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ORIGINAL ARTICLE

Evaluation of hematological and biochemical profiles in dairy cows with left displacement of the abomasum

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Abstract For the present study, 25 Holstein and crossbreed, 3 to 7-year-old cows diagnosed with left displacement of the abomasum and 15 healthy cattle as control groups over a period of 2 years were used. LDA diagnosis was based on clinical examinations (high-pitched bell-like sounds) and confirmed by laparoscopy. Two blood samples were collected from each case through the jugular vein including one tube containing EDTA for hematological parameters analysis and one tube without anticoagulant for biochemical analysis. Hematological parameters including Ca, P, Mg, Cl, AST, urea, and glucose concentrations were measured by routine procedures. Serum was determined by use of an atomic absorption spectrophotometer, and Na and K values were obtained using a flame photometer. The results of this study showed that Hb, percentage of PCV, total leukocytic, neutrophils, total protein count plus AST, urea, and glucose concentrations were significantly increased in the LDA cases compared to the control group, whereas a marked decrease in plasma electrolyte concentrations (hyponatremia, hypochloremia, hypokalemia, and hypocalcemia) was found in 88–92% of LDA cases. In conclusion, in the present study, it was shown that DA causes alterations in the clinical, hematological, and biochemical profiles and these alterations can be more severe when DA is concurrent with other diseases.

Keywords Hematological · Biochemical profiles · LDA · Dairy cattle

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Introduction

Abomasal displacement in cattle is a worldwide disease, the majority of which is seen with higher frequency specifically after calving (Radostits et al. 2007). Abomasal diseases of dairy cattle are mainly associated with stress conditions, nutritional disorders, and metabolic disturbances. Dairy cattle with high milk production and being fed large quantities of grain where exercise is limited may have abomasal atony (Lester and Bolton 1994). Other contributing factors that can cause decreasing abomasal motility include metabolic disorders (hypocalcaemia and ketosis), concurrent diseases (mastitis, metritis, retained placenta, or subclinical milk fever), changes of intra-abdominal organs (especially in late pregnancy), and genetic predisposition (Radostits et al. 2007; Delgado-Lecaroz et al. 2000). Abomasal displacements can cause economic losses in dairy herds because of treatment costs, premature culling, and production loss. Cows with displacement of the abomasum (LDA) are at increased risk of complicated ketosis and metritis (Radostits et al. 2007). The economic consequences of LDA have become more significant as the incidence rate has increased to 5% of postpartum dairy cows (Geishauser et al. 2000).

Normally, the abomasum contains fluid and is situated in the ventral part of the abdomen. In postpartum cows, the abomasum may transfer to the left without causing clinical signs (Van Winden et al. 2003). The LDA can be detected clinically if gas is present in the abomasum resulting in a tympanic, resonant, high-toned ping sound (Breukink and Kroneman 1963). It is possible that the clinical LDA resolves spontaneously; this LDA is, in the veterinary field, described as a floater.

In this paper, the persisting clinical LDA that requires veterinary intervention is referred to as LDA. The early postpartum period is considered to be the major risk period, because hypocalcemia, metritis, negative energy balance, as well as nutritional factors play a central role in the pathogenesis of LDA (Shaver 1997; Van Winden et al. 2003). Thus, the objective of this research was the evaluation of some of the hematological and biochemical parameters in left displacement the abomasum in cattle, and their comparison with healthy cattle.

Materials and methods

For the present study, a total number of 40 Holstein dairy cows and crossbreeds (3–7 years old) from industrial farms in the Tehran suburbs over a period of 2 years were selected. The examined animals were distributed into two groups. Group 1 included 25 cattle with clinical findings of left abomasal displacement, which was confirmed by abomasocentesis. Group 2 included 15 clinically healthy cattle that were considered as control for LDA. Clinical examinations included inspection and recording of respiratory and pulse rates and body temperature, and percussion and auscultation at the left or right rib cage were conducted and recorded (Table 1).

