Milk yield and survival of Holstein-Friesian dairy cattle after laparoscopic correction of left-displaced abomasum

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The milk yield and survival of 91 Holstein-Friesian dairy cows that had had a left-displaced abomasum (LDA) corrected laparoscopically were compared with those of 193 control cows matched for herd, parity and calving date. Ninety per cent of the LDA treatments were performed within four weeks after calving. The risk of being culled during the whole observational period of at least three years was 1·5 times greater for the LDA cows than for their matched herdmates (P<0·01). The risk of being culled in the current lactation was 1·8 times greater for the LDA cows (P=0·01), but risk of being culled after the next calving following the LDA correction was similar for both groups. For the lactation in which the LDA was corrected, there was no difference in the 305-day milk production of 80 of the LDA cows and 182 of the matched cows; however, the mean interval from calving to first service during the same lactation was longer for the LDA cows (115 v 98 days) and the mean calving interval was also longer (451 v 418 days).

DISEASES related to high milk production have emerged as the dairy industry has become more intensive and the milk yields of dairy cows have increased. Among these production diseases, ketosis, mastitis, metritis, cystic ovarian disease and left-displaced abomasum (LDA) have been major causes of economic losses on dairy farms (Bartlett and others 1995).

The normal position of the abomasum is ventral in the abdominal cavity. However, as a result of accumulated gas and hypomotility, the abomasum can move from its normal position and become entrapped between the rumen and the abdominal wall, a condition known as LDA. The condition has been studied since the 1950s and is regarded as a multifactorial disorder. In dairy cows, an animal's breed, age, parity, genetics, diet and energy metabolism (particularly whether it is in negative energy balance), the season, and a variety of periparturient events have been associated with the development of LDA (Van Winden and Kuiper 2003). However, a higher milk production in the previous lactation does not appear to be a risk factor for LDA (Rohrbach and others 1999).

There are several approaches to the treatment of LDA in dairy cattle, which in practice range from dietary interventions to surgical treatment to fix the abomasum. The surgical treatments aim to form an adhesion between either the abomasum or the pylorus and the abdominal wall. Omentopexy during a laparotomy is one of the most commonly used surgical techniques for the correction of LDA; it provides good visual inspection of the abomasal wall and optimal access to the abdominal structures. Because of the expense of the surgery, the closed-suture technique was developed. Another technique, roll-and-toggle, has some advantages over the closed-suture technique, for example, by confirming the suture placement by the identification of abomasal gas, and by deflating the abomasum during the procedure (Van Winden and Kuiper 2003). With the roll-and-toggle technique, bar sutures are introduced into the abomasum at two different locations paramedian to the linea alba using a trocar and cannula. It was therefore considered to be a cheap, time-saving and technically very simple procedure compared with pyloro-omentopexy (Bartlett and others 1995). The surgical procedure of laparoscopy for correcting LDA is a more recent technique (Janowitz 1998), and is further described in this paper. Recently, a ventral laparoscopic abomasopexy has been described by Mulon and others (2006). The technique enables a good visual inspection of the degree of dislocation of the abomasum and a high degree of control as it is repositioned. The technique is minimally invasive and an abomasum filled with little gas can be treated. However, compared with the roll-and-toggle technique, it takes longer and costs more because special instruments are required. The treatment of LDA by rolling cows into dorsal recumbency should be discouraged in pregnant animals because it may induce mesenteric volvulus.

This paper describes an investigation of the effects of apparently successful laparoscopic corrections of LDA in 91 cows on their survival, milk yield and fertility.

