The Effect of Left Displacement of Abomasum Corrected by Toggle-Pin Suture on Lactation, Reproduction, and Health of Holstein Dairy Cows

E. A. Raizman1 and J. E. P. Santos
Veterinary Medicine Teaching and Research Center
University of California – Davis, Tulare CA 93274

ABSTRACT

Our objectives were to evaluate the effect of left displacement of abomasum (LDA) after correction by toggle-pin suture (TPS) on lactation performance, reproduction and health in Holstein dairy cows in a commercial dairy farm. Cows diagnosed with LDA and corrected by the TPS procedure (188 cows) during the first 70 d postpartum were matched with control herdmates (186 controls) according to lactation number, calving date, and previous lactation 305-d mature equivalent milk yield. Cows were grouped according to parity and days in milk and fed the same total mixed ration throughout a 321-d lactation. Data collected included yields of milk and 3.5% fat-corrected milk (FCM), concentration and yields of milk fat, somatic cell count, incidence of mastitis, abortion, death and culling, in addition to reproductive measures. Cows affected with LDA corrected by the TPS procedure produced less milk and tended to produce less 3.5% FCM than control cows, but the decrease in production occurred only during the first 4 mo of lactation. Left displacement of abomasum did not affect the interval from calving to conception and conception rates, but it extended the period from calving to first postpartum artificial insemination. Incidences of abortions and mastitis were not influenced by LDA. Cows affected with LDA remained in the study for a shorter period than their control herdmates, and higher proportions of cows with LDA were sold or died. Death and culling were more pronounced immediately after the diagnosis of LDA and the TPS procedure.

(Key words: left displacement of abomasum, dairy cows, lactation, reproduction)

INTRODUCTION

Left displacement of abomasum (LDA) is a condition primarily of dairy cows in which the abomasum becomes enlarged with fluid and gas and is mechanically displaced from its normal position to the left side of the abdominal cavity, between the rumen and the left lateral abdominal wall (Coppock, 1974). Numerous studies have been conducted to identify risk factors for LDA, many of which may be related to periparturient events (Constable et al., 1992; Cameron et al., 1998; Rohrbach et al., 1999). Dairy cows are more likely to develop LDA if they have recently experienced one or more periparturient disorders including dystocia, stillbirth, twins, retained placenta, metritis, ketosis, or milk fever (Rohrbach et al., 1999). Other studies linked LDA with nutritional and management factors (Coppock, 1974; Cameron et al., 1998), breed, age, and season (Constable et al., 1992).

Medical management of LDA varies from casting and rolling the cow to surgical abomasopexy or omentopexy via laparatomy (Kelton et al., 1988). Because of the need for veterinary intervention when surgery is required to correct a case of LDA, less expensive alternative procedures have been developed. One of these procedures is the bar suture technique, which can be performed in about 10 min and has been reported to result in a success rate of 81.5 to 93% (Grymer and Sterner, 1982). A modification of the bar-suture technique is the toggle-pin suture (TPS; Bartlett et al., 1995).

Although few studies have addressed the effect of LDA on milk production, one (Detilleux et al., 1997) observed that from calving to 60 d after the diagnosis of LDA, affected cows produced an average of 557 kg less milk than herdmates without LDA, which represented 6.1% of 305-d milk production. Bartlett et al. (1995) reported that affected cows reached the production of the control herdmates only 120 d after the correction of LDA. Martin et al. (1978) observed a decrease of 725
kg (11%) in 305-d milk production, and multiparous cows had a greater loss in milk production than primiparous cows. However, in these studies, LDA was not corrected by TPS.

The primary objective of the current study was to evaluate the effect of LDA after correction by TPS on milk production and milk components during a complete lactation on a commercial dairy farm. An additional objective was to evaluate the effect of LDA after correction by TPS on reproductive performance, culling, and death rates, and on incidence of mastitis. Data from matched control cows were used for comparison to cows with left displaced abomasum after correction by the TPS technique.

