Analysis of the incidence and treatment of left displaced abomasum on a dairy farm in Southwest China from 2018 to 2023: a retrospective study

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SUMMARY

Left displaced abomasum (LDA) significantly affects both farm economics and dairy cow performance; however, there is a paucity of retrospective studies examining the incidence characteristics and treatment options for LDA. To explore the risk factors of LDA, in this study, we aimed to investigate the incidence of LDA and various disease-related events, including season, lactation days, parity, fetal birth weight, fetal sex, and prenatal body condition score (BCS), in a large-scale dairy farm in southwest China over 6 years (2018-2023), along with the effectiveness of different surgical treatments. The results showed that the average incidence of LDA was 3.77% during these 6 years. The average annual incidence of LDA in 2018, 2019, 2020, 2021, 2022, and 2023 was 2.76%, 3.79%, 4.60%, 3.13%, 4.19%, and 4.14%, respectively, with a high incidence during the summer and winter seasons. LDA was associated with parity (58.23% for the primiparous), lactation days (concentrated within 35 days postpartum), birth weight of calves (the incidence is higher when the weight is between 37 and 48 kg), BCS (higher the BCS, higher the incidence), and accompanying diseases, but not with fetal sex. Given that the left flank with ventral abomaso/omentopexy has a high success rate (91.59%) and ensures rapid recovery of milk production, these findings offer valuable insights for optimizing LDA prevention and control strategies in dairy management.

KEY WORDS

Dairy cows, risk factors, diagnosis, surgical treatment.

INTRODUCTION

Displaced abomasum (DA) is the alteration of the normal anatomical position of the abomasum. According to the direction of the displacement, it can be divided into the right or left displaced abomasum (LDA) side in cattle, with LDA being more frequently diagnosed than right DA[1-2]. LDA is one of the high-incidence diseases of postpartum dairy cows, especially for high-yielding dairy cows within one month of postpartum. Specifically, more than 50% of cases occur in the first week of postpartum[2-4]. The etiology of LDA is still not entirely known[5]. It is generally believed that its occurrence is related to multiple factors such as species, breed, sex, age, milk yield, nutrition, metabolism, and perinatal diseases[5]. Abomasal retardation and excess gas concentration in the abomasal lumen are often used as the pathogenesis of LDA to explain the occurrence and development of the disease.

On average, a cow with LDA yields economic losses of more than $700 to the dairy farm, including both direct (correction, medication, discarded milk, and death) and indirect (loss of future milk production, loss of body weight, decreased reproductive performance, and increased risk of removal from the herd) losses, which increase with the incidence of LDA[6]. In a nationwide survey, the incidence of DA in American cattle herds is about 3.5%, ranging from 2.5% in farms with 500 or more heads to 4.8% in those with less than 500 heads[2]. The median incidence of LDA among Holstein cattle based on 12 studies is 2.71%[7].According to reports, the cure rate of LDA treated with surgical reduction is greater than 90%, and the resulting prognosis is good[8]. At present, the main surgical treatments used in domestic and foreign farms are the Grymer-Sterner toggle technique, left flank with ventral abomaso/omentopexy, and right flank pyloro/omentopexy[9-13]. Due to the importance of the disease, a retrospective analysis was conducted on data related to LDA in a commercial farm located in southwestern China from 2018 to 2023. By analyzing the conditions of cows affected by LDA and their environmental factors, and by comparing the cure and recurrence rates associated with various surgical treatments, this research aimed to elucidate the characteristics of cows with LDA and the efficacy of different treatment methods. The findings may serve as valuable references for developing prevention and control strategies for LDA.

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SURVEY OBJECT AND METHOD

Respondents

Adult cows on a large farm in Ziyang City, Sichuan Province (of the 2,500 total cows, 2,000 were adults, and 1,800 were lactating), were the survey subjects. All cow breeds were Chinese Holstein cows aged between 2 and 10 years. All animal procedures were conducted in accordance with the guidelines and approved by the Animal Care and Use Committee of Chongqing Three Gorges Vocational College (Approval No. 20241025).

