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The effect of retained placenta on the reproductive performance and its economic losses in a Holstein dairy herd

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Abstract

Retention of placenta (RP) is a failure of the fetal membrane to be expelled and remained from 8 to 48 hours, average 12 hours after parturition**.** There are a variety of risk factors for the occurrence of RP. So, the aim of this study was to quantify the relative risk of calving season, parity, and gestation length on the occurrence of RP, and assess the impact of RP on the subsequent reproductive parameters, and the economic losses. A data of 2940 purebred Holstein-Friesian cows were collected from reliable records of large commercial dairy farm, Sharkia governorate, Egypt. These cows calved during the period extended from January 2018 to December 2019. Cows that did not release the fetal membranes within the first 12 hours after calf expulsion were diagnosed with RP. Results of logistic regression analysis revealed that the important risk factors for the occurrence of RP were summer calving season and short gestation period. Odds ratio estimation for summer calving season compared to spring calving was 2.84. The probability of RP incidence in cows with shorter gestation period was 0.19 times more than cows with longer gestation length, and the total direct economic losses from RP was 47 $/cow. Finally, we can conclude that short gestation length and summer calving season are strongly correlated with the development of RP in dairy cows. Subsequently, the occurrence of RP significantly affects reproductive parameters resulting in economic losses in dairy herds.

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Introduction

The reproductive efficiency of a herd is an essential component of dairy cattle profitability worldwide (1). A cow's reproductive success is assessed by factors such as age at first calving, calving interval, days open, and number of services per conception. Low fertility and poor reproductive efficiency have a detrimental effect on the potential milk production and the number of cow calves each year and are considered the primary cause of involuntary culling (2). Several factors influence dairy cattle's reproductive efficiency such as feeding scheme, herd management and genital diseases (3). In the last two decades, several researches have been interested in studying the impact of diseases on reproductive performance in dairy cattle as they found that the reproductive success is substantially impaired by postpartum diseases (4). One of the most common disorders found in domestic animals after parturition is the retained placenta (RP). Retention of placenta is a failure of the fetal membrane to be expelled from 8 to 48 hours, average 12 hours following parturition (5); it is a serious condition that causes major economic losses and renders the animal sub fertile even after treatment and recovery. In dairy cows placenta retention may be the cause of serious economic losses to the farmers as cows with RP may have infection of bacteria and

become ill and thus decrease the amount of milk production (6).The occurrence of RP is associated with several risk factors including parity, season of parturition (7), shortened gestation (8), nutritional imbalance, and metabolic disorders, especially milk fever. On top of that, the incidence rate of RP can range between 20 and 50% or even more after abnormal calving (e.g. twin pregnancy, abortion, caesarean section, fetotomy, forced extraction of the fetus, premature calving) and in herds infected with brucellosis (9). Hormonal factors such as creatine kinase can be used as an indicator for tissue damage in the retained placenta in cows (10) .Our first aim in this study was evaluation of the effects of some factors (calving season, parity number, and gestation length) on the incidence of retained placenta in a Holstein dairy herd by the use of a logistic regression analysis method. The second goal was to assess the impact of retained placenta on the subsequent reproductive performance and financial losses.

Materials and methods

Herd management

All farm animals were housed in a free-stall barn provided with water splashing systems (cooling system) that operate when the ambient temperature exceeds 30°C. The cows were machine-milked three times a day, with milk yield and composition recorded at each milking. The total mixed ration (TMR) was given twice a day for all animals, and determined based on the actual milk production and body condition score. The TMR was formulated to satisfy the optimized requirements of energy, protein, vitamins, and minerals. Monthly, TMR was sampled and analyzed using wet chemistry methods. The primary analysis of TMR includes crude protein 16.55%, net energy for lactation (Mcal/kg = 1.79), and neutral detergent fiber 24.74%. The main utilized forage is Alfalfa hay. All animals were regularly vaccinated against most common diseases. Cows were estimated in estrus by visual detection and/or abnormal movement reported by the pedometer, after that they were introduced to insemination 10 to 16 hours later. A commercial on-farm software program (AfiFarm version 4.1) was used to monitor the productive and reproductive data.