MATERIALS AND METHODS

Animals and Management

The study was carried out on a 1600-cow Holstein dairy farm in the Central Valley of California. Cows calving between June 1997 and February 2000 (374 cows; 64 primiparous LDA, 124 multiparous LDA, 63 primiparous controls, and 123 multiparous controls) were followed during their first 321 DIM. Only cows with less than 70 DIM at the time of the diagnosis of LDA were included in the study. Every cow diagnosed with LDA was matched, within the same week of the LDA event, with a control herdmate that calved within 20 d of the affected cow, was in the same lactation and had a similar 305-d mature equivalent (ME) milk yield (± 300 kg) in the previous lactation (multiparous).

Cows were housed in open corrals with shades over the feedbunk and in the central area of the corral. Misters above the feedbunk were activated when the ambient temperature reached 27°C. Grouping of cows into different pens was based on parity (primiparous and multiparous) and stage of lactation.

All lactating cows were fed the same TMR formulated by the herd nutritionist. The TMR met or exceeded NRC (1989) requirements for a 650-kg lactating cow producing 35 kg/d of milk with 3.5% fat and 3.1% CP. Dry cows were fed two TMR, one during the first 30 d of the dry period, and a close up TMR during the last 21 d of gestation. The lactating cow TMR consisted of alfalfa hay, corn silage, barley silage, steam-rolled corn, steam-rolled barley, almond hulls, soybean meal, cannola meal, whole cottonseed, citrus pulp, cane molasses, sodium bicarbonate and a mineral-vitamin premix, and it contained (DM basis) at least 1.68 Mcal of NE₃/kg, 18.1% CP, 6.5% RUP, 30.1% NDF, and 5.2% ether extract. The dry cow TMR consisted of alfalfa hay, corn silage, barley silage, steam-rolled corn, soybean meal, almond hulls, and mineral-vitamin premixes, and they contained at least 1.50 Mcal/kg of NEL, 13.1% CP, 34.2% NDF, and 3.5% ether extract. The mineral-vitamin premix fed during the last 21 d prepartum also contained acidogenic salts.

Reproductive management included AI during the first 150 DIM and natural breeding by bulls afterwards. The voluntary waiting period for the first postpartum AI was 40 d. Pregnant cows in the AI groups were usually moved to a corral with bulls in the weeks following pregnancy diagnosis. Nonpregnant cows usually received a dose of 25 mg of PGF₂ᵦ, (Dinoprost Tromethamine; Lutalyse, Pharmacia Upjohn Company, Kalamazoo, MI). Pregnancy diagnosis was performed by weekly rectal palpation on all nonpregnant cows with more than 36 d since last AI. Pregnancy confirmation at approximately 170 d after conception date was also used to identify those cows that aborted during the lactation.

Cows were milked twice daily at 0300 and 1500 h. Milk yields were recorded monthly for individual cows, during official DHIA tests. Composite individual milk samples were collected monthly from consecutive milkings (a.m. and p.m.). Samples were analyzed for SCC and fat content by infrared technique (Bentley, 2000; Bentley Instruments, Chaska, MN) at the Tulare DHIA Laboratory in California.

Twice daily, all cows were examined for clinical mastitis by the herd personnel during milking. Clinical mastitis cases were characterized by the presence of abnormal milk or by signs of inflammation in one or more quarters and were treated by intramammary infusion of antibiotics according to treatment protocols established by the herd veterinarian. A new case of mastitis was defined for the same cow when a different quarter was affected or a period of 21 d had passed since the previous diagnosis.

Herd health was evaluated at least twice a week by clinicians of the University of California-Davis. Diagnosis of LDA was based upon clinical signs presented by the affected cow, which included reduced milk production, rumen atony, ketonuria (Ketostix, Bayer Co., Pittsburgh, PA), diarrhea, and the presence of an acute ping sound at auscultation and percussion on the left side of the abdomen. The diagnosis was made either by the dairy personnel or by one of the veterinary clinicians. When LDA was diagnosed by the herdsman, the affected cow was further examined by the veterinarian for confirmation of the diagnosis. Because the dairy was visited at least twice weekly by a veterinarian, some cows suspected of having LDA might not have been treated by TPS at the same day of the diagnosis, when this was first made by the herdsman. The TPS procedure was performed by the same herdsman in every cow diagnosed with LDA. The procedure involved casting and rolling the cow on to her back and tacking the
abomasum with toggles introduced after trocar punctures (Bartlett et al., 1995).