Diagnosis and treatment of LDA

In the early stage of the disease, dairy cows with LDA are mainly characterized by depression, loss of appetite, and reduced abdominal circumference. In some cases, dehydration and tachycardia may occur. Defecation becomes progressively less frequent, with feces appearing mushy or resembling coal tar. Furthermore, rumen motility slows, leading to reduced rumination frequency, which may even stop completely. There is a significant reduction in milk production, and some cows may develop ketosis, indicated by a beta-hydroxybutyrate (BHBA) level of ≥1.2 mmol/L. Therefore, attention should be given to cows displaying these clinical symptoms. The «ping» metallic sound is typically detectable by simultaneous auscultation and percussion over an area between the upper third of the 9th and 12th ribs. Absence of ciliates in the puncture solution, combined with a pH of 1.0-4.0, is indicative of LDA.

All confirmed cases of left displaced abomasum (LDA) received immediate therapeutic intervention following definitive diagnosis, which was established through simultaneous auscultation-percussion assessment demonstrating characteristic clinical findings, including marked tympanic resonance and distinctive high-pitched «ping» sounds upon abdominal percussion. Conservative management was implemented in dairy cows meeting the following clinical criteria: (1) maintenance of normal mental status, (2) absence of significant dehydration, (3) presence of only mild reduction in both feed intake and milk production, and (4) no evidence of concurrent complications. The treatment protocol was as follows: first, a puncture needle was employed to decompress the tympanic area of the abomasum. Second, a mixture of 4 L of vegetable oil and 3 L of a 10% sodium sulfate solution was administered once, with two subsequent doses given at 12-h intervals. Cows with moderate decrease in feed intake and milk production and significant abomasum expansion (characterized by large «ping» area and obvious metallic sound upon percussion and auscultation) underwent the Grymer-Sterner toggle technique. Cattle exhibiting poor overall condition, lack of appetite, severe dehydration, and a significant decrease in milk production were treated via left flank ventral abomaso/omentopexy or right flank pyloro/omentopexy. Clinical signs improved within 7 days, and milk production normalized within 15 days after treatment initiation.

Data collection

Data on herd structure, calving events, onset of treatment, peripartum body condition score (BCS), and farm operation data from January 2018 to December 2023 were collected. Treatment progress and prognosis of cows with LDA were continuously monitored. Local temperature data were collected according to the article published by the China Meteorological Administration (http://www.cma.gov.cn/).

Data analysis

The incidence rate of LDA was calculated on a monthly and annual basis. The annual average total incidence rate is determined by the formula: annual total number of LDA cases divided by the total number of calves for that year, multiplied by 100%. The loss associated with each LDA-affected cow is calculated as follows: the milk production of cows suffering from LDA decreases by an average of 15 kg per day for a duration of 14 days. The costs associated with LDA surgery treatment amount to $100 per head, with additional labor costs of $40 per head. Furthermore, milk production is halted for 7 days post-treatment, with each LDA cow typically producing 15 kg of milk per day. The local milk price is set at $0.76 per kg. Consequently, the total loss per LDA cow is calculated as follows: (15 kg/day * 14 days * $0.76/kg) + (15 kg/day * 7 days * $0.76/kg) + $100 + $40 = $379.40. The incidence rate of LDA-related events, including parity, days in milk, calf birth weight, body condition score (BCS), and other diseases, was analyzed using SPSS software (version 26.0). The dynamic changes in the average maximum and minimum temperatures from 2018 to 2023 were visualized using GraphPad (version 10.0) software.

RESULTS AND ANALYSIS

Morbidity of LDA

Based on the monthly incidence curve of LDA, the curve in 2018 is relatively flat, and the incidence of LDA fluctuates greatly from the end of 2019 to the beginning of 2023. After the cattle enter the calving peak, the incidence of LDA subsequently increases (Table 1). The findings indicated the average incidence of LDA over 6 years was 3.77%.