Data collection and evaluation of the risk factors for retained placenta

Data were collected from 2940 calving from a large commercial dairy farm, Sharkia governorate, Egypt, during the period extended from January 2018 to December 2019. Retained placenta (RP) was diagnosed when the placental membranes were visible at the vulva after 24 hours or longer post-partum or by vaginal examination (11). In order to determine which explanatory variable in dairy cow farm (Parity, calving season, and gestation length) influence the development of RP, binary logistic regression (BLR) was applied with the SPSS software statistical package version 25.0 (SPSS, Inc., Chicago, Ill, USA). RP is considered the outcome variable which has binary codes: Zero for normal healthy cows, and 1 for cows with RP. The incidence of retained placenta for each parity, season of calving, and gestation length is illustrated in Table 1.

Table 1: Descriptive statistics of data of retained placenta in relation to some risk factors

Factors	Total No.	Retained placenta (-)		Retained placenta (+)	
		No.	%	No.	%
Overall	2940	2312	78.6	628	21.4
Parity					
Uniparous	811	680	83.8	131	16.2
Multiparous	2129	1632	76.7	497	23.3
Season of calving					
Summer	599	330	55.1	269	44.9
Autumn	992	850	85.7	142	14.3
Winter	1056	907	85.9	149	14.1
Spring	293	223	76.1	70	23.9
Gestation length					
<271	375	350	93.3	25	6.7
271-280	1419	1156	81.5	263	18.5
>280	1146	799	69.7	347	30.3

Firstly, the association between the occurrence of retained placenta and the risk factors was tested by Chi-square. Secondly, a stepwise procedure of logistic regression analysis was applied to obtain the appropriate model with $\alpha = 0.05$. The equation of logistic function according to (12) is: $\text{Logit}(p) = \text{Log}(p/1-p) = \beta_0+\beta_1x_{i1}+\beta_2x_{i2}+\beta_3x_{i3} + \varepsilon$. Where; p: The chance of selecting a category of RP results, X_1, X_2, X_3: The explanatory variables (parity, season of calving, and gestation length). β_0: The intercept (constant), β_1, β_1, β_3: the regression

coefficient of x. ε: error terms. The term p / (1-p) is the odds ratio; odds Ratio (OR) and their 95% confidence intervals (95% CI) were used as estimates to compare risk factors for RP in both normal healthy and RP groups and to evaluate the strength of the association between the disease and potential risk factors.

Evaluation of the effect of retained placenta on reproductive performance

Data on the subsequent days to first insemination (DFI), days open (DO), calving interval (CI), and number of services per conception (N/C) between the RP and the control healthy groups were recorded in the study, and then analyzed by Linear mixed model, using SPSS program after verifying normality and homogeneity of variance components between tested groups. The statistical significance level was selected at *P*-value < 0.05.

Assessment of direct economic losses of retained placenta

For estimating the direct economic losses due to RP, we gathered information on average daily milk yield before and after the disease, price of kilogram milk, reduction in milk yield during treatment period, number of days in treatment, discarded milk during treatment period, and cost of treatment. These measurements are represented for the following inputs as average values according to (13)**.** Treatment cost include veterinarian fee, drug cost during the period of treatment. Total milk discarded = Amount of milk that discard X period of treatment. Cost of discarded milk = Total discarded milk X Kg milk price. Cost of loss in milk production = [(average daily milk yield before disease - average daily milk yield after disease) X days in milk] X Kg milk price.

Result

Risk factors for retained placenta

The results of Chi-square test (Table 2) showed the significant relationship between calving season (χ^2 =26.4, *P*-value < 0.001), gestation length (χ^2 = 8.92, *P*-value = 0.008) and occurrence of retained placenta. While, parity had no significant effect on retained placenta ($\chi^۲$ =1.98, *P*-value = 0.167).

On the other hand, binary logistic regression analysis showed that summer calving season (odd ratio = 2.84, *P*-value = 0.041) and gestation length < 270 d (odd ratio = 0.19, *P*-value = 0.003) were the significant risk factors for the occurrence of retained placenta. While, other calving seasons, cow parity and gestation period of 271-280 d were not identified by the model (Table 3).

