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# Clinicopathological and Ultrasonographic Studies on Abomasum Displacement in Cows

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**Abstract:** Abomasum displacement is a condition causing confusion with metabolic diseases in dairy cows. This work was aimed to evaluate the changes may be encountered in hematology, blood chemistry, acid base balance, blood gases and ultrasonographic findings of cows with either left or right abomasum displacement. Seventy six, 4-7 years old, Friesian dairy cows were used. Thirty eight healthy cows, 28 cows with left abomasum displacement and 10 cows with right abomasum displacement were examined. Cows with left and right abomasum displacement had a significant increase of the total leukocytic count, neutrophils count, total bilirubin, conjugated bilirubin, aspartate aminotransferase, alanine aminotransferase, malondialdehyde, bicarbonate and power of hydrogen. The serum levels of total protein, albumin, potassium and chloride were decreased significantly in both abomasum displacement groups compared to control cows. Ultrasonographic findings revealed the displacement of the rumen by abomasum in cases of left abomasum displacement and displacement of liver in cases of right abomasum displacement. It could be concluded that the presence of alterations in the liver function beside metabolic alkalosis at the early period post parturition could be used as an indicative for abomasum displacement. Also special attention must be done at the first 6 weeks post parturition (period of high incidence). Moreover, abomasum displacement increased lipid peroxidation so the using of antioxidants during the treatment of such cases is recommended.

**Key words:** Abomasum displacement · Acid base balance · Blood chemistry · Hematology · Dairy cattle · Ultrasonographic examination

## INTRODUCTION

Displacement of the abomasum (DA) is one of the most common diseases recorded in dairy cattle specially after calving [1-3]. Moreover it is more common in intensive production [4]. It causes post-calving digestive upset [5]. Many factors have been implicated in the etiology of such cases. The primary causative factor appears to be atony of the abomasum [6]. The diminished of abomasum motility, followed by disturbed abomasal evacuation and gas accumulation, are the predisposing causes for dilatation and subsequent displacement [7]. High milk yielding cows fed large amounts of grain with limited exercise might have abomasal atony [8, 9]. Other causes for diminishing the motility of abomasum include hypocalcaemia, ketosis, mastitis, metritis, especially in late pregnancy, retained placenta and hereditary predisposition [10, 11]. The early period after parturition is considered the main period of risk, as low serum calcium level, negative energy balance and metritis play the main effect in the pathogenesis of abomasum displacement [12, 13]. Abomasum displacement caused economic losses in dairy farms as a result of treatment prices, premature culling and production loss [3]. Left DA is much more common (85–96% of DA) than right DA which accounting for 4–15% of cases [5]. Clinical findings of abomasal displacement included inappetence, sometimes complete anorexia, marked drop of milk yield, varying degrees of ketosis and tinkling sounds on auscultation [3, 11]. The economic consequences of left

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DA became important because the rate of occurrence has increased [14]. On left DA, the rumen displaced by the abomasum dorsally and the abomasum is seen between the rumen and left abdominal wall [15,16]. In right DA, the liver displaced medially from the right abdominal wall [16, 17]. This work was aimed to evaluate the changes may be encountered in hematology, blood chemistry, acid base balance, blood gases and ultrasonographic findings of cows with either left or right abomasum displacement.

## MATERIALS AND METHODS

**Animals:** A total number of seventy six Friesian dairy cows, 4-7 years old, were used during the present study from August 2012 to February 2014. The animals belonged to Sharkia and Dakahlia governorates. Control cows were selected from the same flocks and nearly within the same age, breed and calving date. The examined animals were divided into 3 groups. Group (1) was clinically healthy control cows (n=38). Group (2) was diagnosed as left abomasum displacement (n=28) and group (3) was right abomasum displacement (n=10). The experiment was done in accordance to the guidelines of Animal Health Research Ethics Training Initiative, Egypt and the protocol was approved by the institutional animal ethics committee.