The months March, April, August, November, and December showed the highest occurrence in 2018, whereas July, September, October, November, and December showed the highest occurrence in 2019. Further, January, February, and March showed the highest incidence in 2020, whereas February, August, and December showed the highest incidence in 2021. January, July, August, and December were the months with the highest incidence in 2022. In 2023, January, August, September, November, and December will have the highest incidence. During the summer months of July through September, the maximum average daily temperature was around 35°C (Figure 1), and during the winter months of November through March, the highest average temperature was approximately 7°C.

The impact of LDA on farm management

The average annual incidences of LDA in this farm in 2018, 2019, 2020, 2021, 2022, and 2023 were 2.76%, 3.79%, 4.60%, 3.13%, 4.19%, and 4.14%, respectively. Excluding the death rate, the economic loss due to 316 cows with LDA in the past 6 years to the pasture was as high as $149,483.6 (the economic loss was calculated at $379.4 per head) (Table 1).

The relationship between LDA and parity, lactation days, fetal weight, and fetal sex

Based on the data of 316 cows with LDA and the parity records that were available from January 1, 2018, to December 31, 2023, it was found that LDA mainly occurred in the primiparous (ac-

Table 1 - The economic loss caused by left displaced abomasum (LDA) to the dairy farm.

Item	2018	2019	2020	2021	2022	2023
Annual average total incidence (%)	2.76% (32/1,158)	3.79% (46/1,214)	4.60% (61/1,326)	3.13% (45/1,437)	4.19% (64/1,526)	4.14% (68/1,644)
Loss per LDA cow ($)	379.4	379.4	379.4	379.4	379.4	379.4
Total annual loss ($)	12,140.8	17,452.4	23,143.4	17,073.0	24,281.6	25,799.2

Table 2 - The relationship between left displaced abomasum (LDA) and parity.

Parity	Number of sicknesses (head)	Proportion (%)
Primiparous	184	58.23
2 fetuses	69	21.83
3 fetuses	42	13.29
≥4 fetuses	21	6.65

Table 3 - Time of onset of left displaced abomasum (LDA).

Days in milk (day)	Number of sicknesses (head)	Proportion (%)
0-7	46	14.56
8-14	89	28.16
15-21	103	32.59
22-28	41	12.97
29-35	26	8.23
36-42	7	2.22
≥43	4	1.27

Table 4 - The influence of calf birth weight on left displaced abomasum (LDA).

Calf birth weight (kg)	Number of male and (female) calves (head)	Proportion (%)
28-32	12(4)	5.06
33-36	19(26)	14.24
37-40	43(33)	24.05
41-44	35 (48)	27.12
45-48	39(25)	20.25
49-52	18(6)	7.59
≥53	5 (3)	2.53

counting for 58.23%), followed by that in the second, third, and fourth or higher parity, which accounted for 21.83%, 13.29%, and 6.65%, respectively (Table 2). In addition, the time of LDA was mainly restricted to 35 days after delivery, accounting for 96.51% of all cases. Those occurring after 35 days only accounted for 3.49% (Table 3). As shown in Table 4, there were 54% male and 46% female dairy calves with LDA, respectively. The incidence of calves with birth weight between 37 and 48 kg was higher (71.42%) compared to those with birth weight <37 kg (19.30%).

The impact of BCS and concomitant diseases on LDA

According to the method described by Edmonson et al.,[14] a five-point system is used to measure BCS, wherein 1 indicates weight loss, and 5 indicates obesity, with each gradient increment being 0.5. The BCS is measured before the delivery of the cow, and the incidence of LDA in the cow is observed after delivery. The data presented in Table 5 indicate that a higher BCS correlates with an increased incidence of LDA. Specifically, when the BCS reached or exceeded 4.0, the incidence surpassed the 6-year average rate of 5.4%. Furthermore, the results revealed that 191 of the 316 cows diagnosed with LDA also exhibited other health conditions, with 112 cases of ketosis reported in Table 6, representing 60.44% of associated diseases.

