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Effects of Dystocia on the Postpartum Complications, Milk Production and Reproductive Performance in Dairy Cows

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Abstract : This field study investigated the effects of dystocia on the postpartum complications, milk production, and reproductive performance in Holstein dairy cows. Calving difficulty was scored on a rank scale of 1 to 5. Cows with a calving score of three or higher were judged to have dystocia. The cows (n = 565) were categorized based on the presence (n = 61) or absence (n = 504, control) of dystocia. The incidence of retained placenta (45.9% *vs*. 16.3%), metritis (39.3% *vs*. 17.1%), endometritis (47.5% *vs*. 16.3%) and pyometra (9.8% *vs*. 1.2%) were greater in cows from the dystocia group than those from the control group ($p < 0.0001$); however, there was no difference in the incidence of metabolic disorders (32.8% *vs*. 31.0%) between the two groups ($p > 0.05$). The prevalence of culling was higher in cows from the dystocia group (26.2%) than in those from the control group (14.5%, $p < 0.05$). During the 5-month postpartum period, milk production was lower ($p < 0.05$) in cows from the dystocia group than in those from the control group. Furthermore, the hazard of insemination by 150 days in milk (DIM) was lower in cows from the dystocia group (hazard ratio [HR] = 0.64, $p < 0.005$) than in those from the control group. Logistic regression analysis revealed that the odds ratio for the probability of pregnancy after the first artificial insemination was 0.36 times ($p < 0.05$) higher in cows from the dystocia group than in those from the control group. The hazard of pregnancy by 360 DIM was lower in cows from the dystocia group (HR = 0.45, $p = 0.0001$) than in those from the control group. In conclusion, dystocia resulted in increased postpartum complications, and decreased milk production and reproductive performance in Holstein dairy cows, leading to increased culling.

Key words **:** dairy cows, dystocia, postpartum complications, milk production, reproductive performance.

Introduction

The reproductive health of dairy cattle is an economically important attribute, and calving improves productivity and profitability for dairy producers (26,29). Dystocia, more commonly known as difficult calving, is the leading cause of calf death at or shortly after birth (5,23). In an uneventful delivery, the front legs present first, followed by the head, shoulders, hips, and hind legs. In a dystocia delivery, however, the fetus is not properly oriented, requiring the assistance of a veterinarian. Although the most common cause of dystocia is a small cow giving birth to a large calf, there are other contributing factors such as gestation length; sex of the calf; age, breed and parity of the dam; pelvic dimensions of the dam; breed of the sire; diet and exercise of the dam; and season of the year and geographical location. Along with the increased incidence of calf death, dystocia also associated with veterinary, management and culling costs, impaired subsequent reproductive performance, increased risk of postpartum health problems, and reduced milk production (3-6, 18,21). Dystocia occurs in 2.5% to 13.9% of vaginal deliveries in cows (1,3,5,19). Thus, dairy producers should promote health management practices that minimize the frequency of dystocia and postpartum-related complications.

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Dystocia causes several complications in both the dam and calf. In the calf, dystocia increases the prevalence of respiratory and digestive problems that usually result in death, whereas surviving heifers often perform poorly (20). Calves that are not properly positioned at birth are also more likely to have weak or depressed immune responses. In the dam, dystocia increases the prevalence of uterine bleeding, retained placenta, metritis, endometritis, infertility, and death (2,12). If the reproductive tract becomes contaminates with bacteria, infection may also result (7). Unfortunately, there are few studies that examine the effect of dystocia in cows (2,12). In this study, we evaluate the short-term and long-term effects of dystocia on the postpartum complications, milk production, and reproductive performance in Holstein dairy cows.

Materials and Methods

Animals and herds

This study involved Holstein dairy cows from eight farms in Chungcheong Province. The cows were maintained in a loose housing system, fed a total mixed ration, and milked twice daily. The average milk yield was approximately 8,500-12,000 kg per cow per year. Veterinarians on the staff at the College of Veterinary Medicine, Chungbuk National University, conducted reproductive health checkups every 2-4 weeks. Health checkups included an examination of ovarian structures, such as the corpus luteum, follicles, or cysts, and

the uterus via transrectal palpation and ultrasonography.