**Data Collection**

Data were collected from a computerized dairy herd management software program (Dairy Comp305; Valley Agricultural Software, Tulare, CA) after veterinary visits.

Daily milk production was estimated from DHIA records when a cow completed a 305-d lactation. For cows that left the study before 305 DIM, the projected 305-d milk production from DHIA was used to estimate the daily milk yield.

Reproductive measures evaluated were: interval from calving to first postpartum AI, conception rate at the first postpartum AI, percentage of animals pregnant by 150 d postpartum, percentage of cows pregnant by the end of the lactation (321 DIM), mean and median days from calving to conception for all cows (days open), and proportion of cows aborting during the study. Days open was defined as the number of days from calving to conception for those cows diagnosed as pregnant, in addition to the DIM when the cow left or finished the study (321 DIM) for those diagnosed as not pregnant.

Health data evaluated were: general incidence of mastitis, DIM when the first mastitis case was diagnosed, mortality rate, DIM when a cow died, percentage of cows sold during the study period, DIM when a cow was sold, percentage of cows leaving the study (sold or dead), and DIM when cows left the study.

**Experimental Design and Statistical Analyses**

A prospective cohort study design was used. Data from cows that remained in the herd after the voluntary waiting period of 40 d were included in the statistical analyses for the reproductive data. Cows not diagnosed pregnant were not eligible to abort and, therefore, were not included in the analysis of abortion incidence. Lactation performance data were analyzed separately for primiparous and multiparous cows. The GLM procedure of the SAS (SAS, 1999) was used to analyze continuous variables according to the following linear model:

\[ Y_{ij} = \mu + G_i + E_j \]

where

- \( Y \) = observation
- \( \mu \) = overall mean,
- \( G_i \) = group effects (LDA vs. control),
- \( E_j \) = residual error.

To assess whether the effect of LDA on milk production differed throughout the lactation period, monthly milk production of both groups was compared by ANOVA for repeated measures using the PROC MIXED procedure of SAS (Littell et al., 1998). The model included observed mean, group, period, interaction between group and period, and the random experimental error of cow nested within group.

Dichotomous outcomes such as conception rate, mortality and culling rates, and mastitis incidence were analyzed by logistic regression using the LOGISTIC procedure of SAS (SAS, 1999) according to the same model described for the GLM of ANOVA, but with all cows included in the model (primiparous and multiparous).

To assess the effect of LDA on DIM when a cow left the study and the interval from calving to conception (days open), the product limit method of the Kaplan-Meier model (Kaplan and Meier, 1958) for the survival analysis procedure of the SPSS (SPSS, 1999) program was used. For both variables, an event was defined as left the study or conceived, respectively. Cows that did not experience the event at the end of the study were censored at 321 DIM. Univariate differences in respective cumulative proportion between LDA and control cows were assessed using the logrank nonparametric method. Survival time was calculated from the time of LDA diagnosis to the day of removal from the herd for those cows diagnosed with LDA.

Treatment differences with \( P < 0.05 \) were considered significant and those with \( P < 0.15 \) were considered a tendency.

**RESULTS**

**Lactation Performance**

Cows enrolled included 188 in which LDA was diagnosed and corrected by TPS and 186 matched control cows with no LDA. The median and the mean (± SEM) DIM when LDA was diagnosed were 14.0 and 16.1 d (± 0.73), respectively.

The number of DIM when cows ended the study was similar for LDA and control cows for both, multiparous (Table 1) and primiparous cows (Table 2). Multiparous cows with LDA produced less milk compared with matched control cows (34.5 vs. 36.2 kg/d; \( P < 0.04 \)). A similar effect of LDA on milk yield was observed for primiparous cows. Cows diagnosed with LDA tended to produce less 3.5% FCM than did control herdmates. This negative effect of LDA on 3.5% FCM production was observed for multiparous (34.2 vs. 35.7; \( P < 0.07 \)), as well as primiparous cows (30.8 vs. 31.3; \( P < 0.12 \)). Similarly, 305-d ME milk production tended to decrease for cows affected with LDA compared with control herd-
Table 1. Effect of left displacement of abomasum (LDA) corrected by toggle-pin suture on lactation performance of multiparous dairy cows.