MATERIALS AND METHODS

Animals and herds

Between January 2001 and June 2002, 103 Holstein-Friesian cows that were diagnosed with LDA by the five veterinarians of the veterinary practice in Oosterwolde, the Netherlands, were corrected laparoscopically. Eight of these cows were excluded from the study owing to the noncompliance of the farmers, and four were excluded because they died shortly after surgery. The remaining 91 cases came from 60 herds of average size (50 to 120 cows) and milk production (7500 to 11000 kg) for the country; none of them was a repeat case. All the cases were matched with up to six cows from the same herd, with the same lactation number and with a calving date within four weeks before or four weeks after the calving date of the case. In total, 193 matched cows were included. Data concerning insemination date(s), 305-day milk production in the current lactation and culling dates were collected for all the animals, which were followed for at least three years after the correction of the LDA unless they were culled or sold (and censored at that time).

Laparoscopic technique for LDA correction

A cow with LDA underwent laparoscopic treatment within 24 hours after its diagnosis, following a procedure described by Janowitz (1998). The standing animal was sedated by the intravenous injection of 0·025 to 0·03 mg/kg bodyweight xylazine (Sedamun; Eurovet), and a site approximately 2 cm caudal to the last rib and 10 cm ventral to the transverse processes in the left flank was clipped and disinfected (Sterilium; Bode Chemie). The site was infiltrated with 10 ml 2 per cent lidocaine hydrochloride with adrenaline (Lidocaine cum Adrenaline; Eurovet), and an incision approximately 2 cm long was made in it. Through the incision, a laparoscope 8 mm in diameter was inserted via a trocar, and using a light source connected to the laparoscope, the degree of dislo-

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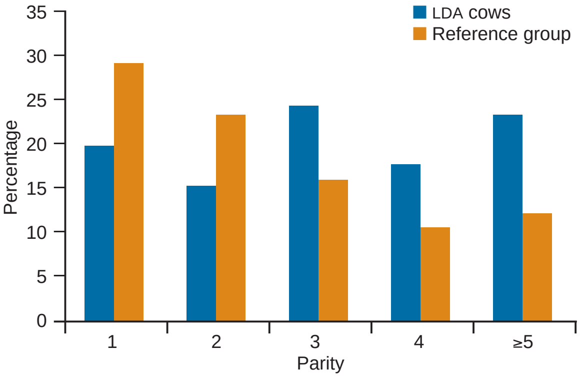

FIG 1: Parity distribution of 91 cows with left-displaced abomasum (LDA) and a reference group of 869,000 cows registered in a herdbook (CR-Delta/NRS 2006)

TABLE 1: Survival times and hazard ratios (HR) for three different risk periods for 91 cows with left-displaced abomasum (LDA) and 193 matched control cows

	Number of cows (+ culled, censored)	Survival time (days) Minimum	Maximum	Median	HR	P
Total survival (three years)						
LDA	66 (+25)	52	1706	717	1·5	<0·01
Matched cows	112 (+81)	29	1686	966	Ref	
Current lactation						
LDA	34 (+57)	52	764	375	1·8	0·01
Matched cows	39 (+154)	27	1540	368	Ref	
Survival next lactation						
LDA	32 (+22)	310	764	386	0·88	0·6
Matched cows	73 (+75)	27	1540	377	Ref	

Ref Reference category

cation and the condition of the abomasal wall was investigated. After clipping and surgical preparation, a second site was infiltrated with 10 ml 2 per cent lidocaine hydrochloride with adrenaline, and an incision approximately 1 cm long was made in the 12th intercostal space. Through this incision, a toggle-placing trocar 40 cm long was introduced into the abdomen and through the abomasal wall. A special toggle, a 4 cm long metal pin secured with two sutures 80 cm long tied together in a loop (Dr Fritz), was placed in the abomasum. The escape of abomasal gases resulted in the deflation of the abomasum. The trocars were taken out and the incisions closed with a single cutaneous suture (Vicryl 2; Johnson & Johnson), leaving the toggle and suture attached to the abomasum. The cow was then moved into right lateral recumbency and turned clockwise into full dorsal recumbency. The abomasum moved to its normal position against the ventral abdominal wall. Again, two small incisions approximately 2 cm long were made in the ventral abdominal wall, approximately 10 cm right and cranial from the umbilicus, one for the laparoscope and the more cranial one for special forceps. With these instruments, the suture attached into the abomasum was visualised and brought outside the abdomen. Both ends of the toggle were passed through a gauze bandage and tied together. One stitch was used to close the small caudal incision and all the incisions were treated with an antibiotic spray (CTC spray; Eurovet). No standard postoperative treatments were applied, but if a cow had a concurrent disease, for example, endometritis, mastitis or ketosis, it was treated. The gauze bandage and knot were removed approximately 14 days after the surgery.