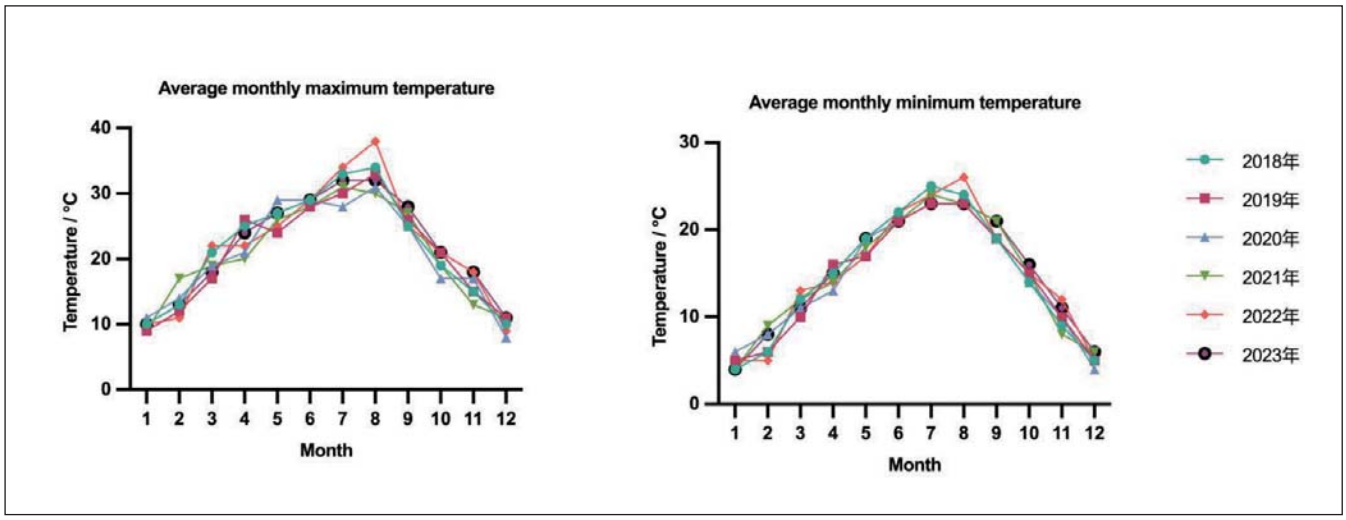

Figura 1 - The monthly average temperatures at dairy farms in the region from 2018 to 2023

Table 5 - Effect of prepartum body condition scores (BCS) on the incidence of left displaced abomasum (LDA).

BCS	Total (head)	Number of illnesses (heads)	Prevalence rate (%)
BCS≤3	102	3	2.94
3<BCS≤3.5	1923	57	2.96
3.5<BCS≤4.0	3466	104	3.00
BCS≥4.0	2814	152	5.40

Table 6 - Other diseases associated with cows with left displaced abomasum (LDA).

Item	Number of sicknesses (heads)	Proportion (%)
Ketosis	64	17.09
Ketosis + Metritis	27	1.44
Ketosis + Mastitis	21	2.16
Metritis	22	4.32
Retained placenta	17	2.16
Mastitis	19	2.88
Enteritis	12	2.88
Milk fever	9	1.44

Evaluation of the effect of different surgical methods on LDA treatment

In the past 6 years, out of the 316 cows that developed LDA, 42 did not receive surgical treatment. Among these, 18 recovered following conservative management, one cow died of an unknown cause during infusion before operation, and 23 were excluded due to other serious diseases. Meanwhile, 274 cows received surgical treatment. The cure rates of the Grymer-Sterner toggle technique, left flank with ventral abomaso/omentopexy, and right flank pyloro/omentopexy in the treatment of LDA in this farm were 65.28%, 91.59%, and 83.16%, respectively (Table 7).