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>LDA</th>
<th>SEM</th>
<th>P ≤</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIM at end of study, d</td>
<td>292</td>
<td>292</td>
<td>5.1</td>
<td>0.96</td>
</tr>
<tr>
<td>DIM at end of study</td>
<td>292</td>
<td>292</td>
<td>5.1</td>
<td>0.96</td>
</tr>
<tr>
<td>Milk, kg/d</td>
<td>36.2</td>
<td>34.5</td>
<td>0.60</td>
<td>0.04</td>
</tr>
<tr>
<td>3.5% FCM, kg/d</td>
<td>35.7</td>
<td>34.2</td>
<td>0.61</td>
<td>0.07</td>
</tr>
<tr>
<td>305-d ME, kg</td>
<td>12,596</td>
<td>12,077</td>
<td>240</td>
<td>0.11</td>
</tr>
<tr>
<td>Milk fat, %</td>
<td>3.44</td>
<td>3.46</td>
<td>0.04</td>
<td>0.67</td>
</tr>
<tr>
<td>kg/d</td>
<td>1.24</td>
<td>1.19</td>
<td>0.02</td>
<td>0.05</td>
</tr>
</tbody>
</table>

LDA = Left displacement of abomasum corrected by toggle-pin suture during the first 70 DIM.

Table 2. Effect of left displacement of abomasum (LDA) corrected by toggle-pin suture on lactation performance of primiparous dairy cows.

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>LDA</th>
<th>SEM</th>
<th>P ≤</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIM at end of study, d</td>
<td>306</td>
<td>299</td>
<td>4.5</td>
<td>0.30</td>
</tr>
<tr>
<td>DIM at end of study</td>
<td>306</td>
<td>299</td>
<td>4.5</td>
<td>0.30</td>
</tr>
<tr>
<td>Milk, kg/d</td>
<td>30.9</td>
<td>29.9</td>
<td>0.25</td>
<td>0.004</td>
</tr>
<tr>
<td>3.5% FCM, kg/d</td>
<td>31.3</td>
<td>30.8</td>
<td>0.27</td>
<td>0.12</td>
</tr>
<tr>
<td>305-d ME, kg</td>
<td>12,271</td>
<td>11,747</td>
<td>256</td>
<td>0.13</td>
</tr>
<tr>
<td>Milk fat, %</td>
<td>3.56</td>
<td>3.70</td>
<td>0.06</td>
<td>0.11</td>
</tr>
<tr>
<td>kg/d</td>
<td>1.05</td>
<td>1.04</td>
<td>0.03</td>
<td>0.69</td>
</tr>
</tbody>
</table>

LDA = Left displacement of abomasum corrected by toggle-pin suture during the first 70 DIM.

Reproduction and Mastitis

Of 186 control cows, 180 were included in the analysis of pregnancy at 320 DIM and 146 were pregnant (95 multiparous and 51 primiparous). Of 188 LDA cows, 137 were included in the analysis of pregnancy at 320 DIM and 105 were pregnant at the end of the study (64 multiparous and 41 primiparous). Cows diagnosed with LDA had a longer period from calving to first postpartum AI compared with control cows (90.9 vs. 78.2 d; P < 0.001). However, no effect of LDA was observed for first postpartum AI conception rate and percentage of cows pregnant by 150 and 321 DIM (Table 3). Cows with LDA tended to have a lower number of AI during the first 150 DIM compared with control cows (1.55 vs 1.72; P < 0.08). Results of survival analysis indicated that cows with LDA had a similar period from calving to conception with a median of 144 d (SE median =
Table 3. Effect of left displacement of abomasum (LDA) corrected by toggle-pin suture on reproductive performance of dairy cows.