**Clinical Examination:** The clinical examination included inspection, auscultation, percussion, rectal palpation, respiratory and pulse rates and body temperature. The diagnosis was based on simultaneous auscultation and percussion which revealed an area of high-pitched tympanic resonance (ping); presented at the line extended from the tuber coxae to the elbow; on the left or right side.

**Sampling:** Three blood samples were obtained from jugular vein of each animal. The first was 1 ml blood received in a clean tube containing dipotassium salt of EDTA and used for hematological examination. The second sample was 10 ml blood collected into a centrifuge tube to separate serum for determination of serum biochemical assays. The third sample was 3 ml blood collected in heparinized syringe for blood gas analysis.
Hematological studies:

**Hematological Studies:** The red blood cell count (RBCs), hemoglobin concentration, hematocrit value and total leukocytic count (TLC) were performed using automatic cell counter (Hospetix Hemascreen 18, Florence). The blood films were stained by Giemsa stain and differential leukocytic count was carried out according to [18].

**Biochemical Studies:** Serum obtained by centrifugation was used for measurement of total proteins [19] and albumin levels [20]. Serum globulin level was calculated mathematically by subtracting albumin values from total proteins. Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities were determined [21]. Serum malondialdehyde (MDA) was estimated colorimetrically [22].Serum calcium (Ca) was estimated [23]. Serum sodium (Na) and potassium (K) levels were determined using flame photometer [24]. Serum chloride (Cl) was determined [25]. Serum bicarbonate ($HCO_3^-$) was also estimated [26]. The serum anion gap was calculated by the difference between the concentration of the major cations and the major anions. $Pco_2$ and pH were determined [27].

**Ultrasonographic Examination:** For examining abomasums displacement, digital Veterinary Ultrasound Scanner machine (Mindray DP- 2200 Vet-China) equipped with convex transducer (2.5-5 MHz) and linear array transducer (5-10 MHz) was used. After routine skin preparation, ultrasonographic coupling gel (Medico lab- Egypt) was applied on the animal's skin during examination, to ensure a good contact between the animal's skin and the probe. Ultrasonographic examination of abomasum was performed in cows at the right and left side between the $10^{th}$ and the $12^{th}$ intercostal spaces. The area was examined ventrally to dorsally with a 3.5 MHz transducer held parallel to the ribs.

**Statistical Analysis:** All statistical procedures were performed using SAS statistical system Package V9.2 [28]. Variables were analyzed using one-way analysis of variance (*ANOVA*) through the general linear models (GLM) procedure, after verifying normality using Kolmogorov-Smirnov test. The comparison of means was carried out with Duncan's multiple range tests.

## RESULTS

Off food and drop of milk yield were the initial chief complaints of the animal owners brought to the clinic. Most cases (n =35) occurred within the first 6 weeks postpartum, while the others (n=3) occurred along the whole gestation period. Pulse rate, Temperature and respiratory rate were normal. Rumen contractions were present but weak. Simultaneous auscultation and percussion revealed an area of high-pitched tympanic resonance (ping); presented in the line extended from the tuber coxae to the elbow; on the left or right side.

Table 1: Hematological changes in both healthy control and abomasal displacement (mean values ±SE)

| Parameters | Groups: Healthy control | Left abomasal displacement | Right abomasal displacement | LSD |
|---|---|---|---|---|
| RBCs count(x $10^6$/µl) | 6.38 ± 0.19[a] | 6.51 ± 0.09[a] | 6.46 ± 0.30[a] | NS |
| Hematocrit value (%) | 29.40± 0.70[a] | 29.93± 0.41[a] | 29.60± 1.25[a] | NS |
| Hemoglobin (gm/dl) | 11.79± 0.31[a] | 11.99± 0.18[a] | 11.86± 0.54[a] | NS |
| TLC count(x$10^3$/µl) | 6.63 ± 0.16[b] | 8.66 ± 0.07[a] | 8.92 ± 0.41[a] | 0.37 |
| Lymphocytic count(x$10^3$/µl) | 4.04 ± 0.11[a] | 4.18 ± 0.05[a] | 4.07 ± 0.19[a] | NS |
| Monocytic count(x$10^3$/µl) | 0.35 ± 0.07[a] | 0.36 ± 0.02[a] | 0.38 ± 0.08[a] | NS |
| Neutrophil count(x$10^3$/µl) | 2.13 ± 0.07[c] | 4.01 ± 0.03[b] | 4.35 ± 0.20[a] | 0.17 |
| Eosinophil count(x$10^3$/µl) | 0.08 ± 0.01[a] | 0.08 ± 0.02[a] | 0.09 ± 0.04[a] | NS |
| Basophil count(x$10^3$/µl) | 0.03 ± 0.01[a] | 0.03 ± 0.01[a] | 0.03 ± 0.02[a] | NS |