DISCUSSION

The incidence of LDA and its impact on the economic benefits of pastures

With the improvement in the physique of dairy cows and an increase in milk yield, the incidence of LDA has also increased significantly. From 2009 to 2018, it was found that the incidence of DA in dairy cows in a large farm in Lanzhou was relatively high in 2009 and 2016, reaching 6.24% and 5.19%, respectively[15]. Our study found that the incidence rate was higher in the summer and winter seasons. This result was not only related to the peak production period but also to the ambient temperature of the cattle area. Cattle farms are hotter in the summer and colder in the winter. It has been reported that there is a correlation between the incidence of LDA and the respective season, and negative energy balance (NEB) is often used to explain this correlation. The high-temperature environment during the summer reduces the dry matter intake (DMI), while the cold winter weather increases the energy requirements of dairy cows[9]. A previous study suggests that winter is the season of high incidence of LDA in dairy cows in the Xinjiang region of China, accounting for 63% of the total annual incidence of LDA[16]. The main reasons for this are the long cold winter in Xinjiang, the poor body condition of dairy cows in the perinatal period, reduced postpartum digestive function, and the need to maintain physical strength to fight against cold, resulting in the tendency to cause LDA.

The correlation of LDA with parity, lactation days, fetal weight, and fetal sex

The current body of knowledge on the relationship between parity and LDA is inconsistent. According to a previous Chinese study, the incidence of LDA is highest in primiparous dairy cows, at 82.6%, and it gradually decreased with increasing parity[17]. Specifically, the incidence of LDA is relatively high in cows of parities 1 to 3, accounting for 44.26%, 20.85%, and 20.85% of the total cases, respectively[15]. However, some reports contradict this conclusion, that the risk of DA increases with parity[18-19]. The incidence of first-feet cattle in this farm was 64.75%, which is consistent with previous reports[15,17]. The high incidence of LDA during the first lactation may be caused by the inadaptability of the cow between the development of body cavity and body function of the first calf in the late gestational period and the growth rate of the fetus, resulting in the abomasum being easily squeezed. This causes a change in its position and functional impairment, which aggravates the abomasum relaxation and leads to LDA[17,20]. In addition, a low concentration of Ca2+ in the blood may be related to the first-fetal cattle being prone to LDA[5]. A previous study also confirmed this point, revealing that the

Table 7 - Surgical treatment of 274 cows with left displaced abomasum (LDA).

Surgical methods	Number of surgeries	Number of cures	Cure rate (%)	Number of failures and causes
Grymer-Sterner toggle technique	72	47	65.28	16 cases relapsed (fixed line rupture) 9 cases died (perforated abomasum).
Left flank with ventral abomaso/omentopexy	107	98	91.59	2 cases died (adhesion of abomasum to abdominal wall) 4 cases were eliminated (postoperative complications of other diseases) 3 cases recurred in the next birth.
Right flank pyloro/omentopexy	95	79	83.16	7 cases were eliminated (abomasum adhered to the left abdominal wall). 9 cases died (pyloric fixation of abomasum was too tight during operation).

blood Ca^{2+} concentration in primiparous cows (1.31 mmol/L) was significantly lower than that in multiparous cows (1.40 mmol/L)[21]. A decrease in the concentration of Ca^{2+} will cause smooth muscle contraction and relaxation, which in turn will lead to gastrointestinal motility disorders[22]. The vulnerability of the first-fetal cattle to LDA in the Beijing area was related to the strict control of concentrate in late pregnancy and the rapid release of concentrate in large quantities after delivery, the gastrointestinal tract relaxation caused by feeding stress in the perinatal period, and too short hay cutting [23]. Similarly, we analyzed that the high incidence of the first fetus in this farm may be due to poor feeding, insufficient weight, increased feed supplementation after mating, high BCS score (possibly fatty liver), inadequate DMI after delivery, more severe NEB, and stress response of the young cattle when they reached mating age.

