

Haematological and biochemical profiles in right displacement of abomasum in cattle

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SUMMARY

Because displacements of abomasum cause great economical losses in Southern Turkey and can be complicated by lethal abomasal torsion, the objectives of this study were to evidence the main haematological and biochemical alterations occurring in right displacements of abomasums (RDA) with only dilatation. Haematological and biochemical parameters in blood and urine were investigated in 48 Holstein cows from the Burdur region diagnosed with simple RDA. Body temperature, heart and respiratory rates were also examined. RDA occurred mainly within the 4th lactation of cows, during winter and on animals fed with a diet regimen enriched with concentrates. Body temperature, and heart/respiratory rates were altered according to the severity of the disease. Except leukocytosis associated with increased lymphocyte, monocyte or neutrophil counts observed in the early stages or in cows with secondary infections, haematological parameters were usually within the normal ranges. Marked decreases of plasma electrolyte concentrations (hypochloremia, hypokalemia, hyponatremia and hypocalcemia) were commonly found with incidence of 89 - 93% and were associated with metabolic alkalosis revealed by urinary high pH (in 90% of cases) and by high blood pH values (in 62.5%). Hyperglycaemia (in 100%) coupled to a marked to severe ketonuria (in 90%) as well as to increases of plasma AST activities (in 90%) were considered as high sensitive markers of RDA and suggested the exacerbation of the liver metabolism.

Keywords : cattle, abomasum, right displacement, haematology, biochemistry

RÉSUMÉ

Profils hématologiques et biochimiques obtenus lors de déplacement à droite de l'abomasum chez la vache. Par SIMA SAHINDURAN, M. KORAY ALBAY

Comme les déplacements de la caillette causent de fortes pertes économiques dans le sud de la Turquie et peuvent se compliquer de phénomènes de torsion létaux, cette étude a pour but de mettre en évidence les principales modifications hématologiques et biochimiques qui surviennent dans les cas de déplacements de l'abomasum à droite (DAD) occasionnant seulement une dilatation. Ces explorations ainsi que la mesure de la température corporelle, des fréquences cardiaques et respiratoires ont été réalisées sur 48 vaches Holstein de la région de Burdur atteintes de cas simples de DAD. Les cas de DAD sont apparus essentiellement sur des vaches en 4^{ème} lactation, pendant l'hiver et sur des animaux dont la ration était riche en concentrés. La température et les rythmes cardiaques et respiratoires ont augmenté en fonction de la sévérité de l'affection. A part une leucocytose associée à une lymphocytose, à une monocytose ou à une neutrophilie observée dans les premiers stades ou sur des vaches secondairement infectées, les paramètres hématologiques sont restés normaux. Les concentrations plasmatiques en électrolytes (chlorémie, kaliémie, natrémie et calcémie) ont fortement diminué dans 89 à 93% des cas et une alcalose métabolique a été conjointement révélée par une augmentation de pH urinaire dans 90% des cas et du pH sanguin dans 62.5%. L'hyperglycémie (dans 100% des cas), une cétonurie associée, importante à sévère (90% des cas) ainsi qu'une augmentation conjointe de l'activité plasmatique de l'AST (90% des cas) constituent des marqueurs sensibles de cette pathologie et suggèrent l'intensification du métabolisme hépatique.

Mots-clés : Vache, abomasum, déplacement à droite, hématologie, biochimie

Introduction

Right-side displacement and dilatation of the abomasum (RDA) is a sub-acute disease which occurs in mature cows within a few weeks after calving and is characterized by inappetence to anorexia, scant faeces, depression, moderate dehydration, poor milk production, rumen sluggish, fluid filled viscous under right costal arch, ping commonly audible, may be palpable per rectum, progressive and commonly torsion due to accumulation of fluid and gas in the abomasum [1, 18]. The cause of the dilatation is a primary distension of the abomasum due to the obstruction of the pylorus or to the primary atony of the abomasal musculature. Torsion of abomasum is characterized by sudden onset of acute abdominal pain, distension of right abdomen, loud "pinging" sound on percussion distended tense abomasum palpable per rectum, marked circulatory failure, weakness, bloodstained faeces and death in 48-60 hours [1].

The haematological changes, and particularly electrolyte and acid-base abnormalities usually associated with right displacement of the abomasum (RDA) and abomasal volvulus (AV) have already been described [14]. Moderate to severe ketonuria is always present [2]. The decreased of plasma Cl^- and K^+ concentrations were related to the gastric content sequestration or to anorexia, whereas high bicarbonate and excessive base concentrations were attributed to the obstruction of abomasal outflow and to the consequent accumulation of HCO_3^- in the extracellular fluid space [15, 16]. While alkalosis, hypochloremia and hypokalemia are seen in dilatation cases, dehydrating alkalosis and hypochloremia are the prominent findings of torsion of the abomasum. Temperature and heart rate may be change with increasing severity of diseases [4].