Means within the same row followed by different letters a,b,c were statistically significant at p $\leq$ 0.05 and the highest values were represented with the letter (a). -TLC: Total leukocytic count. -NS: Not significant.

Table 2: Some biochemical changes in both healthy control and abomasal displacement (mean values ±SE)

| Parameters | Groups: Healthy control | Left abomasal displacement | Right abomasal displacement | LSD |
|---|---|---|---|---|
| Total protein(gm/dl) | 7.37 ± 0.12[a] | 7.03 ± 0.04[b] | 6.89 ± 0.09[b] | 0.20 |
| Albumin (gm/dl) | 3.92± 0.07[a] | 3.63± 0.03[b] | 3.51± 0.04[b] | 0.13 |
| Globulin (gm/dl) | 3.45± 0.06[a] | 3.40± 0.03[a] | 3.38± 0.06[a] | NS |
| Total bilirubin (mg/dl) | 0.28± 0.02[b] | 0.44± 0.03[a] | 0.56± 0.06[a] | 0.13 |
| Direct bilirubin (mg/dl) | 0.10± 0.01[c] | 0.22± 0.02[b] | 0.36± 0.04[a] | 0.08 |
| Indirect bilirubin (mg/dl) | 0.18± 0.02[a] | 0.22± 0.01[a] | 0.20± 0.03[a] | NS |
| Aspartate aminotransferase (U/L) | 55.80± 0. 99[c] | 103.46± 1.12[b] | 109.20± 1.91[a] | 4.02 |
| Alanine aminotransferase (U/L) | 15.40± 0. 83[c] | 29.21± 0.75[b] | 34.80± 2.27[a] | 2.92 |
| Malondialdehyde(nmol/ml) | 0.47±0.01[c] | 1.00±0.03[b] | 1.42±0.06[a] | 0.21 |

Means within the same row followed by different letters a, b, c were statistically significant at p $\leq$ 0.05 and the highest values were represented with the letter (a). -NS: Not significant

Table 3: The major serum cations, anions, calculated anion gap and blood gases in healthy control and abomasal displacement(mean values ±SE)

| Parameters | Groups: Healthy control | Left abomasal displacement | Right abomasal displacement | LSD |
|---|---|---|---|---|
| Calcium mg/dl | 10.33± 0. 33[a] | 8.95± 0.19[b] | 9.33± 0.42[b] | 0.78 |
| Sodium mEq/l | 141.36 ± 0.67[a] | 140.24 ± 0.24[a] | 140.10 ± 0.54[a] | NS |
| Potassium mEq/l | 4.52± 0.07[a] | 3.99± 0.04[b] | 3.77± 0.09[c] | 0.15 |
| Chloride mEq/l | 105.23± 0.65[a] | 98.56± 0.26[b] | 97.70± 0.27[b] | 1.15 |
| $HCO_3^-$ mEq/l | 23.90± 0.38[b] | 27.43± 0.31[a] | 28.20± 0.49[a] | 1.13 |
| Anion gap mEq/l | 17.75± 0.98[a] | 18.22± 0.55[a] | 17.96± 0.88[a] | NS |
| PH | 7.39± 0.01[b] | 7.54± 0.02[a] | 7.55± 0.05[a] | 0.08 |
| $PCO_2$ mmHg | 38.20± 0. 70[a] | 38.57± 0.61[a] | 38.40± 0.75[a] | NS |