Statistical analysis

Three survival analyses were applied using the Cox proportional hazard technique. The first analysis considered the whole observation period (three years), the second analysis considered the period until the next calving of each cow, and the third analysis included the cows that were still on the farm after the next calving. In the survival analyses culling was defined as an event. The follow-up of animals that were not culled was stopped (animals were censored), at the end of an observational period of at least three years or when the animals were sold, for example, because the farmer went out of business. In all the analyses the variable that indicated the status of the case or control cow was forced into the model. A group of cows, consisting of one LDA cow and up to six matched control cows, was included as a cluster variable. Finally, a random herd effect was included in all the analyses because the matched groups within herds could not be assumed to be independent. The assumption of proportional hazards was checked graphically and by the calculation of the slopes of the Schoenfeld residuals. The outcome of this analysis is the hazard ratio (HR), which can be interpreted in a similar way to relative risk. Thus, a HR greater than 1 means that there is an increased risk (hazard) of being culled.

The differences between the LDA and matched control cows in terms of completed 305-day milk production, calving interval and calving to first service interval were evaluated by two-sample *t* tests. The data were checked for normality. All the analyses were carried out using S-Plus 6.2 (Lucent Technologies).

RESULTS

Eighty of the 91 LDA cases had at least one matched control, leaving 11 without an eligible control; 26 had one control, 23 had two controls, 12 had three controls, 10 had four controls, seven had five controls and two had six controls. The parities of the LDA cows are shown in Fig 1. Given the average age distribution in Dutch dairy herds of registered cows, the higher parities appeared to be overrepresented (CR-Delta/NRS 2006).

The median interval between calving and the diagnosis of LDA was 15 days (range two to 76 days), and 90 per cent of the cases occurred within four weeks after calving (Fig 2). During the three years of observation, 66 (73 per cent) of the LDA cows and 112 (58 per cent) of the control cows were culled. The times between the diagnosis of LDA and culling or censoring for the three defined periods are shown in Figs 3, 4, and 5. Data on the median survival and HR are given in Table 1. The risk of being culled or censored within three years was 1·5 times higher for the LDA cows (P<0·01); within the current lactation, the risk was 1·8 times higher for the LDA cows (P=0·01). The risk of being culled or censored after the next calving, that is, in the next lactation, was similar for both groups.

The completed 305-day milk yields averaged 8455 kg (range 4558 to 12,926 kg) for 80 of the LDA cows, and 8334 kg (range 4088 to 13,330 kg) for 182 matched control cows. The mean calving interval was 451 days for 54 of the LDA cows (range 325 to 783 days) and 418 days for 148 of the matched control cows (range 307 to 739 days). The mean interval from calving to first service was 115 days for 69 of the LDA cows (range 50 to 381 days) and 98 days for the matched control cows (range 24 to 324 days). The 305-day milk yields of the LDA cows and the control cows were not significantly different, but the LDA cows had a longer calving interval (P=0·04) and a longer period between calving and first insemination (P=0·03).

