. The data, including cow parity, abnormal puerperium, endometritis, body condition score (BCS), and breeding status were collected from 634 cows in 9 dairy herds. We used logistic regression to evaluate the effects of these factors on ovarian cysts. A stepwise procedure, used to obtain the appropriate model with $\alpha=0.05$, revealed that cow parity was the most important risk factor for ovarian cyst development within 8 weeks postpartum, while development of endometritis and BCS loss $\geq 1$ from the dry period to 8 weeks postpartum were the most important risk factors for ovarian cyst development beyond 8 weeks postpartum. The occurrence of ovarian cysts beyond 8 weeks postpartum prolonged (P<0.01) the mean intervals from calving to first service (27 days) and conception (77 days), and increased (P<0.05) the culling rate (7.8%), while ovarian cyst development within 8 weeks postpartum did not affect (P>0.05) the mean intervals from calving to first service and conception or the culling rate. The economic loss resulting from the occurrence of ovarian cysts was estimated at approximately 823,996 won ($687) due to effects on the cost of nutrition, average growth of calves, labor and medical costs, and culling. These results suggest that cow parity is correlated with the development of ovarian cysts within 8 weeks postpartum, and endometritis and BCS loss $\geq 1$ from the dry period to 8 weeks postpartum are correlated with the development of ovarian cysts after 8 weeks postpartum, which decreases reproductive performance and results in economic loss in dairy herds in Korea.

Key words: Economic loss, Dairy cows, Ovarian cyst, Risk factors, Reproductive performance

Accepted for publication: April 20, 2005
Published online: June 10, 2005
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The ovarian cystic condition in cows is characterized by persistent anovulatory follicular structures in the absence of corpus luteum and interrupted normal estrous cycles [1]. Ovarian cysts are a major reproductive disease responsible for economic loss in the dairy industry [2–4]. The incidence of ovarian cysts ranges from 6 to 30% [5–10], and is generally highest between 30 and 60 days postpartum [9–12], although it does occur frequently during late lactation periods [13]. Many cysts that develop during the early postpartum period regress spontaneously [14]. Lack of release or inappropriate release of hypothalamic gonadotropin-releasing hormone at the time of estrus [15] appears to be an important pathological factor in development of ovarian cysts, although the exact cause of ovarian cysts is not certain. Various risk factors related to development of ovarian cysts in individual cows have been identified, although some are controversial. Some predisposing factors include
heredity [16, 17], cow parity [14], seasonal variation [10], high milk production [8, 14], abnormal puerperium [14, 19], uterine infection [20], and nutrition [21]. However, risk factors for ovarian cysts may vary among different regions or countries because of differences in general management, environment, and herd health control conditions.

Bovine ovarian cysts adversely affected reproductive performance of dairy cows in several studies [11, 22, 23], but did not affect subsequent fertility in one report [24]. The economic impact of ovarian cysts is mainly related to a prolonged interval from calving to conception. Bartlett et al. [13] reported that the average economic loss associated with ovarian cysts was estimated at approximately $137 due to effects on reproduction, culling, medical costs, and labor.

Our first objective was to determine the risk factors for development of postpartum ovarian cysts by evaluating several factors: cow parity, abnormal puerperium, endometritis, and BCS in dairy herds in Korea. Our second objective was to determine the effect of ovarian cysts on subsequent reproductive performance and the resulting economic impact.

Materials and Methods

Herd

This study was performed on nine Holstein dairy farms located in Beun County, Chungbuk Province, central Korea, over the period of May 2002 to November 2004. All herds contained 50 or more cows and received regular reproductive health checkups every 2 to 4 weeks from veterinarians at the College of Veterinary Medicine at Chungbuk National University, Korea. The regular reproductive health checkup included diagnosis, and treatment of reproductive disturbances, pregnancy diagnosis, and measurement of BCS (based on criteria developed by Edmonson et al. [25]). Average milk yield was 9,990 kg per year per cow. The cows were maintained in free-stall facilities and fed a total mixed ration.