Study design

A total of 565 parturient Holstein dairy cows were scored for calving difficulty on a rank scale of 1 to 5 (1 = no assistance, 2 = some assistance, 3 = plenty assistance, 4 = extreme force, and 5 = caesarian section). Cows with a score of three or higher were judged to have dystocia, which was defined according to a previous study (5). The cows were grouped based on the presence (n = 61) or absence (n = 504) of dystocia. This study investigated the effects of dystocia on the incidence of postpartum complications (i.e., retained placenta, metritis, metabolic disorders, endometritis, and pyometra) and culling, milk production and reproductive performance in dairy cows. Reproductive performance was defined as the probability of pregnancy after the first artificial insemination, and the hazards of insemination by 150 DIM and pregnancy by 360 DIM).

Diagnosis of health problems

The health problems observed in Holstein dairy cows during the calving and postpartum periods in this study were similar to those reported in previous studies (9,17,27,28). Retained placenta was defined as the retention of the fetal membrane for longer than 24 h. Metritis was defined by the presence of fever (≥ 39.5ºC) and watery, fetid uterine discharge during the first 10 days postpartum. Ketosis, a condition characterized by an increased level of ketone bodies, was diagnosed by the serum β-hydroxybutyrate concentration (≥ 1,200 μmol/L) using a model 7180 Biochemistry Automatic Analyzer (Hitachi Ltd., Tokyo, Japan) at 1 and 2 weeks postpartum. Milk fever, a disorder characterized by a reduced level of calcium, was diagnosed by weakness and recumbence after calving. Abomasal displacement was diagnosed by a ping sound during abdominal auscultation. Endometritis was diagnosed with the Metricheck device (Metricheck, Simcrotech, Hamilton, New Zealand) at 4 weeks postpartum. Cows with a score of three or higher were judged to have endometritis. Cervical and vaginal discharge was scored on a rank scale (0 = no discharge, 1 = clear mucus, 2 = flecks of purulent material within otherwise clear mucus, 3 = mucopurulent with < 50% purulent material, 4 = mucopurulent with > 50% purulent material, and 5 = mucopurulent with > 50% purulent material and a fetid odor). Pyometra was defined by the presence of a distended uterus with pus using ultrasonography. Veterinarians on staff at the College of Veterinary Medicine examined the cows and diagnosed the conditions. Culling was recorded for 12 months postpartum.

Reproductive management

The voluntary waiting period from calving to first artificial insemination (AI) was 40 days. In addition to estrous detection, a herd reproductive management program was employed for cows failing to receive AI within the 80-day postpartum period. This included estrus synchronization with prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) or Ovsynch. Cows that exhibited estrus naturally or after estrus synchronization with $PGF_{2\alpha}$ were inseminated according to the AM-PM rule, whereas cows treated with Ovsynch received timed AI. Pregnancy was diagnosed rectally 40-50 days after AI using both manual palpation and ultrasonography.

Statistical analysis

Statistical analyses were performed using SAS program (version 9.4, SAS Inst., Cary, NC, USA). Results were expressed as the means ± standard error of the means (SEM). For statistical analyses, cow parity was categorized as primiparous or multiparous. The Chi-squared test was used to compare the occurrence of postpartum complications (i.e., retained placenta, metritis, metabolic disorders, endometritis, and pyometra), and culling was compared between groups using the Chi-squared test. Metabolic disorders included ketosis, milk fever, and abomasal displacement.

The effects of group (control or dystocia), sampling time (month postpartum), and two-way interactions between group and sampling time on milk yields from the first 5 months postpartum were determined using the mixed model. For this purpose, only the milk yields from the first 5 months postpartum were included in the analysis.

The probability of pregnancy after the first AI was analyzed by logistic regression using the LOGISTIC procedure. The logistic regression model included farm, cow parity, retained placenta, metritis, metabolic disorders, endometritis, pyometra and group. Backward stepwise regression was used in all models, and elimination was performed based on the Wald statistic criterion when $p > 0.11$. Odds ratios (OR) and 95% confidence intervals (CI) were determined by logistic regression. Results were presented as percentages and OR with their respective 95% CIs.