Diagnosis of the disease is based on invasive and non-invasive techniques: the invasive techniques are laparotomy and laparoscopy, while non invasive ones are simultaneous auscultation and percussion, non-ballotement, sonography, and rectal exploration [8].

RDA is a sub-acute disease which can cause mortality and high economical losses in dairy cattle [1]. Burdur is one of the most important dairy cattle reared area in Turkey. This area consists of approximately 115.000.000 cattle and RDA

is one of the major problems observed in cattle in this area. The objectives of this study were to clinically well-characterize the simple RDA cases and to investigate significant haematological and biochemical alterations in urines and blood from affected cows, in the Burdur region.

Materials and Methods

Forty eight fresh Holstein, 3 to 7 years old, cows diagnosed with simple RDA (only dilatation) were used. Five cows (10.4 %) were in their second lactation (3 year old), 6 cows (12.5 %) in their third lactation (4 year old), 15 cows (31.3 %) in their fourth lactation (5 year old), 12 cows (25 %) in their fifth lactation (6 year old), and 10 cows (20.8 %) in their sixth lactation (7 year old). The cows were classified according to the milk production to 3 classes: poorly productive (by 5 kg milk production, n=5), mildly productive (by 10 kg milk production, n=18) and highly productive (< 20 kg milk production, n=25). The livestock-farming systems are traditional in Burdur and stables are usually closed and populations are crowded, concentrated foods are more commonly used in breeding.

The abdomen was examined by percussion with a flick of the finger and, most reliably, with a plexor and was auscultated at the same time. The stethoscope was placed immediately adjacently to the area being percussed and examiner listened for resonant sounds, which varied from high-pitched

bell-like sounds (pings) to a low-pitched bass drum sound (pungs). To elicit the diagnostic ping, it was necessary to percuss and auscultate side by side, and to percuss with a quick, sharp, light and localized force. All clinical diagnoses were later confirmed by right laparotomy. Immediately after prognosis, the body temperature (°C), heart and pulse rates (beats/min) and the respiratory rates (breaths/min) were examined.

Blood samples were collected from jugular vein into heparinized tubes, and then centrifuged at 1500g for 7 minutes (Hettich Zentrifugen Universal 30F model centrifuge device). Plasma biochemical analyses were performed with Konelab 60i analyser and blood haematological analyses with MS9. Urine samples were obtained from all cows by spontaneous micturition. For urine analyses URIPSIN 10 urine test strips were used. Data was analyzed by SAS packed program [12]. Differences were considered as significant when p values were less than 0.05.

Results

In the present study, the higher incidence rate of RDA (31%) was observed in cows during their 4th lactation whereas the RDA percentage was the lower in cows in the 2nd lactation (10%). In addition, RDA was diagnosed in all cows during the first 45 days after calving. This affection mainly occurred in winter (71% of observed cases) whereas the

Lactation range	Number of cows	Diet regimen		Season	
		HC (> 60%) – LF (< 40%)	LC (< 50%) – HF (< 50%)	Winter	Summer
2	5	4	1	4	1
3	6	5	1	4	2
4	15	12	3	11	4
5	12	11	1	9	3
6	10	8	2	6	4
Total	48	40 (83.3%)	8 (16.7%)	34 (71%)	14 (29%)

HC-LF: ration with a high concentrate proportion and a low forage proportion.

LC-HF: ration with a low concentrate proportion and a high forage proportion

TABLE I. — Numbers of simple RDA cases (only dilatation) and incidence rates (%) according to the range of lactation, the diet regimen and the seasons in the 48 RDA affected Holstein cows.

Clinical parameters	Normal range	Interval of observed values	Number of cases
Body temperature (°C)	38-38.5	38-38.5	25
		38.5-39	13
		>39	10
Heart rate (beats / min)	75-85	75-85	38
		85-90	10
Respiratory rate (breaths / min)	25-28	25-28	33
		>28	15

TABLE II. — Clinical findings (body temperature, heart and respiratory rates) in simple RDA-affected cows (n = 48).

Clinical parameters	RDA- affected cows (Milk production)		
	Low (n = 5)	Mild (n = 18)	High (n = 25)
Body temperature (°C)	40 ± 0.6	38.8 ± 0.2	38.3 ± 0.2
Heart rate (beats / min)	89.9 ± 0.2	86.9 ± 0.2	78.8 ± 0.2
Respiratory rate (breaths / min)	32.8 ± 0.3	29.9 ± 0.2	27.2 ± 0.2

TABLE III. — Clinical signs (body temperature, heart rate and respiratory rate) in simple RDA- affected cows (n = 48) according to milk production. Results are expressed as mean ± standard errors..

number of cases recorded in summer was low (29%). Moreover, RDA incidence (83.3%) was very high in cows fed with a ration enriched in concentrates (>60%) compared to incidence in animals fed with 50% forage (16.7%) at least. (Table 1).