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>LDA</th>
<th>SEM</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIM at 1st AI</td>
<td>78.2</td>
<td>90.9</td>
<td>2.12</td>
<td>0.001</td>
</tr>
<tr>
<td>First AI CR</td>
<td>36.4</td>
<td>35.1</td>
<td></td>
<td>0.82</td>
</tr>
<tr>
<td>Number of AI</td>
<td>1.72</td>
<td>1.55</td>
<td>0.07</td>
<td>0.08</td>
</tr>
<tr>
<td>Pregnancy rate</td>
<td>61.9</td>
<td>54.9</td>
<td></td>
<td>0.20</td>
</tr>
<tr>
<td>Abortion, %</td>
<td>15.5</td>
<td>18.0</td>
<td></td>
<td>0.59</td>
</tr>
</tbody>
</table>

1LDA = Left displacement of abomasum corrected by toggle-pin suture during the first 70 DIM.
2DIM = Days in milk at the first postpartum AI.
3First AI CR = First postpartum AI conception rate.

14.0) and 140 (SE median = 9.0) for LDA and control cows, respectively (Figure 2). Incidence of abortions was unaffected by LDA, and it averaged 16.6%. Days in milk at the diagnosis of the first clinical mastitis case were similar for both groups (P < 0.17). Similarly, LDA had no effect on incidence of mastitis, number of clinical mastitis cases per cow, and the linear SCC score when compared with control herdmates (Table 4).

Cow Survival

Mortality and culling rates were higher for cows diagnosed with LDA. Of the 188 LDA cows included in the survival analysis, 15 (8.0%) died and 52 (27.7%) were sold, whereas of the 186 control cows, 2 (1.1%) died and 17 (9.1%) were sold during the study period (Table 5). A lower proportion of cows with LDA remained in the study for the entire period compared with control cows (64.4 vs. 89.8%; P < 0.0001). Cows with LDA survived a median of 321 d and a mean (± SEM) of 239.2 (± 6.8), and control cows survived a median of 321 d and a mean (± SEM) of 310.7 (± 6.8). Forty-four cows (23.4%) in the LDA group were removed from the study within the first 70 DIM, whereas only 1 of the control cows (0.5%) was removed during the same period (P < 0.001). A difference in survival rates was apparent in the first 70 DIM, after which the difference disappeared (P = 0.16), as shown also by the parallel survival curve after 70 DIM (Figure 3). Survival rates tended to differ between primiparous and multiparous cows in the LDA group (P = 0.11), while the difference in parities was significant in the control group (P = 0.03). The median for survival for all cows in the LDA and control groups was 321 d. The mean survival was 306.8 and 318.5 d for multiparous and primiparous cows, respectively, in the control group, and 225.5 and 265.8 d for multiparous and primiparous cows, respectively, in the LDA group. More LDA cows died during the study period (P < 0.01; Table 5) and death occurred sooner in lactation (P < 0.01). The mean (± SEM) interval from diagnosis of LDA to death was 10.4 d (± 2.7 d). The mean survival

Figure 2. Proportion of cows with left displacement of abomasum corrected by the toggle-pin-suture procedure (thick curve; LSMean = 183; SEM = 7.9) and of matched control cows (thin curve; LSMean = 171; SEM = 7.3) remaining nonpregnant over the course of the study period.

Table 4. Effect of left displacement of abomasum (LDA) corrected by toggle-pin suture on mastitis in dairy cows.

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>LDA</th>
<th>SEM</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastitis incidence, %</td>
<td>37.1</td>
<td>39.5</td>
<td></td>
<td>0.64</td>
</tr>
<tr>
<td>DIM at 1st mastitis, d</td>
<td>97.0</td>
<td>119.0</td>
<td>11.2</td>
<td>0.17</td>
</tr>
<tr>
<td>Mastitis cases/cow</td>
<td>0.61</td>
<td>0.56</td>
<td>0.07</td>
<td>0.67</td>
</tr>
<tr>
<td>SCS</td>
<td>2.72</td>
<td>2.85</td>
<td>0.11</td>
<td>0.40</td>
</tr>
</tbody>
</table>

1LDA = Left displacement of abomasum corrected by toggle-pin suture during the first 70 DIM.
2DIM = Days in milk at the first postpartum clinical mastitis case.