Means within the same row followed by different letters a, b, c were statistically significant at p = 0.05 and the highest values were represented with the letter (a). - $HCO_3^-$: Bicarbonate. -PH: Power of hydrogen. -PCO2: partial pressure of carbon dioxide. -NS: Not significant

Cows with either left or right abomasum displacement had a non significant increase in the RBCs count, Hematocrit value and hemoglobin concentration. A significant increase in the total leukocytic count and neutrophils count was recorded in both groups but monocytes, lymphocytes, eosinophils and basophils counts showed non significant change compared to normal control (Table 1).

Serum total protein and albumin were decreased significantly but serum levels of total bilirubin, conjugated bilirubin, aspartate aminotransferase, alanine aminotransferase and malondialdehyde were increased significantly in both left and right abomasum displacement cows. The data showed that the effect of right displacement was more pronounced than left one (Table 2).


Fig. 1: Ultrasonographic examination of left displacement of abomasum in a cow imaged from 12th intercostal space. The rumen was displaced from the abdominal wall (1) by the abomasum (2). 3) ruminal wall, Ds) dorsal, VT) ventral

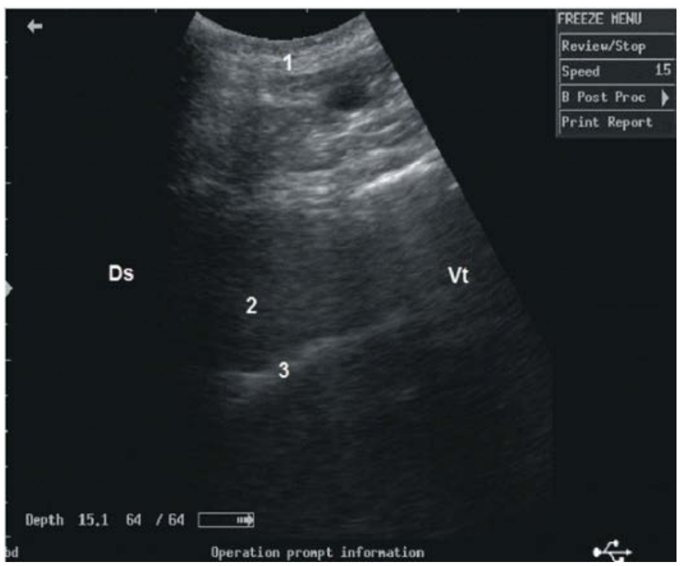


Fig. 2: Ultrasonographic examination of left displacement of abomasum (2) in a cow imaged from 12th intercostal space. The abomasum fold (3) was visible in the hypoechogenic ingesta. 1) abdominal wall, Ds) dorsal, VT) ventral

A significant hypocalcemia, hypokalemia and hypochloridemia were recorded in both abomasum displacement groups. Bicarbonate and power of hydrogen (PH) were increased significantly in the same groups compared with the normal healthy control. Serum sodium, anion gap and partial pressure of $CO_2$ ($PCO_2$) did not show significant change (Table 3).

Ultrasonographic findings revealed that, the wall of the rumen appeared as a thick echogenic line beside the wall of the abdomen in the ventral region. The rumen was displaced from the abdominal wall by the abomasum on moving the probe dorsally (Fig. 1).

Fluid ingesta within the abomasum appeared hypoechogenic at the ventral region where the abomasal folds were visible in cows as vague echogenic stripes (Fig. 2). Dorsally there was gas cap with characteristic reverberation artifacts which appeared as lines run parallel to the surface of the abomasum (Fig. 3). The lines of the reverberation artifacts were not visible at depth of 10 cm and they prevent visualization of the ruminal wall medial to the abomasum gas cap. Right abomasum displacement was diagnosed ultrasonographically in 10 Friesian cows, where the liver and intestine were displaced from the right abdominal wall by the abomasum and a dorsal gas cap