Case definition

An abnormal puerperium included dystocia (veterinary-assisted calving or pulling with extreme force), caesarean section, twins, stillbirth, retained placenta, or metabolic disorder [3, 14, 26]. The postpartum reproductive and metabolic disorder definitions used in this study are similar to the definitions used in previous studies [27–29]. Retained placenta was defined as the retention of the fetal membrane for > 24 h. Metabolic disorders (abomasal displacement, milk fever, and ketosis) were diagnosed by clinical signs observed by a veterinarian and/or farmer within 4 weeks postpartum. Abomasal displacement was diagnosed by a pinging sound upon abdominal auscultation by a veterinarian, and all cases were corrected by surgery. Milk fever was diagnosed by the presence of the following clinical signs: weakness, cold skin, and favorable response to calcium therapy. Ketosis was defined as the presence of the following clinical signs: anorexia, depression, and odor of acetone on the breath. Endometritis was diagnosed 4 weeks postpartum by determination of the presence of the following clinical signs: cloudy discharge and enlarged uterus observed by rectal examination with or without other clinical signs. Therefore, endometritis included cases of metritis and pyometra as well as endometritis [30, 31]. Ovarian cysts were diagnosed from 4 to 16 weeks postpartum with repeated examinations at 2 to 4 week interval by ultrasonography (Sonoace 600 with 5.0 MHz linear-array transducer; Medison Co., Ltd., Seoul, Korea) based on ovarian structures present: an ovarian structure of greater than 25 mm internal diameter with a wall less than 3 mm thick (follicular cyst) and with a wall more than 3 mm thick (luteal cyst) in the absence of a normal corpus luteum [32, 33]. Repeat occurrences of these conditions in a single cow were included.

Data collection and processing for determination of the risk factors for ovarian cysts

Data were collected from 634 Holstein cows from nine dairy herds calving from May 2002 to April 2004. Table 1 lists independent variables that describe cow parity, health status, and the amount of BCS loss from the dry period to 8 weeks postpartum. Cows were grouped by BCS loss from the dry period to 8 weeks postpartum (mean ± S.D., 0.84 ± 0.5) into two categories: <1 (0–0.75 points) or ≥1 (1–2.25 points). All diseases were coded as dichotomous variables (no=0, yes=1). In order to evaluate the influence of cow parity, abnormal
puerperium (total cases of dystocia, caesarean section, twins, stillbirth, retained placenta, and metabolic disorder), endometritis, and the amount of BCS loss from the dry period to 8 weeks postpartum on the development of ovarian cysts, we used logistic regression along with the SAS program [34]. Initially, to determine which independent variables influence ovarian cysts, simple logistic regression was applied separately to each independent variable. Later, a stepwise procedure was used to obtain the appropriate model with $\alpha=0.05$.

**Table 1.** Descriptive statistics for data included in the analysis of risk factors for ovarian cysts (OC) in 634 calvings in nine Korean dairy herds

<table>
<thead>
<tr>
<th>Variables</th>
<th>Level</th>
<th>Within 8 weeks postpartum</th>
<th>Beyond 8 weeks postpartum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>OC+</td>
<td>OC-</td>
</tr>
<tr>
<td>Cow parity</td>
<td>Primipara</td>
<td>10</td>
<td>158</td>
</tr>
<tr>
<td></td>
<td>Multipara</td>
<td>64</td>
<td>402</td>
</tr>
<tr>
<td>Abnormal puerperium</td>
<td>Yes</td>
<td>21</td>
<td>161</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>53</td>
<td>399</td>
</tr>
<tr>
<td>Endometritis</td>
<td>Yes</td>
<td>28</td>
<td>247</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>46</td>
<td>313</td>
</tr>
<tr>
<td>BCS loss$^b$</td>
<td>&lt;1</td>
<td>39</td>
<td>314</td>
</tr>
<tr>
<td></td>
<td>≥1</td>
<td>35</td>
<td>246</td>
</tr>
</tbody>
</table>

$^a$ Abnormal puerperium included dystocia, caesarean section, twins, stillbirth, retained placenta, and metabolic disorder.