Table 2: The association between the occurrence of retained placenta and the risk factors by Chi-square value

Variables	x^2 value	*P*-value
Parity	1.98	0.167
Season of calving	26.4	< 0.001
Gestation length	8.92	0.008

Table 3: Risk factors for retained placenta analyzed by a stepwise selection procedure in logistic regression analysis

Variables	Estimate	SEM	*P*-value	Odds ratio	95% Confidence interval
Intercept	-0.61	0.48	0.214	-	-
Parity					
Uniparous cow vs Multiparous	-0.32	0.37	0.386	0.72	[0.35, 1.49]
Season of calving					
Summer vs Spring	1.04	0.53	0.041	2.84	[1.01, 8.01]
Autumn vs Spring	-0.63	0.53	0.243	0.53	[0.19, 1.52]
Winter vs Spring	-0.68	0.53	0.199	0.50	[0.18, 1.42]
Gestation length					
<271 vs >280	-2.32	0.79	0.003	0.19	[0.02, 0.46]
271-280 vs >280	-0.56	0.32	0.081	0.57	[0.31, 1.06]

References were multiparous cow, spring season, and >280.

Impact of retained placenta on reproductive

Linear mixed model was applied to quantify the effect of retained placenta on reproductive parameters. The results revealed that there was a significant (*P* < 0.001) effect of RP on calving interval (CI), days open (DO), days to first insemination (DFI), and number of services per conception (N/C) than in the normal healthy cows (Table 4, Figures 1 and 2).

Direct economic losses of retained placenta

The direct economic losses due to occurrence of RP are listed in table 5. The total direct economic loss from RP in the studied farm during the study period was estimated at 47 $/affected cow, including cost of loss in milk production 30.3 $/cow which considered the major loss, followed by treatment cost 9.5 $/cow, then discarded milk cost 7.2 $/cow.

Table 4: Linear mixed model for assessing the effect of retained placenta (RP) on reproductive parameters

Parameters	RP	Mean ± SEM
Days to first insemination	0	59.0±0.84
	1	89.0±2.98
Services per conception (n)	0	1.48±0.04
	1	2.38±0.09
Days open	0	74.0±1.5
	1	145.0±3.9
Calving interval (day)	0	350.0±1.57
	1	426.0±3.92

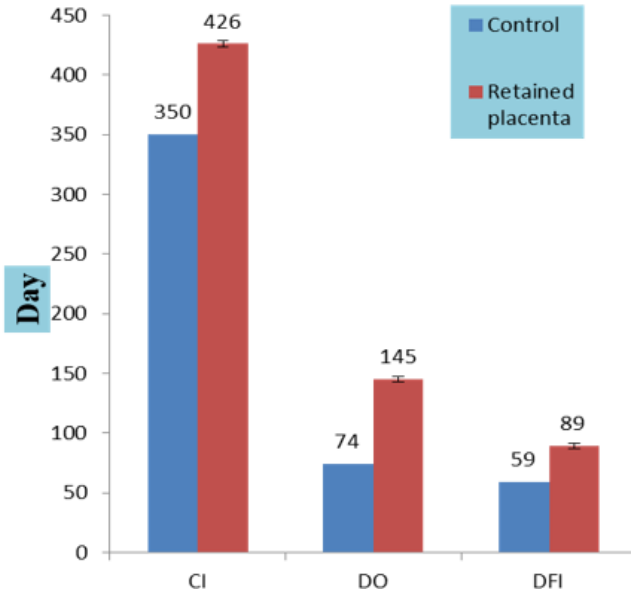

Figure 1: Effect of RP on CI, DO, and DFI.

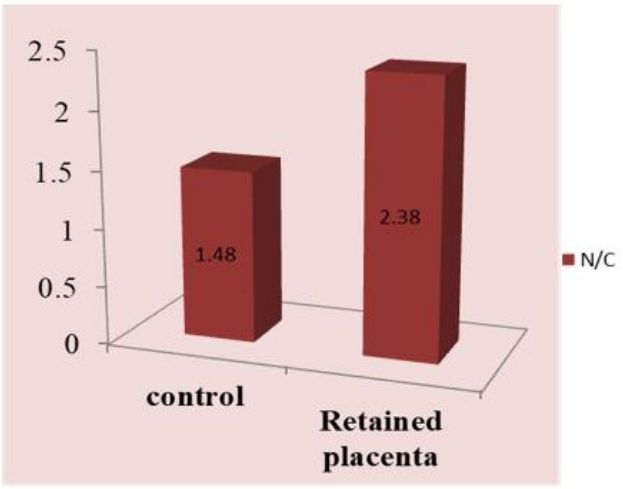

Figure 2: Frequency of number of services per conception in retained placenta group and control group.