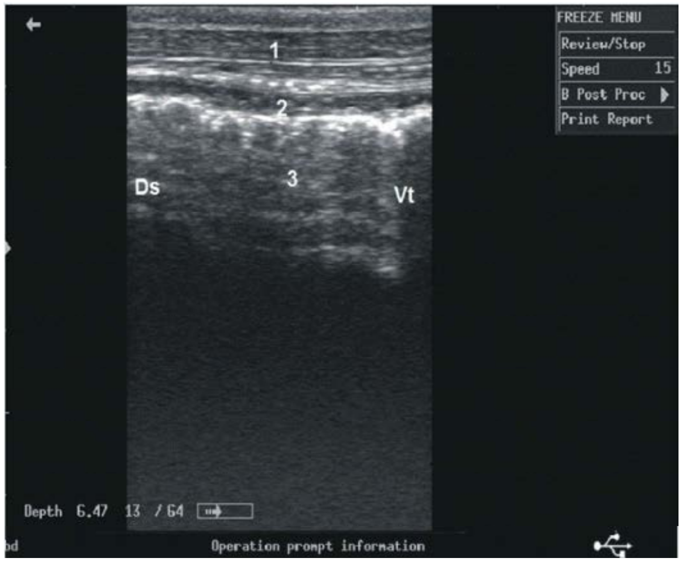


Fig. 3: Ultrasonographic examination of left displacement of abomasum in a cow imaged from the dorsal region of 12th intercostal space showed reverberation artifacts (3) 1) abdominal wall, 2) abomasum wall, Ds) dorsal, VT) ventral


Fig. 4: Ultrasonographic examination of right displacement of abomasum in a cow imaged from the right 12 intercostal space showing the interface (c) between reverberation artifact due to gas (b) and abomasum contents (d). a) abdominal wall, Ds) dorsal, VT) ventral

with a characteristic reverberation artifact was observed. The dorsal abomasum region appeared hypoechogenic in a cow with no gas cap. The ventral contents of the abomasum appeared hypoechoic and was differentiated from the dorsal reverberation artifacts at an interface between the ingesta and the gas cap (Fig. 4). This interface was viewed at the level of the costal arch in only 3 cows that cause distal acoustic shadow.

## DISCUSSION

Cows diagnosed with left abomasum displacement (n=28) were higher than those diagnosed with right displacement (10). This coincides with Constable *et al*. [5] as they stated that left DA is much more common than right DA. Clinical signs and clinical examination of studied cows were in accordance with findings of other studies [4, 29, 30].

Regarding to the erythrogram, abomasum displacement groups revealed non significant increase in the erythrocytic count, hemoglobin concentration and hematocrit value. Our results disagreed with Zanik [31], as he reported a significant increase in the hemoglobin concentration in cows with left and right DA. He attributed this increase to a state of hemoconcentration and dehydration. The leukocytosis, observed in the right and left displacement of the abomasum, can be attributed to neutrophilia. Such increase in the neutrophils count could be due to endotoxemia, abomasitis and peritonitis [31]. Also some investigators attributed the increase in the total leukocytic and neutrophils counts in cows suffered from abomasum displacement to the circulating bacteria, metabolic toxins and inflammation of peritoneum, uterus and udder [32, 33].