$^b$ BCS loss: the amount of body condition score loss from the dry period to 8 weeks postpartum.

Evaluation of the effect of ovarian cysts on reproductive performance and the economic impact

The effect of ovarian cysts on subsequent reproductive performance was evaluated by dividing cases of ovarian cysts into two groups based on time of ovarian cyst diagnosis: within 8 weeks (voluntary waiting period from calving) or beyond 8 weeks postpartum (during breeding period). Cows were grouped based on the incidence of ovarian cyst before or after 8 weeks postpartum: the ovarian cyst group ($n=74$) or the non-ovarian cyst group ($n=560$) within 8 weeks postpartum, and the ovarian cyst group ($n=113$) or the non-ovarian cyst group ($n=521$) beyond 8 weeks postpartum. The cows diagnosed with ovarian cysts within 8 weeks postpartum were not treated. The cows diagnosed with ovarian follicular cysts beyond 8 weeks postpartum were treated with 100 $\mu$g fertirelin acetate (GnRH, Conceral, Dongbang Co., Seoul, Korea) and cows diagnosed with luteal cysts were treated with 25 mg PGF$_{2\alpha}$ (Lutalyse, Pharmacia & Upjohn, Puurs, Belgium). The cows with endometritis were treated with one intrauterine infusion of 1500 mg oxytetracycline hydrochloride solution (Metrijet 1500, Intervet, U.K.) or 2% povidone-iodine solution (Betadine solution, Korea Pharma Co. Ltd., Hwasung, Kyonggi, Korea), and re-treated as necessary. The voluntary waiting period from calving to first artificial insemination (AI) established for this study was 56 days. AI was performed according to the a.m.-p.m. rule. The conception to AI ratio was determined per rectum 60 to 70 days after AI by both ultrasonographical observation and manual palpation. Reproductive performance data were collected for a minimum of 7 months postpartum or until pregnancy or culling. To evaluate the effect of ovarian cysts on reproductive performance, intervals from calving to first service and conception were compared between the ovarian cyst group and the non-ovarian cyst group within 8 weeks postpartum, and between the ovarian cyst group and the non-ovarian cyst group beyond 8 weeks postpartum, respectively. Data on the intervals from calving to first service and conception between groups were analyzed by $t$-test using the SAS program. Culling rates were compared between groups by chi-square analysis. A value of $P<0.05$ was considered significant.

Expenses associated with ovarian cysts included the cost of nutrition, average growth of calves, labor and medical costs, and culling. The economic
loss resulting from ovarian cysts was calculated based on 2002 standard data from the National Agricultural Products Quality Management Service, Korea [35].

Results

The overall incidence of ovarian cysts among a total of 634 calvings in nine herds was 27.9%. The incidence of ovarian cysts within and beyond 8 weeks postpartum was 11.7% and 17.8%, respectively (Table 2). The final model identified cow parity as the risk factor for ovarian cyst development within 8 weeks postpartum, while endometritis and BCS loss ≥1 from the dry period to 8 weeks postpartum were the risk factors for development of ovarian cysts beyond 8 weeks postpartum (Tables 3 and 4). However, abnormal puerperium, endometritis, and BCS loss ≥1 from the dry period to 8 weeks postpartum were not identified as risk factors for ovarian cyst development within 8 weeks postpartum, and cow parity and abnormal puerperium were not identified by the model as risk factors for development of ovarian cysts beyond 8 weeks postpartum. The effect of ovarian cysts on reproductive performance is shown in Figs. 1 and 2. The occurrence of ovarian cysts beyond 8 weeks postpartum prolonged (P<0.01) the mean intervals from calving to first service (114.0 ± 4.0 vs. 87.3 ± 1.8 days) and conception (210.0 ± 9.0 vs. 132.8 ± 3.8 days, Fig. 2), while ovarian cyst development within 8 weeks postpartum did not affect (P>0.05) the mean intervals from calving to first service and conception (Fig. 1). The culling rate was greater (P<0.05) in the ovarian cyst group (21.2%) than in the non-ovarian cyst group (13.4%) beyond 8 weeks postpartum, while its rate was not different (P>0.05) between the ovarian cyst group (13.5%) and the non-ovarian cyst group (15.0%) within 8 weeks postpartum. The economic loss associated with the occurrence of ovarian cysts was estimated at approximately 823,996 won ($687) due to the effects on the cost of nutrition, average growth of