Cox's proportional hazard model with the PHREG procedure was used to analyze the hazard of first insemination by 150 days in milk (DIM) and the hazard of pregnancy by 360 DIM between the control and dystocia groups. This model estimated the hazard of a cow being inseminated or pregnant at a given time. The time variables used in this model were the interval in days between calving and first insemination, and the interval in days between calving and pregnancy. Cows that were sold, died, not inseminated by 150 DIM or not pregnant by 360 DIM were censored. The Cox models included farm, cow parity, retained placenta, metritis, metabolic disorders, endometritis, pyometra, and group. The proportional hazard rate was determined based on interactions between explanatory variables and time, and by evaluating Kaplan-Meier curves. The median and mean days to first insemination or pregnancy were determined by survival analysis from the Kaplan-Meier model using the LIFETEST procedure. A survival plot was generated using the survival module within MedCalc software (version 11.4, MedCalc Software, Mariakerke, Belgium).

A p-value ≤ 0.05 was considered significant, and $0.05 < p < 0.1$ was considered as a tendency toward significance.

Results

The overall incidence of dystocia in Holstein dairy cows was 10.8% (61/565). To understand the effects of dystocia on the short-term and long-term health of cows, postpartum complications were compared between the two groups (Fig

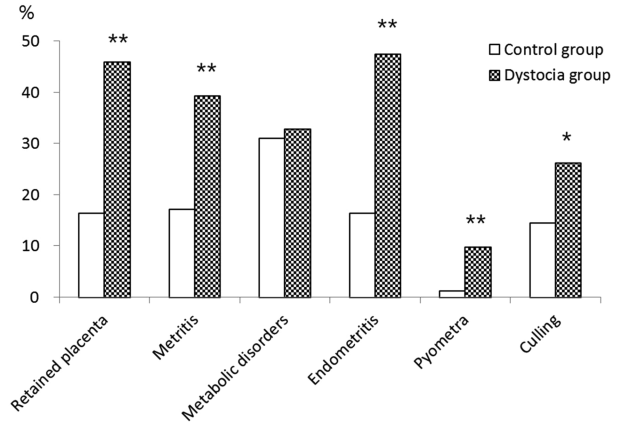

Fig 1. Comparison of the incidence rates of postpartum complications and culling in cows from the control and dystocia groups.
*$p < 0.05$; **$p < 0.0001$ between groups. Metabolic disorders included ketosis, milk fever, and abomasal displacement.

1). The incidence rates of retained placenta (45.9% *vs*. 16.3%), metritis (39.3% *vs*. 17.1%), endometritis (47.5% *vs*. 16.3%), and pyometra (9.8% *vs*. 1.2%) were significantly higher in cows from the dystocia group than in those from the control group ($p < 0.0001$); however, there was no difference in the incidence of metabolic disorders between the two groups (32.8% *vs*. 31.0%, $p > 0.05$). The prevalence of culling was higher in cows from the dystocia group (26.2%) than in those from the control group (14.5%, $p < 0.05$)

Milk production was compared between the two groups (Fig 2). During the 5-month postpartum period, milk production was lower in cows from the dystocia group ($p < 0.05$) than in those from the control group.

The PHREG procedure was used to identify the factors affecting the hazard of insemination by 150 DIM (Table 1). The analysis revealed that group, farm, metritis, and endometritis affected the hazard ($p < 0.1$-0.005). Compared with the control group, the survival curves revealed a lower hazard ratio (HR) (0.64, CI = 0.487-0.840) for cows with

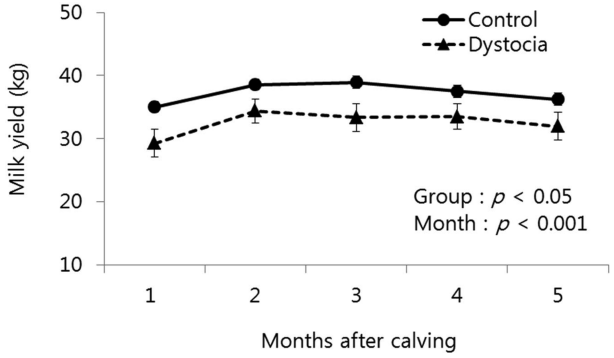

Fig 2. Comparison of milk yields during the first 5 months postpartum in cows from the control and dystocia groups. Results from group ($p < 0.05$) and month ($p < 0.001$) are presented.