Two blood samples were collected from each case through the jugular vein including one tube containing EDTA (as anticoagulant) for hematological parameters analyses, and the other tube was without anticoagulant, for biochemical (electrolytes) analyses. Without anticoagulant samples were allowed to clot and were centrifuged at 2,000×*g* for 10 min, within 2 h after collection. Subsequently, each serum sample was stored at −20°C for a short period until analyzed. In addition, paracentesis of the displaced abomasum was carried out by using a 16/14-gauge needle to determine the pH of the aspirated fluid with stick pH meters.

Table 1 Clinical picture of control groups and cows with LDA

Group	Control	LDA
Body temperature (°C)	38.34±0.207	39.147±0.817
Heart rate (/min)	66.80±3.56	76.316±9.34
Respiratory rate (/min)	19.20±0.192	28.90±8.955
Ruminal movement	3/2 min	2/2 min

RBC count, PCV value, Hb concentration, and WBC counts were measured by routine procedures (Jain 1986). Differential leukocyte counts were performed on routinely prepared Giemsa-stained blood films using the cross-sectional technique. Serum Ca, P, Mg, Cl, AST, urea, and glucose concentration were determined by atomic absorption spectrophotometer with an autoanalyzer (Shimadzu Model AA 6200, Tokyo, Japan) and using commercial kits (Ziest Chem Diagnostics, Tehran, Iran). Sodium (Na) and potassium (K) values were obtained with the use of a flame photometer (Jenway, PFP 7 clinical and Essex, England).

The SPSS package (version 15) was used for hematology and biochemical data analysis. After testing normal distributions of the data, parametric independent *t* test was used to investigate significant differences between control and infected groups at $P<0.05$ or $P<0.001$.

Results

In the present study, the higher incidence rate of LDA was observed in cows during their second to fourth lactation. The LDA incidence was very high in cows fed with a ration enriched in concentrates (>60%) compared to incidence in animals fed with at least 50% forage. The body temperature, heart rate, and respiratory rates were increased in LDA-affected cows ($P<0.05$). Cattle with LDA showed reduction in appetite, selective appetite (eagerness to eat hay but reluctance to eat grains), pasty feces, characteristic high-pitched ping in percussion over the left middle to upper third of the abdomen between ribs 9 and 11, and a splashing sound with bell-like echo induced by ballottement. Rumen movements were reduced where it was 2–1/2 min in LDA compared to the control (3/2 min), and in some cases, the rumen was atonic. Paracentesis of the region demonstrated large quantities of blood-tinged fluid with a pH of 2–3 in different cases. On rectal examination, the rumen was displaced medial rather than normal in left abomasal displacement.

The mean±SD of the hematological and biochemical parameters in healthy cattle and cattle with LDA is presented in Table 2. In the hematological parameters, there were significant increases of Hb concentration, PCV percentage, leukocytic count, and neutrophil count, and total protein was detected in cows with LDA compared to control. Also, in the biochemical parameters, there were significant decreases ($P<0.001$) of serum sodium, potassium, chloride, and calcium and a significant increase in glucose ($P<0.05$), AST, and urea ($P<0.001$) in cows with LDA compared to the control group.

Table 2 Distribution of mean±SD of hematological and biochemical parameters in cattle with LDA and healthy cattle

Variables	Control	LDA
RBCs (×10^{12}/L)	6.86±0.39	5.59±1.24
Hemoglobin (g/dL)	11.38±1.50	13.86±2.14
PCV (L/L)	34.70±5.48	35.68±7.06
WBCs (×10^{12}/L)	7.65±0.50	8.86±3.97
Neutrophils (×10^{9}/L)	34.20±2.58	37.84±19.07
Lymphocytes (10^{9}/L)	64.20±1.78	52.32±21.55
Fibrinogen (g/dL)	0.48±0.08	0.37±0.16
Total Pr (g/dL)	7.38±0.39	7.07±1.39
Sodium (mmol/L)	140.600±3.050	130.0±1.63
Potassium (mmol/L)	4.340±0.321	3.52±0.43
Chloride (mmol/L)	102.600±3.050	87.1±0.12
Calcium (mmol/L)	9.76±0.76	8.13±1.56
Phosphorus (mg/dL)	6.17±0.40	4.39±1.40
Magnesium(mg/dL)	1.99±0.19	1.80±0.62
Glucose (mmol/L)	63.0±7.55	82.59±22.39
AST (IU/L)	98.7±0.64	186±3.11
Urea (mmol/L)	39.96±3.2	68.43±5.66

