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Research Article

Evaluation of Clinical, Serum Biochemical and Oxidant-antioxidant Profiles in Dairy Cows with Left Abomasal Displacement

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Abstract

Objective: This study aimed to evaluate the clinical and laboratory metabolic alterations in left displaced abomasum cattle with particular emphasis on the oxidative effects. **Methodology:** Cows with left displaced abomasum were confirmed on the basis of clinical symptoms. Blood samples were collected from 12 diseased cows during 4-6 weeks after parturition and were assayed for the selected biochemical parameters. Another 10 healthy cows were selected from similar environmental conditions and served as control. **Results:** The results showed that serum values of glucose, urea, creatinine, aspartate aminotransferase and amylase were significantly increased in the left displaced abomasum cows whereas, a significant decrease was found in serum concentrations of total protein, albumin, cholesterol, calcium, phosphorus, sodium, potassium and chloride. Metabolic alkalosis was evidenced by the significant elevation in blood bicarbonate concentrations plus pH. Oxidant-antioxidant study revealed a significant increase in the levels of hydrogen peroxide, nitric oxide and malondialdehyde in the diseased group while, serum enzymatic activities of catalase and glutathione reductase demonstrated a significant decrease. **Conclusion:** It was concluded that oxidative stress appeared to contribute in the pathogenesis of abomasal displacement in cattle and thus using of anti-oxidant therapies is recommended both to prevent and treat the disease.

Key words: Dairy cows, left abomasal displacement, biochemical profile, antioxidant, nitric oxide, hydrogen peroxide

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Abomasal displacement is one of the most important metabolic disorders of cattle which is distributed worldwide^{1,2}. The disease occurs most frequently in high yielding cows on high concentrate diets during early lactation. Most of cases of displacements were found to be seen within the first month of parturition; however, they can be seen at any time³. There are two manifestations of abomasal displacement. In both the abomasum becomes trapped between rumen and abdominal wall. The left displacement (LDA) is more common in which the abomasum moves ventral and left to the rumen. In addition, the omasum, reticulum and liver are also displaced.

Although the exact reason for the disease is still unspecified, important predisposing factors such as abomasal hypomotility, concurrent diseases (mastitis, metritis) and decreased rumen fill as well as periparturient changes in the position of intra-abdominal organs may contribute to the development and exacerbate the problem. Genetic predisposition also cannot be ruled out^{4,5}.

The early postpartum period was considered to be of major risk because hypocalcemia, lack of energy as well as nutritional factors due to increasing demands for nutrients for milk synthesis play a main role in the pathogenesis of LDA⁴. During this period, feeding a large amount of concentrations or corn silage to dairy cows inhibits the abomasal motility with the resultant gas accumulation followed by dilation and atony leading to displaced abomasum. Once the abomasum is displaced gas production continues causing distension and further displacement^{5,6,7}. The disease is of major economic importance in dairy herds because of treatment costs and production loss^{1,8}.

Although various studies have been performed about the effect of abomasal displacement on some biochemical profiles particularly those that may reflect nutrient status of the cow in postparturient period, there have been few studies to assess oxidant-antioxidant status in the left displaced abomasum cows. Therefore, the objective of this study was to determine and discuss the oxidative effect with other related metabolic parameters in cows with left displaced abomasum.

MATERIALS AND METHODS

Animals: For this study, a total of 22 cows 3-7 years old were chosen. About 12 cows were diagnosed with left abomasal displacement over a period of 12 months within 4-6 weeks after parturition. Diagnosis was confirmed through clinical examination on the basis of the characteristic clinical signs.

Clinical examinations included inspection and recording of respiratory and pulse rates and body temperature. Percussion and auscultation at the left rib cage were conducted and recorded. Another 10 healthy cows were selected from similar environmental and feeding conditions and served as control.

Blood samples: Blood samples were collected from the animals of both groups through the jugular vein in tubes containing heparin (20 IU mL⁻¹) for measuring blood pH and bicarbonate concentrations. Another blood samples were collected in plain centrifuge tubes and serum samples were separated and stored at -20°C until assayed for the selected biochemical parameters.