Table 2. Incidence of ovarian cysts in 634 calvings in nine Korean dairy herds

<table>
<thead>
<tr>
<th>Total no. of cows</th>
<th>No. of cows with ovarian cysts</th>
<th>Within 8 weeks postpartum</th>
<th>Beyond 8 weeks postpartum</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>634 (100.0%)</td>
<td>74</td>
<td>113a</td>
<td>177</td>
<td></td>
</tr>
</tbody>
</table>

*a In eight of the 113 cows, the cystic condition continued from the time of development within 8 weeks postpartum, while the cystic condition recurred in sequence within 8 weeks postpartum in two of the 113 cows.

Table 3. Risk factors for ovarian cysts occurring within 8 weeks postpartum analyzed by a stepwise selection procedure on data from 634 calvings in nine Korean dairy herds

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>S.E.M.</th>
<th>P</th>
<th>Odd ratio</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.30</td>
<td>0.18</td>
<td>&lt;0.0001</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Cow parity</td>
<td>0.46</td>
<td>0.18</td>
<td>0.0089</td>
<td>2.52</td>
<td>[1.260,5.022]</td>
</tr>
</tbody>
</table>

Table 4. Risk factors for ovarian cysts occurring beyond 8 weeks postpartum analyzed by a stepwise selection procedure on data from 634 calvings in nine Korean dairy herds

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>S.E.M.</th>
<th>P</th>
<th>Odd ratio</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.70</td>
<td>0.13</td>
<td>&lt;0.0001</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Endometritis</td>
<td>0.44</td>
<td>0.11</td>
<td>&lt;0.0001</td>
<td>2.43</td>
<td>[1.568,3.770]</td>
</tr>
<tr>
<td>BCS lossa</td>
<td>0.47</td>
<td>0.11</td>
<td>0.0001</td>
<td>2.56</td>
<td>[1.659,3.944]</td>
</tr>
</tbody>
</table>

*a BCS loss: the amount of body condition score loss from the dry period to 8 weeks postpartum.
calves, labor and medical costs, and culling (Table 5).

**Discussion**

The data presented here shows that cow parity is the most important risk factor for ovarian cyst development within 8 weeks postpartum, while endometritis and BCS loss ≥1 from the dry period to 8 weeks postpartum are the risk factors for ovarian cyst development beyond 8 weeks postpartum, which decreases reproductive performance, thus incurring economic loss in dairy herds in Korea.

The overall incidence of development of postpartum ovarian cysts in this study (27.9%) was similar to that reported by López-Gatius et al. [14], but was higher than many previously reported rates (10–15%; [9, 13, 24, 36]). The different incidence rates of ovarian cysts in these studies might be explained by the different diagnostic
methods employed, different time periods of ovarian cyst detection, different characteristics of the cows, or varied herd management practices [2, 14, 37–39].