Discussion

Displacement of the abomasums has been introduced as one of the most important metabolic and organic internal disorders of cattle. Abomasal displacement occurs most frequently in high-yielding cows during early lactation (Veysi et al. 2003). Cases with abomasal displacement were recorded within a period from 3 to 7 weeks after parturition, which was similar to those reported by Constable et al. (1991), Zadnik (2003b), and El-Attar et al. (2007). The occurrence of LAD during this period may be related to the feeding behavior. In the dry period, the diet consists mainly of roughage, while after calving the ration is rich in concentrates (Veysi et al. 2003). It has been reported that feeding a large amount of concentrations or corn silage to dairy cows inhibits motility, resulting in gas accumulation followed by dilation and atony, and by this means causes abomasal displacement (Veysi et al. 2003).

Diseased cows were afebrile with increased heart and respiratory rates and reduced ruminal movements. These findings conform to those of Goetze and Müller (1990) and El-Attar et al. (2007). Moreover, in general, rumen activity declines during moderate hypocalcemia (Jorgensen et al. 1998) that usually occurs with abomasum displacement and is considered a risk factor for its occurrence. Clinical examination of diseased cows indicated reduction in appetite, sudden drop of milk yield, selective appetite, pasty feces, distention of the left side of the abdomen according to the type of displacement, and a splashing sound with a bell-like echo induced by ballottement. Moreover, high-pitched resonant pings were audible on simultaneous percussion and auscultation of the left flank, especially in the upper third of the abdomen between ribs 9 and 11 in cases with LDA.

On rectal examination, the rumen was displaced medial rather than normal in left abomasal displacement. All of these clinical findings were nearly similar to those recorded by Buchanan et al. (1991), Jubb et al. (1991), and El-Attar et al. (2007). Cows with displacement defecate less frequently, and the feces are usually scanty (Radostits et al. 2007) because emptying of the content from the organ is obstructed (Zadnik 2003a; El-Attar et al. 2007). Besides the abomasal position in the abdomen and the motility of the abomasum, there is a third reason for LDA development—gas production. A possible pathway for abomasal gas production is prolongation of fermentation in the abomasum (Van Winden et al. 2002a, b, 2003). The group of parameters that showed a significant increase in the hematocrit and hemoglobin concentration compared with the control cows which could be attributed to hemoconcentration and dehydration (Jubb et al. 1991; Rohn et al. 2004). Hemoconcentration in cows with LDA results from trapping of fluid in the displaced organ and blockage of the transport of fluid into the duodenum (Janowitz 1990; Ward et al. 1994; Geishauser and Seeh 1996).

In this study, the two parameters were not significantly associated with fecal consistency; therefore, it seems likely that hemoconcentration was a result of the failure of resorption of fluid from the duodenum because of the blockage of fluid transport from the abomasum into the duodenum. This means that the degree of hemoconcentration was associated with the severity of the disease (Rohn et al. 2004). The leukocytosis and neutrophilia observed in LDA might be an immunological response to the endotoxemia and abomasitis that occurs secondary (Zadnik 2003b; El-Attar et al. 2007). Serum biochemical changes in cows with LAD revealed a significant increase in ALP and AST. These results were agreeable with those of O'Zkan and Poulsen (1986), Zadnik (2003b), and El-Attar et al. (2007). Most cases of LDA occur in the postpartum period. Inanition during this period leads to serious metabolic consequences as the postpartum energy balance is mostly influenced by feed uptake. Prolonged periods of bad appetite lead to the same consequences (Rohn et al. 2004).