Analytical methods: Serum concentrations of total protein (TP), albumin (Alb), glucose (G), blood urea (U), creatinine (Cr), cholesterol (Ch), calcium (Ca), inorganic phosphorus (iP), magnesium (Mg) and serum enzymatic activities of aspartate aminotransferase (AST) and amylase (Amy) were measured spectrophotometrically using diagnostic kits of Spinreact (Spain) and following the manufacturer's instructions. Serum sodium (Na), potassium (K) and chloride (Cl) values were determined by using OPTI LION Automated Cassette-Based Electrolyte Analyzer (OPTIMEDICAL, USA). Blood pH and bicarbonate (HCO₃) were measured at 37°C by Rapid point 340® Blood Gas Analyzer (England) using kits supplied by Synbiotics Corporation, 11011 via Frontera, San Diego, according to the manufacturer's instructions. Oxidant-antioxidant status was evaluated by measuring serum levels of hydrogen peroxide (H₂O₂), nitric oxide (NO), malondialdehyde (MDA), catalase (Cat) and glutathione reductase (GR) which all were detected by spectrophotometer using kits supplies by Biodiagnostics, Egypt.

Statistical analysis: All the values were presented as Mean ± Standard Deviation (SD). Mean laboratory values of both groups were compared by student's t-tests at 0.05 level of probability.

RESULTS

Clinical signs: Clinical examination of diseased cows indicated reduction in food consumption, sudden drop of milk yield, loss of weight and scanty pasty faces. No changes were recorded in the internal body temperature and respiratory and pulse rates. The left side of the abdomen was distended and crescent in shape. The number of ruminal movements was decreased and on rectal palpation, the rumen

Table 1: Serum biochemical variables in LDA cows compared to the healthy animals

Parameters	Control	LDA
TP (g dL ⁻¹)	6.86±0.20	5.14±0.10*
Alb (g dL ⁻¹)	3.32±0.25	2.40±0.08*
Glucose (mg dL ⁻¹)	61.43±3.53	76.22±1.79*
Urea (mg dL ⁻¹)	46.19±3.10	58.23±1.17*
Creatinine (mg dL ⁻¹)	0.90±0.20	1.34±0.20*
Cholesterol (mg dL ⁻¹)	117.40±11.09	92.13±6.32*
AST (U L ⁻¹)	62.21±6.41	110.11±4.43*
Amylase (U L ⁻¹)	168.13± 7.28	238.84±6.30*

*Significant differences in the values between the LDA and control groups at $p<0.05$, values are Means±SD, n = 8

Table 2: Serum minerals and electrolytes concentrations and blood pH in LDA cows compared to the control animals

Parameters	Control	LDA
Calcium (mg dL ⁻¹)	9.86± 1.65	7.68±0.31*
Phosphorus (mg dL ⁻¹)	7.67± 1.60	5.87±0.26*
Magnesium (mg dL ⁻¹)	2.62±0.61	2.38±0.31*
Sodium (mEq L ⁻¹)	135.23±5.20	87.76±7.11*
Potassium (mEq L ⁻¹)	7.13±0.46	5.23±0.76*
Chloride (mmol L ⁻¹)	109.0±5.38	88.23±4.68*
HCO ₃ (mEq L ⁻¹)	7.97±1.10	15.73±0.95*
pH	7.31±0.04	7.76±0.10*

*Significant differences in the values between the LDA and the control groups at $p<0.05$, values are Means±SD, n = 8

Table 3: Effect of left abomasal displacement on oxidant-antioxidant status of cows

Parameters	Control	LDA
H ₂ O ₂ (μmol L ⁻¹)	288.11±18.01	548.54±33.01*
NO (μmol L ⁻¹)	21.06±3.410	59.16±0.21*
MDA (nmol mL ⁻¹)	7.29±2.520	11.79±0.04*
Cat (U L ⁻¹)	162.43±21.72	56.59±5.94*
GR (U L ⁻¹)	13.86±2.590	10.75±0.15*

*Significant differences in the values between the LDA and the control groups at $p<0.05$, values are Means±SD, n = 8

was displaced medial than normal. High-pitched resonant pings were audible on simultaneous percussion and auscultation of the left flank, especially in the cranial third of the paralumbar fossa in the line extended from the tuber coxae to the elbow on the left.