Table 5. Effect of left displacement of abomasum (LDA) corrected by toggle-pin suture on culling and mortality rate in dairy cows (LSM ± SEM).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control</th>
<th>LDA</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sold, %</td>
<td>9.1</td>
<td>27.7</td>
<td>0.0001</td>
</tr>
<tr>
<td>DIM when sold, d</td>
<td>227.3 (± 24.0)</td>
<td>110.1 (± 13.7)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Mortality rate, %</td>
<td>1.1</td>
<td>8.0</td>
<td>0.001</td>
</tr>
<tr>
<td>DIM when dead, d</td>
<td>163.0 (± 32.2)</td>
<td>27.5 (± 11.8)</td>
<td>0.001</td>
</tr>
<tr>
<td>Left study, %</td>
<td>10.2</td>
<td>35.6</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

1LDA = Left displacement of abomasum corrected by toggle-pin suture during the first 70 DIM.
2Cows that left the study before going dry or completing the 321 d in lactation period.
time after the TPS was performed was 228 d. The greatest decline in survival occurred during the first 20 d after the TPS procedure, when approximately 20% of the cows had either been sold or died (Figure 4). Before the first postpartum DHIA milk measurement, 28

(14.9%) of the cows with LDA had left the study compared with only 1 (0.5%) in the control group ($P < 0.01$).

**DISCUSSION**

Cows with LDA produced less milk than control herdmates, but most of the difference in production was observed during the first 4 mo of lactation. Reported milk production losses caused by LDA vary among studies. Higher milk losses were reported by Martin et al. (1978) and Grymer et al. (1982) who observed that cows affected with LDA produced 725 and 610 kg less milk, respectively, than their herdmates during a 305-d lactation. Lower values of milk losses, however, were observed by Geishauser et al. (1998), who reported a decrease in 316 kg of milk in a 305-d lactation for cows diagnosed with displaced abomasum (DA) compared with those not affected by DA. Our results on the effect of LDA on milk yield during the first postpartum test day confirmed data previously published by Bartlett et al. (1997) and Heuer et al. (1999), who observed that first test-day milk yield for cows diagnosed with LDA was lower than their matched controls by 7.2 and 7.1 kg, respectively.

The negative effect of LDA on milk production is only apparent during the first 4 mo of lactation. Similar to our results, Bartlett et al. (1995) observed that in 37 cows with LDA and treated with TPS approached the production of control cows after 120 d postpartum. Similarly, Bartlett at al. (1997) and Ehrlich (1995) observed that cows affected with LDA reached the production of their matched controls in the third and fifth months of lactation, respectively. The same authors (Bartlett at al., 1997; Ehrlich, 1995), however, observed that milk production of LDA cows surpassed that of control herdmates thereafter. It is possible that cows affected by LDA with poor milk production were those culled during the first 120 DIM, which would diminish the production differences between LDA and control cows as the lactation progresses. Bartlett at al. (1997) suggested that cows with high milk production, based on previous lactation 305-d ME milk yield, are more susceptible to LDA and, therefore, after their recovery they exceed the control cows' milk production. In the present study, multiparous cows were also matched based on their previous lactation 305-d ME milk yield, which minimizes the possibility of a greater lactation potential for cows affected with LDA. In fact, the previous lactation 305-d ME milk yield for mature cows was similar between LDA and control herdmates ($P = 0.85$). This might explain why no differences in milk yields were observed between the two groups after 4 mo in lactation.

Daily milk fat production was only higher among multiparous control cows. No differences were observed.
for primiparous cows because milk fat content was slightly higher for LDA cows at the same time that milk yield was greater for control cows. Similar to our findings for multiparous cows, Geishauser et al. (1998) observed that cows affected with LDA produced 12 kg less milk fat than control cows during a complete lactation. It is possible that the tendency for higher milk fat content for primiparous LDA cows might have been caused by the lower milk production in association with greater BW losses, which are known to contribute to increasing milk fat content (Palmquist et al., 1993). However, the same was not observed for multiparous cows.