Metabolic imbalances in dairy cows have a strong impact on liver function and vice versa. In line with this, increased levels of AST activity and ALP were also significantly associated with failure (Voros and Karsai 1987; Lenz 1993) that could be attributed to hepatic lipidosis, endotoxemia ,and hepatocyte damage as well (Zadnik 2003b; El-Attar et al. 2007). Chloride and potassium were significantly lower in cows with LDA (O'Zkan and Poulsen 1986; Zadnik 2003b; El-Attar et al. 2007). Chloride concentration increases in the rumen and the abomasum during LDA (Geishauser et al. 1996a), indicating that HCl is not transported from the abomasum into the duodenum but flows back into the forestomachs. Potassium is increased in ruminal fluid. Janowitz (1990) reported that after surgery, serum concentrations of potassium remained low in cows with a disturbed ingest transport. Low serum potassium levels are also found in cows with functional pyloric stenosis (Kuiper and Breuking 1986). This indicates that storage of K in the digestive tract is the main reason for low potassium levels. Metabolic alkalosis with hypochloremia and hypokalemia associated with abomasal displacement could be attributed to abomasal atony, continued secretion of hydrochloric acid into the abomasums, and impairment of flow into the duodenum (Svendsen 1969). 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^- and producing metabolic alkalosis (Cunningham 2002).

The significant reduction of sodium electrolyte in cases of LDA could result from the metabolic acid–base imbalance due to the duodeno-abomasal reflux and endotoxemia (Geishauser and Seeh 1996; Ohtsuka et al. 1997). Sodium is decreased in cows when sodium is shed via the kidney to compensate early-stage alkalosis (Kuiper 1980). All three electrolytes (Cl, K, and Na) can therefore be regarded as indicators for the severity of the disease. Urea was significantly higher in cows with LDA. The increase in urea is likely associated with the hypovolemic condition that causes a reduction in renal blood flow (Rohn et al. 2004; Breuking and Kuiper 1980; El-Attar et al. 2007). Consequently, the serum urea and the indicators of dehydration were positively correlated (Anderson 1980). Furthermore, it is likely that absorption of ammonium from the rumen increases when microbial protein cannot be transported to the duodenum (Geishauser et al. 1996b; Rohn et al. 2004).

Present results demonstrated a significant reduction in calcium in cows with LDA (Veysi et al. 2003; Zadnik 2003b; Delgado-Lecaroz et al. 2000; El-Attar et al. 2007), but there were no significant differences in phosphorous and magnesium concentrations of cows with abomasal displacement compared to healthy cows. The puerperal hypocalcemia represents a significant risk factor for development of abomasum displacement in cows (Houe et al. 2001). In cows that developed clinical LDA, decreased values of calcium were detected prior to LDA (Geishauser et al. 1998). Significant increase in the blood glucose level in cows with displaced abomasums is a result that conforms to that of Zadnik (2003b) and El-Attar et al. (2007). It has been found that cows with abomasum displacement often have an elevated glucose and insulin level in the blood circulation (Cupere et al. 1991; Itoh et al. 1998; Muylle et al. 1990; Van Winden et al. 2002a). Holtenius et al. (1998, 2000) reported decreased abomasal motility in cows with high insulin combined with high glucose levels (Holtenius et al. 1998, 2000). On the other hand, Van Winden et al. (2003) found low levels of insulin and glucose in cows that developed abomasum displacement after 10 days. The exact mechanism by which the abomasal displacement leads to hyperglycemia is unknown (Van Winden et al. 2002a). However, Zadnik (2003b) reported that hyperglycemia may be associated with impaired outflow of pancreatic juice and disturbed blood circulation in the pancreatic parenchyma because of changes in the duodenal and omental position that occur during dislocation of abomasums (Zadnik 2003b).

On the basis of the present results and literature, it is concluded that abomasal displacement is expected to occur from the 21st day after parturition and is usually associated with hemoconcentration, electrolyte imbalance, and disturbances in liver and hepatic function. Subclinical hypocalcemia and hyperglycemia are also associated with abomasal displacement. Therefore, it is recommended that special attention be paid to dairy cows starting from the third week postpartum by maintaining the energy balance, electrolyte balance, and calcium homeostasis.