The body temperature, the heart and respiratory rates were increased in RDA affected cows, particularly in 10 cows which simultaneously presented hyperthermia (Table 2). Furthermore, these clinical signs were more frequently enhanced in poorly and mildly productive cows than in highly productive animals (Table 3).

The packed cell volume (PCV) and haemoglobin concentrations were within the normal ranges in many RDA affected cows, whereas a marked leukocytosis, due to lymphocytosis and increases of monocyte or granulocyte counts at a lesser extend, was evidenced in 16 animals (33.3%). Indeed, increases of lymphocytes, monocytes and granulocytes were

also encountered in 33.3%, 20.8% and 26.9% of the RDA affected cows respectively (Table 4) and all of cows with abnormal lymphocyte, monocyte or granulocyte counts present also a moderate to a strong leukocytosis. Alterations of the leukocyte distribution were always found in the 10 cows with strong hyperthermia (>39 °C).

Compared to the respective normal range values, marked decreases of some plasma electrolyte concentrations (Cl⁻, K⁺, Na⁺ and Ca²⁺) were observed in RDA-affected cows, whereas glycaemia, aspartate aminotransferase (AST) activity and total bilirubin concentration at a lesser extend were increased. By contrast, plasma Mg, blood urea nitrogen (BUN) and creatinine concentrations were not modified. High blood pH values (> 7.4) were observed in 62.5% of affected cows, evidencing a metabolic alkalosis. But, on the contrary, some cows (25%) presented a metabolic acidosis (blood pH < 7.4). Plasma concentrations of Cl⁻ (modified in

Parameters	Interval of observed	Number of cases
	values	(%)
PCV (%)	<25	2.1%
	25 - 50	91.7%
	>50	6.2%
Hemoglobin (g/L)	< 80	8.3%
	80-150	77.1%
	>150	14.6%
Total WBC (×10 ⁹ /L)	< 4	4.2%
	4-15	62.5%
	>15	33.3%
Lymphocytes (×10 ⁹ /L)	< 2	20.8%
	2-7	45.9%
	>7	33.3%
Monocytes (×10 ⁹ /L)	≤ 0.1	30.5%
	0.1- 0.8	48.7%
	>0.8	20.8%
Neutrophils (×10 ⁹ /L)	<0.6	3.9%
	0.6- 4	69.2%
	>4	26.9%

PCV: Packed cell volume - WBC: White blood cells

TABLE IV. — Haematological findings in simple RDA - affected Holstein cows (n = 48).

Parameters	Normal range	RDA-affected cows	Number of cases (%) with abnormal values
Cl ⁻ (mmol/L)	110	86.77 ± 1.67	93.75
K ⁺ (mmol/L)	3.9 - 5.8	2.81 ± 0.04	91.66
Na ⁺ (mmol/L)	132 - 152	113.81 ± 1.68	93.75
Ca ²⁺ (mmol/L)	2 - 2.63	1.64 ± 0.04	89.58
Mg ²⁺ (mmol/L)	0.51 - 1.48	0.94 ± 0.05	4.16
Glucose (mmol/L)	1.83 - 3.01	3.99 ± 0.17	100
Total Bilirubine (mg/L)	0 - 19	21.4 ± 0.3	90
BUN (mmol/L)	2.14 - 9.64	3.62 ± 0.51	4.16
Creatinine (mmol/L)	88.40 - 239.68	182.11 ± 87.52	6.25
AST (U/L)	60 - 150 U/L	202.6 ± 4.1	90
pH	7.35 - 7.50	7.6 ± 0.3	62.5

BUN: Blood urea nitrogen - AST: Aspartate aminotransferase

TABLE V. — Blood biochemical findings in simple RDA - affected Holstein cows (n = 48). Results are expressed as mean ± standard errors.

93.75% of cases), K⁺ (in 91.66%), Na⁺ (in 93.75%), Ca²⁺ (in 89.58%) and total bilirubine (in 90%) and plasma AST activity (in 90%) were the most frequently modified markers observed in RDA affected cows (Table 5).

Ketonuria was observed in 90% of RDA- affected cows, and was severe (2⁺ and 3⁺) in 33 cows. Moreover, the majority of RDA- affected cows (62.5%) presented alkaline urine pH values while detectable protein concentrations were evidenced only in 25% of diseased animals (Table 6).