DISCUSSION

In studies of other methods for correcting LDA, the median survival of affected cows after calving has been reported to be between 321 and 545 days (Geishauser and others 1998,

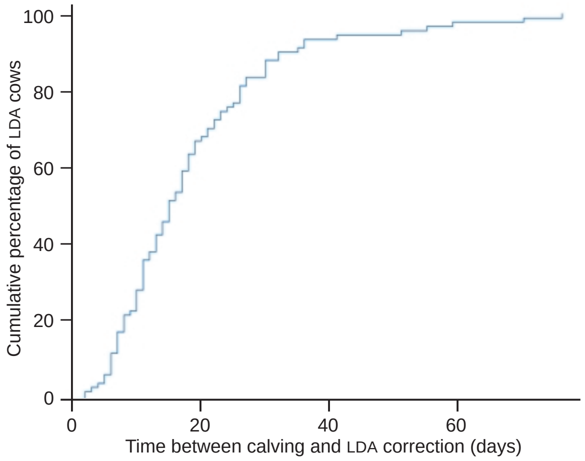

FIG 2: Kaplan-Meier curve for the time between calving and correction of left-displaced abomasum (LDA) in 91 cows

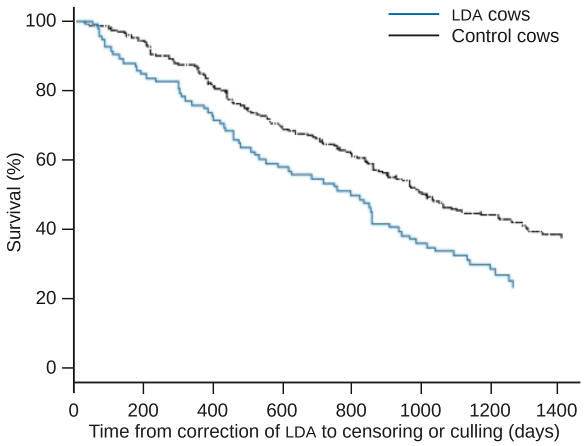

FIG 3: Kaplan-Meier curves for the survival times of 91 cows with left-displaced abomasum (LDA) and 193 matched control cows

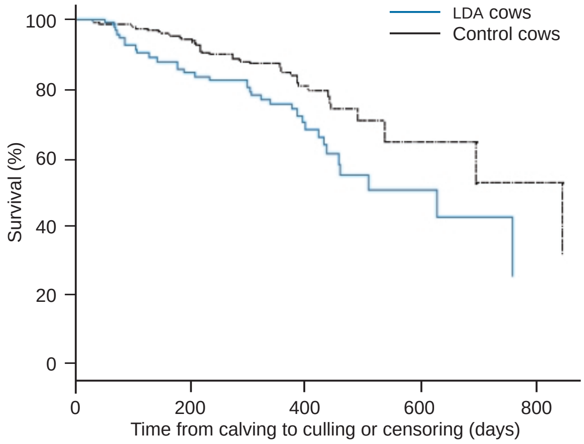

FIG 4: Kaplan-Meier curves for the time from parturition to either culling or the next calving (when the cows were censored) for 91 cows with left-displaced abomasum (LDA) and 193 matched control cows

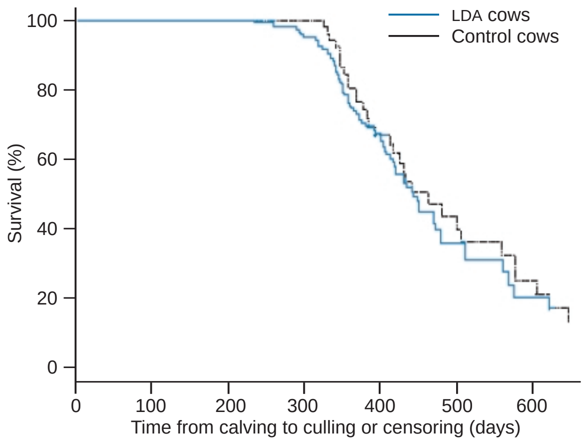

FIG 5: Kaplan-Meier curves for the time from parturition to either culling or censoring for the cows that had another calving, for 54 cows with left-displaced abomasum (LDA) and 148 matched control cows