References

Anderson NV (1980) Veterinary gastroenterology. Lea & Febiger, Philadelphia

Breuking H-J, Kuiper R (1980) Digestive disorders following obstruction of flow of ingesta through the abomasum and small intestine. Bov Pract 15:139–143

Breukink HJ, Kroneman J (1963) Een nieuw diagnostisch hulpmiddel bij het onderzoek van het rund op de aanwezigheid van een gedilateerde en/of gedisloceerde lebmaag; het zgn. “Steelband-effect”. Tijdsch Diergeneeskd 88:282–291

Buchanan M, Cousin DA, MacDonald NM, Armour D (1991) Medical treatment of right-sided dilatation of the abomasum in cows. Vet Rec 129(6):111–112

Constable PD, Jean GS, Hull BL, Rings MR, Hosffsis GF (1991) Prognostic value of surgical post-operative findings in cattle. Am Vet Med Assoc 198:2077–2085

Cunningham JG (2002) Textbook of veterinary physiology, 3rd edn. Saunders, Philadelphia, pp 255–279

Cupere F, Muylle E, Van der Hende C, Oyeart W (1991) Metabolic profile tests in high yielding normal cows and in cows suffering from abomasal displacement. Bov Pract 26:129–130

Delgado-Lecaroz R, Warnick LD, Guard CL, Smith MC, Barry DA (2000) Cross-sectional study of the association of abomasal displacement or volvulus with serum electrolyte and mineral concentrations in dairy cows. Can Vet J 41(4):301–305

El-Attar HM, Yassein M, Abd El-Raof, Ghanem MM (2007) Alterations in the clinical, hematological and biochemical pictures in abomasal displacement in cows in Egypt. Vet Med J 102–109

Geishauser T, Seeh C (1996) Duodeno-abomasal reflux in cows with abomasal displacement. J Vet Med A 43:445–450

Geishauser T, Reiche D, Seeh C, Thunker B, Verwohlt S, Failing K (1996a) pH, Natrium, Kalium, Magnesium, Kalzium, Phosphat und Chlorid im Pansen- und Labmageninhalt von Kühen mit Labmagenverlagerung. Dtsch Tierärztl Wschr 103:16–20

Geishauser T, Reiche D, Seeh C, Thunker B, Verwohlt S, Failing K (1996b) Ammoniak im Pansen- und Labmageninhalt von Kuhen mit Labmagenverlagerung. Dtsch Tierärztl Wschr 103:465–468

Geishauser T, Shoukri M, Kelton D, Leslie K (1998) Analysis of survivorship after displaced abomasum is diagnosed in dairy cows. J Dairy Sci 81:2346–2353

Geishauser T, Leslie K, Duffield T (2000) Prevention and prediction of displaced abomasum in dairy cows. Bov Pract 34:51–55

Goetze L, Müller M (1990) The therapy of hypovolemic shock in cows with right-sided abomasal displacement. Zentralbl Vet A 37(4):300–309

Holtenius K, Jacobsson SO, Holtenius P (1998) Effects of intravenous infusion of glucose and pancreatic glucagon on abomasal function in dairy cows. Acta Vet Scand 39:291–300

Holtenius K, Sternbauer K, Holtenius P (2000) The effect of the plasma glucose level on the abomasal function in dairy cows. J Anim Sci 78:1930–1935

Houe H, Stergaard S, Thilsing-Hansen T, Jorgensen RJ, Larsen T, Jorgensen T, Agger JF, Blom JY (2001) Milk fever and subclinical hypocalcaemia. Acta Vet Scand 42:1–29

Itoh N, Koiwa M, Hatsugaya A, Yokota H, Taniyama H, Okada H, Kudo K (1998) Comparative analysis of blood chemical values in primary ketosis and abomasal displacement in cows. Zentralbl Vet Med A 45(5):293–298

Jain NC (1986) Schalm's veterinary hematology, 4th edn. Lea & Febiger, Philadelphia, pp 381–383

Janowitz H (1990) Elektrolytbestimmungen im Blutplasma und in Hämolysaten zur Berechnung der intraerythrozytären Elektrolytkonzentrationen in Abhängigkeit von Parametern des Säure–Base–Haushaltes im venösen Blut bei an linksseitiger oder rechtsseitiger Labmagenverlagerung erkrankten Kühen. Hannover, Tierärztliche Hochschule, Dissertation

Jorgensen RJ, Nyengaard NR, Hara S, Enemark JM, Andersen PH (1998) Rumen motility during induced hyper- and hypocalcaemia. Acta Vet Scand 39:331–338