Serum biochemical variables: Results of serum biochemical parameters as shown in Table 1 indicated that compared to the control healthy animals, cows with LDA demonstrated a significant decrease ($p<0.05$) in serum concentrations of total protein, albumin and cholesterol and a significant elevation ($p<0.05$) in serum levels of glucose, blood urea, creatinine and serum enzymatic activities of AST and amylase (Table 1).

With respect to serum minerals and electrolytes, the data presented in Table 2 clarified that, serum concentrations of calcium, phosphorus, sodium, potassium and chloride were significantly decreased in the LDA cases ($p<0.05$) compared to

the control group while, serum magnesium levels did not show significant changes. On the other hand, significantly higher values of plasma bicarbonate were found in LDA group ($p<0.05$) in comparison to control. Blood pH was increased significantly ($p<0.05$) as well (Table 2).

Monitoring the oxidant-antioxidant status of cows affected with LDA as presented in Table 3 showed that, compared to the control group, serum hydrogen peroxide, nitric oxide and malondialdehyde levels were significantly increased ($p<0.05$) in LDA group while, a marked decrease was determined in serum enzymatic activities of catalase and glutathione reductase in the diseased animals (Table 3).

DISCUSSION

Abomasal displacements typically occur in high production dairy cows on high concentrate diets. Cases with abomasal displacement in this study were recorded within a period from 4-6 weeks after parturition, which was coinciding to previous reports⁹⁻¹¹. The first month after calving seemed to be the period of greater risk for occurrence of LDA^{6,7,9}. The occurrence of LAD during this period may be related to the feeding behavior whereas, after calving the ration of animal is rich in concentrates³. The typical clinical signs were manifested by anorexia and decreased milk production which could be attributed to decreased ruminal contractions that decrease the production of volatile fatty acids and thus milk production⁸. The most important diagnostic physical finding of an LDA was a ping on simultaneous auscultation and percussion of the abdomen in the area marked by a line from the tuber coxae to the point of the elbow while the characteristic rectal examination findings included a medially displaced rumen and left kidney^{3,9,11,12}.

Previous studies have shown the effect of the disease on many biochemical profiles particularly those reflecting nutrient status of the cow in transition period³. In this study, significant increase in the blood glucose level was noticed in the LDA group, which might be due to anorexia and decreased abomasal motility¹³. Moreover, impaired outflow of pancreatic juice and disturbed blood circulation in the pancreatic parenchyma were reported to be possible causes of hyperglycemia¹⁰. Cows with LDA demonstrated significantly higher values of serum urea and creatinine concentrations which could be regarded to dehydration and hypovolemia with the subsequent decreased renal blood flow¹¹. Hypovolemia and hemoconcentration appeared to be likely due to blockage of fluid transport from the abomasum into the duodenum^{3,14}. Furthermore, absorption of ammonium

