TAKE HOME MESSAGES

♦ Abomasal volvulus (AV) is a twisting of the stomach on the right side of the cow. The condition occurs less frequently than left displaced abomasum. The mortality rate for AV (average 30 percent) is higher than that for left displaced abomasum (average 5 percent).

♦ Blood lactate and pyruvate concentration and lactate-to-pyruvate ratio were all increased in cattle with AV. This indicates that circulatory shock in cattle with AV can be adequately treated with aggressive intravenous fluid therapy.

♦ In cattle with AV, unsuccessful postoperative outcomes are due to local damage to the abomasum, omasum, and duodenum, rather than circulatory shock.

INTRODUCTION

Blood lactate concentration provides information as to the adequacy of oxygen delivery, thereby providing a means of assessing the severity of cardiovascular or pulmonary dysfunction, monitoring the response to treatment, and formulating a prognosis for survival. Increases in blood lactate concentration have been categorized as mild (2.5 to 4.9 mM/L), moderate (5.0 to 9.9 mM/L), and severe (≥ 10 mM/L), with arterial blood lactate concentrations greater than 10 mM/L being associated with very high mortality rates. Studies in critically ill patients have shown an excellent correlation between blood lactate concentration in arterial blood, pulmonary arterial blood, central venous blood, and blood obtained from a peripheral vein, indicating that determination of the jugular venous blood lactate concentration would be clinically useful.

Abomasal volvulus in cattle is characterized by rotation of the proximal duodenum, abomasum, and omasum. Subsequent occlusion of the duodenum and omasal-abomasal or reticulo-omasal junction leads to accumulation of abomasal fluid, resulting in metabolic and cardiovascular derangement. Dehydration and anaerobic metabolism due to reduced peripheral perfusion is often observed in the latter stages of abomasal volvulus. Lactate production increases under these circumstances, the degree of peripheral hypoperfusion potentially being reflected as an increased blood lactate concentration. Blood lactate concentration could therefore provide a measurement of the degree of metabolic and hemodynamic derangement associated with hemorrhagic strangulating obstructions such as AV, and possibly be of prognostic value. We therefore determined blood lactate and pyruvate concentrations, calculated the blood lactate-to-pyruvate ratio, and recorded the postoperative outcome in cattle with AV.

MATERIALS AND METHODS

Forty-one dairy cows with AV were examined. Blood samples were obtained from the jugular vein before intravenous fluid administration or surgical correction. Blood was obtained rapidly and with minimal venous stasis. Abomasal volvulus was subsequently confirmed at surgery.
using established guidelines, and animals discharged from hospital were followed for 12 months to determined post operative success rate. Ten healthy, adult, nonlactating dairy cows were used to obtain normal values for blood lactate concentration, blood pyruvate concentration, and blood lactate-to-pyruvate ratio.

RESULTS

Blood lactate concentration (3.8±2.9 mM/L; range of values, 0.6 to 15.6 mM/L; normal range, 0.6 to 1.4 mM/L), blood pyruvate concentration (0.12±0.10 mM/L; range of values, 0.02 to 0.42 mM/L; normal range, 0.04 to 0.08 mM/L), and lactate-to-pyruvate ratio (37±19; range of values, 11 to 81; normal range, 12 to 18) were all significantly increased in cattle with AV. These results indicated that cattle with AV have hyperlactatemia secondary to cellular hypoxia, hypovolemia, and decreased oxygen delivery.

For all 41 cattle, mean blood pH (7.38±0.07; range of values 7.13 to 7.48), serum protein (7.1±1.2 g/dl; range of values, 4.6 to 9.7 g/dl) and phosphate concentration (6.2±2.7 mg/dl; range of values, 2.5 to 14.2 mg/dl) were within the normal reference range, whereas the mean serum creatinine concentration (1.9±1.0 mg/dl; range of values 0.9 to 4.8 mg/dl) was above the normal reference range.

Surgical correction of AV was performed in all 41 cattle; 12 month follow up indicated that 29 cattle (71 percent) were productive (normal health and milk production) and 12 cattle (29 percent) nonproductive (died or slaughtered). Blood lactate concentration (4.5±3.9 mM/L) and pyruvate concentration (0.15±0.11 mM/L) for nonproductive cattle were similar to those of productive cattle (lactate, 3.5±2.4 mM/L; pyruvate, 0.11±0.09 mM/L). Likewise, mean lactate-to-pyruvate ratio (37±20) for productive cattle was similar to that of nonproductive cattle (37±21).

DISCUSSION

Cattle with AV have increased blood lactate concentration. Such an increase can arise from: (1) an increase in lactate production due to rapid glycolysis and inadequate mitochondrial utilization of pyruvate, increasing lactate concentration through mass action with no change in the lactate-to-pyruvate ratio; (2) a decreased intracellular redox state or pH, due to inadequate mitochondrial O₂ delivery (i.e., true cellular hypoxia), leading to an increase in the lactate-to-pyruvate ratio; or (3) a decrease in lactate metabolism by the liver and renal cortex, with no change in the lactate-to-pyruvate ratio. The lactate-to-pyruvate ratio therefore indicates whether the intracellular redox state or pH is altered, and thereby can indicate the most important mechanism for an increased blood lactate concentration. Because the increase in blood lactate concentration in cattle with AV was accompanied by an increased lactate-to-pyruvate ratio, the predominant cause for hyperlactatemia in cattle with AV is tissue hypoxia (decreased blood flow). This finding emphasizes the importance of adequate intravenous fluid administration in treating cattle with abomasal volvulus. The results of this study indicate that circulatory shock in cattle with AV can be adequately treated with aggressive intravenous fluid therapy, and that unsuccessful postoperative outcomes in cattle with AV result from local damage to the abomasum, omasum, and duodenum.