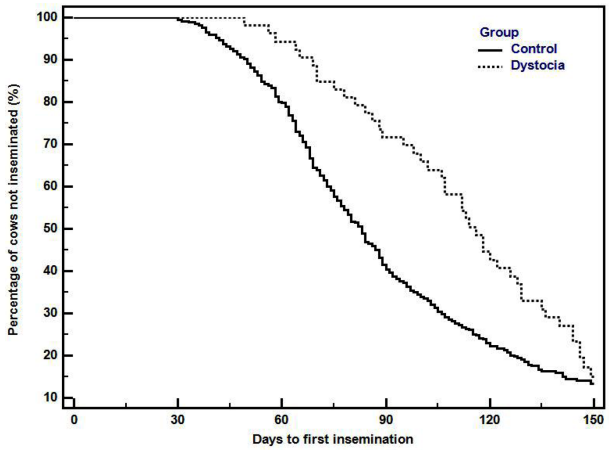

Fig 3. Survival curves for the interval to first postpartum insemination in cows from the control and dystocia groups. The hazard of first insemination by 150 DIM was lower (HR = 0.64, CI = 0.487-0.840, $p < 0.005$) in cows from the dystocia group than in those from the control group.

dystocia (Fig 3). The median and mean (± SEM) days to first insemination were 83 and 90.0 ± 1.9 in the control group and

Table 1. Factors affecting the hazard of insemination by 150 DIM analyzed by the PHREG procedure

Variable	Level	HR	95% CI	*p*-value
Farm		0.92	0.857-0.988	< 0.05
Cow parity				> 0.05
Group				
	Control	Reference		
	Dystocia	0.73	0.522-1.025	< 0.1
Retained placenta				> 0.05
Metritis				
	No	Reference		
	Yes	0.62	0.463-0.841	< 0.005
Metabolic disorders[1]				> 0.05
Endometritis				
	No	Reference		
	Yes	0.71	0.520-0.975	< 0.05
Pyometra				> 0.05

[1]Metabolic disorders included ketosis, milk fever, and abomasal displacement.

Table 2. Adjusted OR of variables included in the logistic regression model on the probability of pregnancy after the first artificial insemination

Variable	Level	Adjusted OR	95% CI	*p*-value
Farm				> 0.05
Cow parity				
	Primiparous	Reference		
	Multiparpus	0.54	0.317-0.927	< 0.05
Group				
	Control	Reference		
	Dystocia	0.36	0.157-0.802	< 0.05
Retained placenta				> 0.05
Metritis				> 0.05
Metabolic disorders[1]				> 0.05
Endometritis				> 0.05
Pyometra				> 0.05

[1]Metabolic disorders included ketosis, milk fever, and abomasal displacement.

Table 3. Factors affecting the hazard of pregnancy by 360 DIM analyzed by the PHREG procedure

Variable	Level	HR	95% CI	*p*-value
Farm		0.93	0.866-1.006	< 0.1
Cow parity				> 0.05
Group				
	Control	Reference		
	Dystocia	0.54	0.349-0.832	< 0.01
Retained placenta				> 0.05
Metritis				
	No	Reference		
	Yes	0.65	0.473-0.893	< 0.01
Metabolic disorders[1]				> 0.05
Endometritis				> 0.05
Pyometra				> 0.05

[1]Metabolic disorders included ketosis, milk fever, and abomasal displacement.

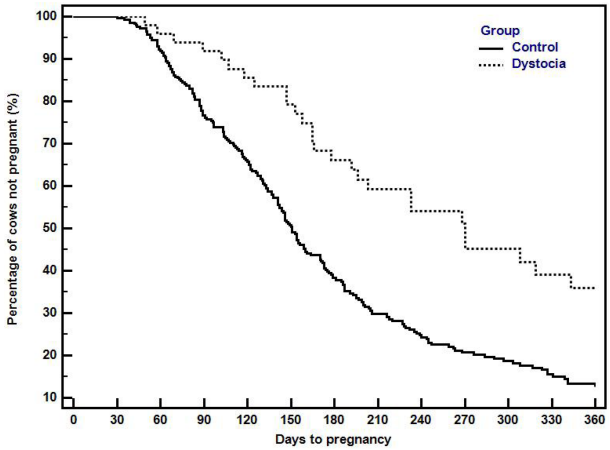

Fig 4. Survival curves for the interval to pregnancy in cows from the control and dystocia groups. The hazard of pregnancy by 360 DIM was lower (HR = 0.45, CI = 0.334-0.614, $p = 0.0001$) in cows from the dystocia group than in those from the control group.