from the rumen was found to increase when microbial protein cannot be transported to the duodenum leading to increased urea synthesis¹⁵. Serum total protein concentrations were significantly lower in LDA affected cows probably because of hypoalbuminemia. Factors that may be involved in the development of hypoalbuminemia may include anorexia with decreased food consumption and decreased albumin synthesis in liver¹⁴. Serum cholesterol levels were significantly lower in cows with LDA possibly due to disturbances in the lipid metabolism and consequently the existence of fatty liver. At the onset of lactation most dairy cows face negative energy balance because the nutrient demand increases than the increase in feed intake¹⁶. Stored body fat will be mobilized to liver in attempt to meet energy demands which will lead to excessive fat accumulation in hepatic cells resulting in fatty liver and reduced lipoprotein synthesis^{17,18}. Serum AST activity showed a significant increase in the diseased group. This finding could be attributed to hepatic lipidosis, endotoxemia and hepatocyte damage¹³. The marked elevation in serum amylase activity can be the result of impaired outflow of pancreatic juice and disturbed blood circulation in the pancreatic parenchyma¹⁰. Amylase enzyme is mainly cleared from serum by renal excretion, so it is reasonable to state that decreased renal blood flow and renal ischemia might contribute to the high serum amylase activity in cows with LDA¹⁹. The significant increase in serum bicarbonate concentrations and pH values indicates the presence of alkalosis. Similar findings were reported by Dezfouli *et al.*³ who attributed it to abomasal atony, continued secretion of hydrochloric acid into the abomasum and impairment of flow into the duodenum. In addition, without stimulation by the passage of ingest, the duodenum does not secrete pancreatic HCO_3^- , thus creating a relative increase in HCO_3^- in the extracellular fluid space producing metabolic alkalosis³. Alterations in serum levels of minerals and electrolytes in cows with LDA were well documented. The present results demonstrated a significant reduction in serum concentrations of calcium in cows with LDA. The puerperal hypocalcemia represents a significant risk factor for development of abomasum displacement as it adversely affects the tone of the abomasal wall and incidence of LDA is increased for cows that are hypocalcemic at calving²⁰. The significant decrease in serum phosphorous concentration seemed to be secondary to phosphorus redistribution as a result of alkalosis which induces intracellular phosphorus entry, thus decreasing serum phosphorous concentration²¹. The significant reduction of sodium, potassium and chloride electrolytes in cases of LDA can be attributed to acid-base imbalance, anorexia, sequestration in the abomasum, disturbed ingest transport combined with impaired general condition^{10,11,14}. Overall, all

three electrolytes could be regarded as indicators for the severity of the disease³.

Abomasal displacement is one of the postpartum diseases which induce stress in cattle and has been specified with an oxidative activity. Biochemically, oxidative stress is associated with increased production of oxidizing species or a significant decrease in the effectiveness of antioxidant defenses with the severity depending on the duration and intensity of such stress^{22,23}. In this study the significant elevation of serum levels of H_2O_2 , NO and MDA and the significant reduction in serum catalase and glutathione reductase activities in LDA cows confirming the induced oxidative stress in LDA. Hydrogen peroxide is one of the most reactive oxygen species which contributes to non-specific host defense mechanisms²⁴. Nitric oxide is a free radical which is generated in biological system by nitric oxide synthases (NOS). Nitric oxide functions as a vasodilator by relaxing smooth muscle in the linings of blood vessels²⁵. Recent studies proved that cattle with abomasal displacement have an increased activity of neuronal nitric oxide synthase the primary controller of smooth muscle tone²⁵. Based on these facts, the significant increase in nitric oxide could result from increased its generation through increased NOS production which will dilate blood vessels to increase blood flow to the compromised abomasum due to gas distention. Malondialdehyde is the major product of lipid peroxidation that reflect the oxidative stress in cells and tissues²⁶. Serum MDA levels were higher in LDA cattle indicating oxidative stress causing an increase in oxidants and decrease in anti-oxidants serum parameters²⁷. Although, we could not find any previous study reporting serum catalase and glutathione reductase levels as antioxidant enzymes in LDA cows, it is reasoned that decreased activities of these enzymes in LDA cases would result from induced stress of the LDA²⁸.

CONCLUSION

On the basis of the present results it can be concluded that left abomasal displacement in cattle is associated with acid-base imbalance, metabolic disturbances and impairment of liver and kidney functions. The incidence of abomasal displacement appeared to increase during the first 4-6 weeks after parturition, therefore, great attention should be paid to dairy cows during this period by maintaining the energy and electrolyte balances, adequate roughage in the diet and avoiding hypocalcemia. These results further recommend the involvement of some drugs inducing a compensated metabolic acidosis as a justifiable addition to the treatment regimen of LDA. The disease resulted in pronounced oxidative

stress response suggesting oxidative stress to take part in the pathogenesis of abomasal displacement. Thus, using of anti-oxidant therapies may play a potential therapeutic role in prevention and treatment of abomasal displacement in cattle.

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