More than 50% of LDA cases are diagnosed within 2 weeks after delivery, and 80% of LDA cases occur in the first month after delivery[2, 21]. This is consistent with the results of our study, wherein the incidence of LDA was as high as 88.28% within 4 weeks after delivery. This may be related to dairy cows undergoing a series of physiological activities such as pregnancy, childbirth, and lactation at this stage, with their metabolism and immune system undergoing tremendous changes. In addition, this period is the peak period for the occurrence of productive diseases of dairy cows, such as milk fever, retained placenta, metritis, ketosis, and mastitis, which are often secondary to LDA[24]. Previous research indicates that fetal sex has a minimal effect on developmental outcomes, with individual differences among dairy cows being the primary contributing factor[15], consistent with the results of this study. At present, there are limited reports on the correlation between fetal birth weight and LDA. Postpartum abdominal space enlargement and cows experiencing NEB are the main reasons for LDA[4]. The larger the fetus, the larger the negative space that is left in the abdominal cavity after delivery, resulting in the greater chance of the abomasum being displaced. In addition, the larger the fetus, the more likely a cow will experience dystocia during delivery (especially for first-feet cows). Due to the greater pain and stress during dystocia, the postpartum DMI cannot be recovered in time. Additionally, an increase in the abdominal space results from an empty rumen, further resulting in aggravation of NEB and induction of LDA.

The impact of BCS and concomitant diseases on LDA

Prenatal BCS is an important method to evaluate the body fat of dairy cows quantitatively, and it is extremely important in preventing metabolic disorders in the early stages of lactation. One study has indicated that the optimal value of BCS for dairy cows before delivery is 3.0-3.5[25]. Compared with lean cows, cows with higher BCS at parturition have a higher risk of DA [26]. Particularly, cows with higher prenatal BCS (≥3.5) are more likely to develop LDA, ketosis, and other metabolism-related diseases, infertility, and elimination[27]. Cows on this farm are generally overfed during the dry period, with cows with a BCS >3.5 accounting for 75.62% (6280/8305) of the total population. When BCS was ≥4.0, the incidence of LDA was 5.40%, which was significantly higher than the average incidence of LDA of 3.77% during the investigation period (6 years). High-scoring dairy cows are susceptible to LDA, which may be related to the predisposing factors of LDA-hypocalcemia, NEB, and oxidative stress. Compared to normal BCS ranging from 3.0 ≤ BCS < 3.5, obese cows, defined as those with a BCS ≥ 4.0, typically exhibit lower blood calcium levels[25]. In addition, having a BCS ≥4.0 in the third trimester may reduce the risk of DA. This is because cows with high BCS have significantly reduced postpartum DMI intake and may experience more severe NEB[28]. Additionally, the contents of malondialdehyde, vitamin A, and vitamin E, as well as the activities of superoxide dismutase and catalase in the serum of dairy cows in the BCS 4.2-4.4 groups, were significantly higher than those in BCS >4.2 group during and after calving ($P<0.05$). This suggests cows with high BCS (4.2~4.4) experienced greater oxidative stress after calving[29].