116 and 112.6 ± 4.2 in the dystocia group, respectively. In addition, the hazard of first postpartum insemination by 150 DIM was lower in cows with metritis (HR = 0.62, $p < 0.005$) or endometritis (HR = 0.71, $p < 0.05$) than that in disease-free cows, while cow parity, retained placenta, metabolic disorders, and pyometra had no effects ($p > 0.05$).

Table 2 shows the adjusted OR of variables included in the logistic regression model on the probability of pregnancy after the first AI. Compared to the control group (32.2%), the probability was significantly lower in cows from the dystocia group (16.3%) (OR = 0.36, $p < 0.05$). The OR for the probability was also lower for multiparous cows than primiparous cows (OR = 0.54, $p < 0.05$). However, the hazard did not associate with farm, retained placenta, metritis, metabolic disorders, endometritis, or pyometra ($p > 0.05$).

Table 3 shows the factors affecting the hazard of pregnancy by 360 DIM analyzed by the PHREG procedure. This analysis revealed that farm, group, and metritis ($p < 0.1$-0.01) affected the hazard. As shown by survival curves, cows with dystocia had a lower HR (0.45, CI = 0.334-0.614) than cows without dystocia (Fig 4). The median and mean days to pregnancy were 151 and 177.4 ± 6.2 in the control group and 270 and 251.4 ± 15.5 in the dystocia group, respectively. In addition, the hazard was lower for cows with metritis (HR = 0.65, $p < 0.01$) than for those without metritis. However, cow parity, retained placenta, metabolic disorders, endometritis, and pyometra did not affect the hazard ($p > 0.05$).

Discussion

This study examined the short-term and long-term effects of dystocia on the postpartum complications, milk production, and reproductive performance in Holstein dairy cows. This study showed that dystocia resulted in increased postpartum complications, and decreased milk production and reproductive performance in dairy cows, leading to increased culling. Thus, dairy farmers should promote health manage-

ment practices that minimize the prevalence of dystocia and postpartum related complications.

In the present study, the overall incidence of dystocia was 10.8%, which was higher than the rate of 2.5-8.2% (1,3,14, 19) and lower than the rate of 13.9% (5) in previous reports. Differences in the breed of the dam, herd management practices, and criteria for evaluation may account for these discrepancies in results. In addition, the increased culling of cows with dystocia as reported herein is consistent with previous studies (22,32).

The incidence rates of retained placenta, metritis, endometritis, and pyometra were higher in cows from the dystocia group than in those from the control group. These results agree with previous reports that show an increased risk of retained placenta and/or metritis in dystocic cows (12,24). On the other hand, the underlying causes of endometriris and pyometra are weak or depressed immune responses induced by damage to the uterus or insufficient contractions during labor (i.e., uterine inertia) (13,15,16,20).

Compared to cows with uneventful deliveries, cows with dystocia produced less milk in the first 5-months postpartum. These results are similar with previous studies in which milk yield decreases in the first 2 to 4 months postpartum in cows with dystocia (3,8,10). Furthermore, Atashi *et al*. (1) reported that dystocia affects 305-day lactation performance; however, Thompson *et al*. (30) reported that dystocia did not affect milk production in the first 3 month or 305-day equivalent milk yield, but only in the first month. There is also an inverse correlation between milk yield and caesarean deliveries in cows with dystocia (21). Presently, it is not clear why theses discrepancies exist; however, the severity of dystocia, breed of the dam, and health management practices may be contributing factors.

In the present study, cows with dystocia exhibited decreased reproductive performance due to metritis and endometritis. Although these results agree with previous reports (3,11,19,25,31), the mean intervals from calving to first insemination (22 days *vs*. 8 days) and pregnancy (74 days *vs*. 28-33 days) were longer than those reported by other investigators (5,10,19).

In summary, dystocia increased postpartum complications, and decreased milk production and reproductive performance in Holstein dairy cows. Thus, dairy producers and veterinary practitioners who perform reproduction consultations for dairy farms should promote health management practices that minimize the frequency of dystocia and postpartum-related complications. Cows with dystocia should be monitored and treated for postpartum complications to preserve subsequent productive and reproductive performance.

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