Ovarian cyst development within 8 weeks postpartum was significantly associated with cow parity in this report. Increased risk of ovarian cyst (odds ratio=2.30) in multiparous cows compared to primiparous cows was consistent with the results (odds ratio=1.36) of López-Gatius et al. [14]. These results suggest that the severe metabolic stress of a previous lactation in multiparous cows impairs ovarian activity, unlike the situation for primiparous cows. Ovarian cyst development beyond 8 weeks postpartum was significantly associated with endometritis and BCS loss ≥1 from the dry period to 8 weeks postpartum. The increased risk of ovarian cysts (odds ratio=2.43) in cows with endometritis than without endometritis in this study was consistent with the results of Hardie and Ax [40]. Uterine bacterial infection or bacterial products suppress pituitary LH secretion and perturb postpartum ovarian follicle growth and function, which disrupts ovulation [41–44]. Bosu and Peter [20] suggested that uterine infection might lead to increased secretion of cortisol and PGF$_{2\alpha}$, which would increase the incidence of cysts. Risk of ovarian cysts (odds ratio=2.56) was increased in cows with BCS loss ≥1 compared to cows with BCS loss <1 from the dry period to 8 weeks postpartum. Excessive lipid mobilization from adipose tissue, noted even in clinically normal cows during early lactation, has been linked to greater incidences of periparturient health disorders [45]. Furthermore, dairy cows with marked BCS loss up to month 1 of lactation recovered body condition more slowly during the subsequent lactation period and suffered a more severe energy deficit, which may have been related to the occurrence of postpartum reproductive and metabolic diseases [46]. In this study, the severe BCS loss from the dry period to 8 weeks postpartum, which reflected a negative energy balance, might have not only suppressed pulsatile LH secretion, but also may have reduced ovarian responsiveness to LH stimulation, as suggested by Butler [47]. On the other hand, López-Gatius et al. [14] reported that a gain in prepartum nutritional status could impair postpartum ovarian function, and thus could be a major risk factor for cyst condition in lactating dairy cows. Abnormal puerperium was eliminated from the final models as this factor did not influence the incidence of ovarian cysts. However, abnormal puerperium was related to the incidence of ovarian cysts in other studies [19, 20, 48].

The effects of ovarian cysts on the intervals from calving to first service and conception were also evaluated. The occurrence of ovarian cysts beyond 8 weeks postpartum prolonged the mean intervals from calving to first service and conception by 27 and 77 days, respectively, while ovarian cyst development within 8 weeks postpartum did not affect the mean intervals from calving to first service and conception. The prolonged interval from calving to conception in this study was longer than intervals measured in other reports (20–64 days; [2, 3, 13, 33]). The more prolonged interval from calving to conception in this study might be explained by the different diagnostic methods and treatments employed, different characteristics of the cows, or varied herd management practices [33, 37–39]. A great proportion (64 of 74 cows) of cows that developed ovarian cysts within 8 weeks postpartum recovered spontaneously in the study, which may explain the absence of effects from ovarian cyst development within 8 weeks postpartum on the subsequent reproductive performance. In addition, cysts that develop during the early postpartum period have been reported to regress spontaneously in more than 50% of cows before insemination programs commence [49]. The economic loss resulting from the occurrence of ovarian cysts was estimated at approximately 823,996 won ($687) due to the effects on the cost of nutrition, average growth of calves, labor and medical costs, and culling. Bartlett et al. [13] reported that the economic loss associated with the average lactating cow with ovarian cysts was estimated at approximately $137, resulting from the effects on reproduction, culling, and medical and labor expenses. The different economic losses reported in the two studies might be explained by differences in reproduction, feed costs, and items included for calculation of economic loss.

In conclusion, cow parity is an important risk factor for ovarian cyst development within 8 weeks postpartum, and endometritis and BCS loss ≥1 from the dry period to 8 weeks postpartum are important risk factors for ovarian cyst development beyond 8 weeks postpartum in dairy herds in Korea. Since the occurrence of ovarian cysts
beyond 8 weeks postpartum prolonged the mean interval from calving to conception and increased the culling rate, resulting in economic loss, the prevention of postpartum endometritis and reduced BCS during early lactation would be beneficial to dairy farmers. Likewise, an improved and efficient treatment protocol for ovarian cysts in dairy herds would improve dairy farming.

Acknowledgements

The authors thank Dr. Daehyun Chung, Department of Statistics, Chungbuk National University for statistical analysis of the data.

References

23. Martin SW, Aziz SA, Sandals WCD, Curtis RA. The association between clinical disease, production