Of the 316 cows experiencing LDA in this farm, 191 were associated with other diseases, including 112 with ketosis (including 27 with concurrent metritis and 21 with mastitis), 22 with metritis, 17 with retained placenta, 19 with mastitis, 12 with enteritis, and 9 with milk fever. Ketosis (diagnosed before DA occurs) is considered a risk factor for DA, and hyperketonemic (BHBA in the blood ≥1.2 mmol/L) cows are 7-8 times more likely to develop DA in early lactation than healthy cows[30-31]. Ketosis is very likely to indirectly reduce the abomasum motility by reducing feed intake, resulting in a smaller rumen volume and lower resistance to DA[5]. A previous literature reports that LDA is closely related to other major perinatal diseases, such as ketosis and hypocalcemia[32]. Hypocalcemia before the occurrence of DA is considered the main metabolic factor that reduces the motility of the abomasum, and cows with hypocalcemia are 3.1-4.8 times more likely to experience DA than other dairy cows[30, 33-34]. Similarly, cows with metritis, mastitis, and retained placenta in the early stages of lactation have a significantly higher risk of DA[35]. Endotoxin and inflammatory mediators released in response to infection, together with other stresses encountered during the perinatal period, can directly reduce the contraction of the smooth muscle of the abomasum[36]. Furthermore, inflammation and fever can reduce DMI, gastrointestinal motility, and rumen filling, thus playing a role in the occurrence and development of DA[37]. Therefore, early diagnosis and treatment of these infectious diseases and metabolic diseases are of great significance in reducing the occurrence of DA. On well-managed pastures, the incidence of DA in the first month after delivery was less than 1%. If the incidence is >3%, the perinatal herd should be monitored for concomitant diseases, with metritis, mastitis, placental retention, clinical hypocalcemia, subclinical hypocalcemia, and ketosis being >15%, >5%, >5%, ≥5%, ≥15%, and >15%, respectively, serving as early warning indicators for DA[2].

The therapeutic effect of different surgical methods on LDA in dairy cows

After LDA was treated with the Grymer-Sterner toggle technique (Method 1), the appetite and milk production recovered quickly (about 3 days), which not only saved the operation time but also reduced the treatment cost. However, the technical requirements for the operator to perform this technique were high, and inefficient surgery would easily lead to the formation of a gastric fistula and peritonitis. In addition, gastric adhesions and ulcerations cannot be identified using this method[9]. Among the 25 cows that were not cured by Method 1 in this farm, 16 cows relapsed within 7 days after the operation due to the breakage of the fixation line, and 9 cows died due to per-

foration of the abomasum. Right flank pyloro/omentopexy (Method 3) was performed on 54 LDA cows via a right paramedian incision. Among these, 5 cows died post-surgery (survival rate 90.7%), 1 cow was culled due to recurrence (1.8%), 41 cows returned to normal performance post-surgery (75.9%), and 39 cows became pregnant within 6 months following the procedure (72%)[38]. When this farm used Method 3 to treat LDA in 95 cows, seven cows were eliminated directly because of the adhesion between the abomasum and the left abdomen, and nine died due to tight omentum fixation and pyloric relaxation after the operation. In a previous study, Zhang et al.[12] used the left flank with ventral abomaso/omentopexy (Method 2) to treat 110 cases of LDA, of which 108 cases were cured (98.18%). The cattle farm adopted Method 2 with a cure rate of 91.59%, wherein nine cases failed (two cases of abomasum and left abdomen wall adhesion, bleeding during separation, resulting in death 2 days after the operation; four cases were eliminated due to other diseases after treatment; three cases relapsed after delivery in the next parity). Although the treatment cost of Methods 2 and 3 is comparable, and the milk production of the conformed cows can be restored in about 7 days after the operation, the procedure in Method 2 is simpler than that of Method 3, which not only deals with the cases of adhesion between the abomasum and the left abdominal wall but also has a higher cure rate.

CONCLUSION

This study revealed an average LDA incidence of 3.77%, with higher occurrences during the summer and winter seasons. LDA incidence was significantly associated with season, parity, lactation days, calf birth weight, body condition score (BCS), and concurrent diseases, though not with fetal sex. The left flank approach with ventral abomaso/omentopexy proved to be the most effective treatment method for LDA.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

KY and ZL contributed to writing the manuscript and literature review. KY, ZL, and QY contributed to the critical revision of the manuscript as well as interpreting and describing the imaging findings. SC and SZ contributed to the critical revision of the manuscript. All authors contributed to the final review.

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