Table 5: Direct Economic losses of retained placenta (N=628)

Parameters	Value
Average loss in milk production (Liter/cow)	61.6
Total discarded milk (Liter/cow)	16.02
Cost of discarded milk ($/cow)	7.2
Cost of loss in milk production ($/cow)	30.3
Treatment cost ($/cow)	9.5
Total economic loss ($/cow)	47

Discussion

The current study revealed that the overall incidence of RP was 21.4%, which were comparable to those of 17.8% and 18.3% reported by Markusfeld (14) ; Gaafar *et al* (7) and Rahawy (15), while was higher than the incidences of 6.6%; 7.8%,and 10% estimated by Bruun *et al*. (16) and Goff (17). The dispersion of RP incidences mentioned by different authors might be attributed to various factors, such as environment, breed, age, heredity, nutrition, immunity, and hormonal status.

Consistent with previous reports Echternkamp and Gregory, Nobre *et al*. and Mahnani *et al*. (18-20), they reported that retained placenta was found to be significantly associated with season of calving. The summer calving season is an important risk factor that has a substantial effect on the occurrence of RP over other seasons. The estimated odds ratio for the summer season indicated that cows calved in summer season are more susceptible to RP occurrence 2.84 times than those calved in spring season. The highest rate of RP in the summer season may be attributed to the influence of heat stress that prevents placenta expulsion (21); this result is in the same line with Fernandes *et al*. (22) and indirect contradiction with Berglund *et al*. (23) who found that the rate of RP was increased in winter season than other seasons due to the stillbirth, dystocia and twinning. Also, (19) documented that the rainy season raises the environmental challenge for animals and predisposes them to the incidence of RP.

Our results revealed that the short gestation period (< 271 days) was also another significant risk factor related to the occurrence of RP. The estimated odds ratio for this significant effect was 0.19 which indicates the lower probability of RP incidence in cows with longer gestation period (> 280 days). The Previous reports Vieira-Neto *et al*. (24); Tolera and Wahid (25) on the association between gestation period and the occurrence of RP showed that the higher incidence of RP occurred with shorter gestation periods in Holstein cows. Notably, Hossein-Zadeh and Ardalan (26) indicated that shorter gestation length was an essential factor for the occurrence of RP in dairy cows in Iran. However, Han and Kim (27) observed that by increasing the gestation time, the incidence of RP increased. Gestation period is affected by many factors,

such as genetic factors, sexing of calf, single or twin pregnancies, age of cow, and Silva *et al*. (28). Moreover, it has been documented that there could be a decrease in gestation duration due to animal exposure to heat stress over the last six weeks of the gestation period (29).

It was found that cow parity did not influence the incidence of retained placenta. The non-significant effect of parity in this study is similar to Han and Kim (27), Silva *et al*. (28), Tao and Dahl (29) and Könyves *et al*. (30), but is on contrary to previous studies Mahnani *et al*. (20); Azad (31) and Sarder *et al*. (32) that reported a significant impact of parity on the incidence of RP in dairy farms. Grunert (33) observed that with increased number of parities, the loosening mechanism in the placentomes was occurred and subsequently developing the retention of placenta.

The effect of retained placenta on reproductive performance was analysed by linear mixed model which was in the same line with Mohammed, (34) who applied linear mixed model to determine the assoctiation between mastitis and reproductive performance. The current results found that RP had a negative effect on the reproductive measurements (CI, DO, DFI, and N/C) of dairy cows. These results were in agreement with previous report Gröhn and Rajala-Schultz (35); Maizon *et al*. (36); Seifi *et al*. (37), and Rahawy (15). However, Kaneko *et al*. (38) showed that RP does not have a significant effect on fertility. Fertility can be decreased by retained placenta in two ways: firstly, by a direct effect through an unknown mechanism and secondly by indirect effect through causing endometritis (27). The adverse effect of RP on dairy cow fertility results in indirect economic losses due to the risk of other peripartum diseases and impaired productive efficiency, i.e. prolongation of calving intervals and open days, decline in pregnancy rates, and increased risk of culling (39).