Left displacement of abomasum did not affect reproductive performance rather than that LDA cows had longer DIM to first postpartum AI. Similarly, Bartlett et al. (1997) observed significant differences in DIM to first postpartum AI between cows that were affected with LDA and their matched herdmates. It is possible that sick cows experienced a more pronounced and extended period of negative energy balance during early lactation. Negative energy balance can affect ovarian activity, which can result in anestrus and prolonged interval from calving to first postpartum service (Butler and Smith, 1989). Nevertheless, the delay on first postpartum AI might also reflect a management decision based on the cow’s health status when in estrus or eligible for AI.

The conception rate in LDA cows did not differ from that of control cows. Domecq et al. (1997) also observed no association between DA and first postpartum service conception rate. As observed by Borsberry and Dobson (1989), the interval from calving to conception did not differ between cows with LDA and their control herdmates. The number of AI during the first 150 d postpartum tended to be higher for cows in the control group. Because control cows had a shorter interval from calving to first postpartum AI, and conception rate was similar between the two groups, we suggest that control cows had more opportunities to be seen in estrus and inseminated during the first 150 DIM. In addition, it is possible that the heavy culling and death that occurred in the LDA group, mainly during the first 70 d postpartum, might have masked some of the effects of LDA on the reproductive measures evaluated.

Incidence of mastitis, DIM when the first clinical mastitis was diagnosed, and the number of clinical cases per cow was similar between the two groups. Furthermore, the SCS was unaffected by LDA. Similarly, Correa et al. (1993) found no association between LDA and mastitis.

In the current study, cows with LDA survived less time than cows in the control group. In a 3-yr study, Geishauser et al. (1998) observed that cows affected with DA survived a median of 545 d and control cows survived a median of 800 d from calving to removal from the herd. Similar to our study, Geishauser et al. (1998) found that the survival curve for DA cows initially fell more steeply than did the curve for control cows.

The main risk of removal from the herd in this study was during the first several weeks after LDA diagnosis, which coincided with the first 70 DIM. Similarly, Rajala-Schultz and Gröhn (1999) observed that DA, in association with other digestive disorders, had a significant effect on culling rates soon after they occurred. Gröhn et al. (1998) observed that LDA was a major risk factor for culling in early lactation, but not later in the lactation. The effect of LDA on the incidence of cows leaving the study was similar for primiparous and multiparous cows because no group by parity interaction was detected.

Culling decisions are affected directly by diseases that result in marked decrease in milk production or increased risk of death (Gröhn et al., 1998). Therefore, it is possible that the reason for the higher culling rate for cows affected with LDA might have been associated with the decrease in milk production, as well as the notion that these cows might die following incomplete recovery after LDA treatment.

It is important to state that the results of this study are restricted only to one dairy farm, which in one hand eliminates the “between-herd effect” but on other hand may limit external validity. Whether the situation described in this study exists in other dairies is beyond the scope of this study, although we suspect that it does. Furthermore, we do not know whether death and early culling were also due to the contribution of other concurrent diseases, or whether the TPS procedure in general or this herdsman’s TPS performance in particular is associated with this outcome. However, control cows might also have had periparturient diseases, which would also affect their survivorship. Additional studies are warranted to extend the validity of these data to other herds, as well as to compare distinct correction methods of LDA and their effect on the production, reproduction, and survival performance of dairy cows.

CONCLUSION
Cows affected with left displacement of abomasum and corrected by the TPS procedure produced less milk than control cows, and all the decrease in production occurred during the first 4 mo of lactation. Left displacement abomasum did not affect the period from calving to conception and conception rates. However, cows affected with left displacement of abomasum had an extended interval from calving to first postpartum artifi-
cial insemination. Cows affected with left displacement of abomasum remained in the study for a shorter period than their control herdmates, and a higher proportion of left displacement of abomasum cows were sold and died. Death and culling were more pronounced immediately after the diagnosis of left displacement of abomasum and the TPS procedure.

ACKNOWLEDGMENTS

The authors wish to thank Ronaldo A. Cerri and Luis G. Corbellini for assistance with data collection. Our appreciation is also extended to Geoff Fosgate and Mark Thurmond for assisting with data analyses.

REFERENCES

SPSS. 1999. SPSS User’s guide (Release 10.0.5). SPSS Inc., Chicago, IL.