Discussion

In the present study, RDA cases were observed within the first 45 days after calving in all diseased cows, particularly in winter, mainly during the 4th lactation, in cows feed with high concentrated ration. These results are consistent with previous studies. Indeed, RADOSTITS *et al* [9] and MATHER *et al* [7] estimated that 90% of RDA occurred with in the first six weeks after calving. Moreover RDA was rare in first- calf heifers, but its frequency increased through the fourth to the sixth calving, and thereafter decreased [10]. Diet regimen also appeared as a predisposing factor. RDA was commonly observed in older cows feed with concentrate (grain or corn silage)-enriched diets [3]. The high rumen propionate concentrations due to the ingestion of concentrates or silage reduced abomasal activity leading to a relative atony [1]. By contrast, high forage supply in the ration (> 85%) would maintain maximal rumen fill and volume would stimulate rumen motility [2] and improve the thickness of the rumen mat [1]. Consequently, when forage availability was depressed in winter months, the rumen mat was lowered and the motility was reduced, favouring RDA occurrence.

In right- side dilatation and displacement of the abomasum, temperature is usually normal, the heart rate can vary from normal to 100/minute [1]. In this study, 10 cows presented a marked hyperthermia, abnormally elevated heart and respiratory rates associated to alterations of the leukocyte formula (leukocytosis due to lymphocytosis, monocyto-

sis or neutrophilia). These chemical and haematological findings would probably be attributed to secondary infections. Indeed, these 10 cows stabilized mastitis. On the other hand, the total and differential leukocyte counts may indicate a stress reaction in the early stages of RDA [1] and leukocytosis could be attributed to the stress reaction in 6 cases of the present study.

The majority of RDA- affected cows (62.5%) presented a metabolic alkalosis in the present study, characterized by high blood pH values associated with urine alkalosis, hypochloremia (93.75%), hypokalemia (91.66%) and hyponatremia (93.75%). Right displacement of the abomasum induces sequestration of abomasal secretions rich in HCl in the fore stomach compartments and abomasum, leading to hypochloremic metabolic alkalosis usually accompanied by hypokalemia and dehydration [13, 16]. The hypokalemia probably results from several factors including anorexia, intracellular movement associated with metabolic alkalosis, and potassium loss through the urine and the abomasal effluent and diarrhoea [3]. However, 25% of cow showed metabolic acidosis in this study, and the dramatic and paradoxical blood pH variations could be associated to the severity of RDA.

Besides, all RDA-affected cows were hyperglycaemic in this study and the great majority of them (43/48) presented also a ketonuria, generally marked. Hyperglycaemia could be related to an intensification of liver neoglucogenesis from rumen propionate production [10] and its association with ketonuria could result from an exacerbation of the liver metabolism, including lipolysis leading to ketogenesis. On the other hand, hyperglycaemia associated with ketonuria may allow the exclusion of primary ketosis diagnosis. Indeed, in the most cases of primary ketosis, ITOH *et al* [6] have shown that glycaemia was significantly lowered and negatively correlated with concentration of the ketone bodies, whereas it was increased and not correlated with ketonuria in the cases of right abomasal displacements. Furthermore, ROBERTSON [11] has also reported that plas-

Parameters	Normal range	Interval of observed values	Number of cases (%)
pH	7 - 9	< 7	25%
		7 - 9	12.5%
		> 9	62.5%
Protein	Negative	Negative	75.0%
		1+	14.6%
		2+	10.4%
Ketone bodies	Negative	Negative	10.4%
		1+	20.8%
		2+	25%
		3+	43.8%

TABLE VI. — Urine analysis of simple RDA - affected Holstein cows (n = 48).

ma glucose concentrations remained in normal range in the left displacement of abomasum.

In the present study, increases of plasma AST activity and of total bilirubin concentration observed in 90% of RDA-affected cows suggest liver damage or intensive metabolism. The increase of plasma AST activity is not obligatory due to liver damage since hyperglycaemic hormones can also induce this enzyme and consequently to lipomobilisation and delayed lipolysis into the liver, steatosis (fatty liver) would occur and provoke liver dysfunction and injury. Our results are in agreement with previous investigations [5, 6, 17], which reported enhanced plasma AST activities during abomasal displacements, especially during right displacements.

RDA is a major problem in southern Turkey (Burdur region) and this study has shown that RDA incidence was linked to a concentrate-enriched ration. Haematology could be helpful in the diagnosis by evidencing leukocyte formula alterations in the early stages of the disease or in the presence of secondary infections, but marked biochemical alterations were commonly observed in simple RDA (only dilatation). Hypotonic dehydration with hypochloremia, hypokalemia, and hyponatremia was associated with metabolic alkalosis found in 62.5% of cases and liver dysfunction characterized by hyperglycaemia coupled to ketosis and increased AST activities was observed with a very incidence (90%).

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