Raizman and others 2002). In this study, the median survival of the cows was 717 days. However, because the survival of the control cows was also longer (966 days, compared with 321 and 800 days), the HRs for being culled after LDA were comparable (1·5 v 1·3 and 1·8) (Milian-Suazo and others 1988, Geishauser and others 1998). Leeuwen and Müller (2002) also investigated laparoscopic correction of LDA, and reported a survival of 76 per cent after 300 days, very similar to the survival reported here. There were differences in survival rates between the LDA and control cows, particularly shortly after the LDA had been corrected, in agreement with the results obtained by Raizman and others (2002), and illustrated by the increased risk of culling for the cows with LDA in the current lactation and the absence of a difference in risk after their next calving. There were no large carry-over effects of LDA on subsequent lactations that resulted in different culling strategies for the LDA cows. The risk of culling shortly after the correction was greater when the cows were in poor physical condition before the treatment.

The study was performed in one veterinary practice, and a standardised protocol was applied; as a result, it is unwarranted to extrapolate the results to other herds served by other veterinary practices or to other countries. Furthermore, the predisposing causes of LDA, the cows' nutrition, management and post-treatment care, and the available veterinary skill for correcting LDA can vary greatly. One drawback of the inclusion of cows from many different farms is that it is difficult to take account of diseases other than LDA, for example, mastitis and ketosis, in a consistent way. It was therefore decided not to analyse the effects of other diseases on the incidence of LDA or culling.

Ninety per cent of the treatments were carried out by one veterinarian, and the other 10 per cent by four other veterinarians in the same practice. Owing to the standardised protocol, the veterinarian was not included in the calculations and it was assumed that the treatment was performed in a uniform way. The matching of the cases and controls by herd and parity would also have helped to reduce bias to a minimum. Raizman and others (2002) used the cows' milk yield as a matching criterion, but because there were few cows with LDA in each of the herds, milk yield was regarded as less important than herd and parity.

As in other studies, most of the LDA cases were observed within four weeks after calving, with a median of approximately two weeks (Geishauser and others 1998, Raizman and others 2002). The average age at which LDA occurs has been reported as between four and seven years (Constable and others 1992), and its highest incidence as being in cows of parity 3 (Detilleux and others 1997). In the present study cows of parity 3 and higher were over-represented compared with the age distribution of the herdbook cows.

The results show that the cows with LDA were inseminated later in the lactation and consequently had a longer calving interval. Raizman and others (2002) also reported that cows with LDA corrected by the toggle and pin suture technique were inseminated later in lactation, but their average interval from calving to conception and their conception rates were not adversely affected. These results suggest that the postponement of the decision to inseminate a cow, as quantified by a prolonged voluntary waiting period, probably has a greater impact on the fertility of LDA cows than the LDA as such.

There was no significant difference between the 305-day milk yields of the LDA and matched control cows. Although the data did not allow the effect of milk production on the incidence of LDA and culling to be assessed, this result agrees with other studies that reported that 305-day milk production was not associated with an increased risk of LDA or culling (Geishauser and others 1989). Apart from a lack of statistical power, this could have been due either to the high milk production of the cows before the LDA was detected, or to the fact that the LDA cows had a higher potential for milk production than their matched herdmates. The higher milk production of a LDA cow in early lactation may have encouraged the farmer to treat the cow. Also, the cow's higher milk production in early lactation may have compensated for the production loss due to LDA, resulting in a similar 305-day milk yield to that of the matched control cows (Detilleux and others 1997).

It is concluded that the laparoscopic technique is a good method for replacing a displaced abomasum, because the LDA cases that were culled survived for a mean period of approximately 24 months. The LDA cases had a higher risk of being culled only in the current lactation, with a HR of 1·8 in that period, and no differences in survival were observed after the cows had calved.

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