Higher incidences of RP lead to considerable economic losses as it has a detrimental impact on the health, productivity and fertility of the cow and thus its prevention and treatment are of economic and welfare significance. In the present results the majority of the direct economic losses of RP were represented in cost of loss in milk production, followed by treatment cost, then discarded milk cost due to drug residues and poor milk quality which is unfit for human consumption and therefore cannot be sold. This is in agreement with Bellows *et al*. (40) who found that costs of treatment of RP in Georgia herds were $0.03 per cow inventory in beef operations and $0.40 per cow inventory in dairy farms. Sheldon *et al*. (41) reported about 239 kg losses in milk in uniparous cows infected with RP.

Conclusion

In this study, we concluded that there is a significant relationship between calving seasons and gestation length and the incidence of retained placenta. So, we can depend on these explanatory variables as risk factors for diagnosing it in dairy farms. Retained placenta negatively affected reproductive measurements and resulted in substantial economic losses in dairy herds.

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Conflicts of interest

There is no conflict of interest of this article to declare.

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تأثير المشيمة المحتبسة على الأداء التناسلي، والخسائر الاقتصادية الناتجة عنها في قطيع أبقار الهولشتاين الحلاب

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[١]قسم تنمية الثروة الحيوانية، كلية الطب البيطري، جامعة بنها، مشتهر، طوخ، القليوبية، [٢]قسم تنمية الثروة الحيوانية، كلية الطب البيطري، جامعة الزقازيق، الزقازيق، مصر

الخلاصة

مرض احتباس المشيمة هو عدم خروج الأغشية الجنينية حيث تظل محتبسه لفترة تتراوح من ثمانية ساعات إلى ثمانية وأربعون ساعة بمتوسط ١٢ ساعة بعد الولادة، هذا ويعتبر مرض احتباس المشيمة من اهم الأمراض التي تتعرض لها أبقار الهوليشتاين، حيث أن هناك العديد من عوامل الخطر المسببة في حدوث احتباس المشيمة، لذلك فأن الهدف من هذه الدراسة هو تحديد عوامل الخطر التي تؤثر علي حدوث مرض المشيمة المحتبسة لأبقار الهولشتاين مثل موسم الولادة، عدد الولادات، وطول مدة الحمل، ثم دراسة التأثير الناتج عنها على الأداء التناسلي، وتقدير الخسائر الاقتصادية الناتجة عن احتباس المشيمة. تم تجميع بيانات ٢٩٤٠ بقرة هولشتاين-فريزيان أصيلة من خلال سجلات موثوقة لمزارع حلاب في محافظة الشرقية بجمهورية مصر العربية، حيث تم تسجيل ولادات هذه الأبقار خلال الفترة الممتدة من يناير ٢٠١٨ إلى ديسمبر ٢٠١٩. وتم تشخيص الأبقار التي لم تتخلص من أغشية الجنين خلال الاثني عشر ساعة الأولى بعد الولادة بأنها مشيمة

محتبسة. تم تطبيق تحليل الانحدار اللوجستي وبينت النتائج أن أهم عوامل الخطر المسببة لحدوث المشيمة المحتبسة هي موسم الولادة الصيفي وفترة الحمل القصيرة. حيث بلغ تقدير نسبة الأرجحية لموسم الولادة الصيفي ٢,٨٤ مقارنة بولادة الربيع. كان احتمال حدوث المشيمة المحتبسة في الأبقار ذات فترة الحمل القصيرة ٠,١٩ مرة أكثر من الأبقار ذات فترة الحمل الأطول، وبلغ إجمالي الخسائر الاقتصادية المباشرة من المشيمة المحتبسة سبعة وأربعون دولار لكل بقرة مصابة. ختاماً، يمكننا أن نستنتج أن فترة الحمل القصيرة وموسم الولادة الصيفي يرتبطان ارتباطًا وثيقًا بتطور المشيمة المحتبسة في الأبقار الحلاب، وبالتالي فإن احتباس المشيمة يؤثر بشكل كبير على الصفات التناسلية مما يؤدي إلى حدوث خسائر اقتصادية في قطعان الأبقار الحلاب.