Jubb TF, Malmo J, Davies GM, Vawser AS (1991) Left-side displacement of the abomasum in dairy cows at pasture. Aust Vet J 68:140–142

Kuiper R (1980) Abomasal reflux in cattle. Utrecht University, Veterinary Faculty, Dissertation

Kuiper R, Breuking HJ (1986) Secondary indigestion as a cause of functional pyloric stenosis in the cow. Vet Rec 119:404–406

Lenz U (1993) Untersuchungen zum Gerinnungs-status und zur Bedetung der Gerinnungsinhibitoren Antithrombin III uns protein C in der Diagnostik der Hepatosteatose von Kuhen mit linksseitiger Labmagenverlagerung. Hannover, Tieraztol. Hoch-sch., Diss

Lester GD, Bolton JR (1994) Effect of dietary composition on abomasal and duodenal myoelectrical activity. Res Vet Sci 57:270–276

Muylle EC, Van den Hende B, Sustronck B, Deprez P (1990) Biochemical profiles in cows with abomasal displacement estimated by blood and liver parameters. Zentralbl Vet A 37(4):259–263

O'Zkan K, Poulsen JSD (1986) Changes in ionized calcium content and related clinical chemical parameters in cases of left sided abomasal displacement. Nordisk Vet Med 38:277–287

Ohtsuka H, Ohki K, Motoshi T (1997) Evaluation of blood acid–base balance after experimental administration of endotoxin in adult cow. Jpn Vet Med Sci 59:483–485

Radostits OM, Gay CC, Hinchcliff KW, Constable PD (2007) Diseases of the abomasum. In: Radostits OM, Gay CC, Hinchcliff KW, Constable PD (eds) Veterinary medicine: a textbook of the diseases of cattle, horses, sheep, pigs and goats, 10th edn. Elsevier Health Sciences, Philadelphia, pp 353–374

Rohn M, Tenhagen BA, Hofmann W (2004) Survival of dairy cows after surgery to correct abomasal displacement: 2. Association of clinical and laboratory parameters with survival in cows with left abomasal displacement. J Vet Med A 51(6):300–305

Shaver RD (1997) Nutritional risk factors in the etiology of left displaced abomasum in dairy cows: a review. J Dairy Sci 80:2449–2453

Svendsen P (1969) Etiology and pathogenesis of abomasal displacement of cattle. Nordisk Vet Med 21(Suppl 1):1–60

Van Winden SCL, Muller KE, Kuiper R, Noordhuizen JPTM (2002a) Studies on the pH value of abomasal contents in dairy cows during the first three weeks after calving. J Vet Med Ser A 49:157–160

Van Winden SCL, Brattinga CR, Muller KE, Noordhuizen JPTM, Beynen AC (2002b) The position of the abomasum in dairy cows during the first six weeks after calving. Vet Rec 151:446–449

Van Winden SCL, Jorritsma R, Müller KE, Noordhuizen JPTM (2003) Feed intake, milk yield, and metabolic parameters prior to left displaced abomasums in dairy cows. J Dairy Sci 86:1465–1471

Veysi A, Mahmut OK, Murat B, Ismail S, Fatih MB, Fahrettin A (2003) The study on the relationship of abomasal displacement and fatty liver syndrome in dairy cows. Abstracts—poster presentations at 11th ICPD

Voros KL, Karsai F (1987) Blut-und pasensaftveraderungen cordem Auftreten der linksseitigen Lambagenverlagerung bei Milchkuhen. Tierarzti Umsch 42:617–624

Ward JL, Smith DF, Fubini SL, Deuel-Armando DN (1994) Evaluation of abomasal outflow diversion as an experimental model of hypochloremic, hypokalemic metabolic alkalosis in lactating cows. Can J Vet Res 58:13–19

Zadnik T (2003a) Review of anterior displacement of the abomasum in cattle in Slovenia. Vet Rec 5:24–25

Zadnik T (2003b) A comparative study of the hematobiochemical parameters between clinically healthy cows and cows with displacement of the abomasum. Acta Vet (Beograd) 53(5–6):297–309