The proteinogram of abomasum displacement groups proved a significant hypoproteinemia and hypoalbuminemia. The hypoproteinemia and hypoalbuminemia may be due to the decreased feed intake and disturbed metabolism of the liver. Also endotoxemia results in an increase in the permeability of capillaries and shifting of albumin and colloids to outside the capillaries [34]. Moreover, hypoproteinemia and hypoalbuminemia were also recorded in abomasum displacement by several investigators [29, 35]. In our study, the significant increase in the serum activities of aminotransferases (AST and ALT) in both left and right displacement of the abomasum was associated with hepatocellular damage [36]. Metabolic disturbance have a strong effect on the function of liver of dairy cows [3]. The increased levels of liver enzymes may be due to hepatic lipidosis, endotoxemia and liver damage [31]. Also, Abd El-Raof and Ghanem [37] reported a significant increase in the serum activities of AST and ALT in cows suffered from displacement of the abomasum. Moreover, Geishauser *et al*. [38] recorded that the increased activity of serum AST at the first two weeks after parturition can help in the diagnosis of abomasum displacement. A significant increase in the serum levels of total and direct bilirubin was recorded in the second and third group. The hyperbilirubinemia is due to the significant increase in the direct bilirubin. From our opinion the significant increase in the conjugated bilirubin is due to bile duct obstruction which resulted from anatomical changes in the abomasum position. According to the observations of Zadnik [31], an increase in the size of gallbladder is usually present during reposition of the abomasum. The increased serum level of malondialdehyde in the second and third groups indicates increased lipid peroxidation and oxidative stress. The hypocalcaemia recorded in both abomasum displacement groups may be due to the development of metabolic alkalosis which is a risk factor for hypocalcemia via a reduced sensibility of the receptors for parathyroid hormone [39]. Our result added further support to that previously obtained by Abd El-Raof. and Ghanem [37] as they reported a significant hypocalcemia in cows suffered from abomasums displacement. Puerperal hypocalcaemia considered as an important predisposing cause for abomasum displacement [40, 41]. As hypocalcaemia decreases the abomasal motility which is the predisposing cause for abomasal displacement [11, 42].

The fore stomach of ruminant has the ability to absorb sodium so the sequestration of abomasal secretions that occurs in an obstruction may make this ion, to some extent, accessible to the plasma through this route [43]. This support the non significant change recorded in the serum level of sodium in both abomasum displacement groups. The serum levels of potassium and chloride were decreased significantly in case of DA [37, 43]. The concentration of chloride in the rumen and abomasum was increased during DA [38]. This indicates that the recorded hypokalemia and hypochloridemia were due to sequestration of abomasal contents [44]. There are three factors concerning metabolism associated with DA: hypocalcemia, metabolic alkalosis and negative energy balance [45]. Our results indicate presence of metabolic alkalosis in both abomasum displacement groups. This was clarified by the presence of a significant increase in the power of hydrogen (PH) and bicarbonate with non significant change in the anion gap and partial pressure of $CO_2$ ($PCO_2$). The small intestine does not secrete pancreatic bicarbonate without stimulation by the passage of nutrients so making an elevation in bicarbonate and producing metabolic alkalosis [3]. Metabolic alkalosis is accompanied by an accumulation of bicarbonate in the extracellular fluid as a result of sequestration of abomasal juice or potassium depletion as hydrogen ions move intracellular to replace the lost potassium [36].

The ultrasonographic findings were generally consistent and characterized by displacement of the rumen from the abdominal wall by abomasum in cases of left DA and displacement of liver in cases of right DA. Similar findings were reported by Dirksen [46].

In healthy cows, the abomasal contents had a uniform hypoechogenic appearance with echogenic stippling. While in displaced abomasum, the contents were not homogenous as the ventrally located ingesta were hypoechoic to echogenic with more distinct abomasal folds and the dorsal gas cap was characterized by reverberation artifact as mentioned by Braun and Feller [47]. In contrast to traumatic reticuloperitonities, ultrasonographic is not essential in displaced abomasum except in dubious cases [15] in which both percussion and auscultation were negative. Also in cases of caecal dilatation and intestinal ileus which have similar clinical signs and may be positive on swinging auscultation and percussion, ultrasonography is needed for accurate diagnosis [48, 49].

It could be concluded that special attention must be done at the first 6 weeks post parturition (period of high incidence).The presence of alterations in the liver function beside metabolic alkalosis during this period could be used as indicative for abomasum displacement. Also ultrasonographic examination is required for accurate diagnosis in doubtful cases. Moreover, abomasum displacement caused stress and increased lipid peroxidation so the using of antioxidants during the treatment of such cases is recommended.

## REFERENCES


1. Radostits, O.M., C.C. Gay, K.W. Hinchcliff and P.D. Constable, (Eds.) 2007. Diseases of the alimentary tract - II, Left-side displacement of the abomasum and Right-side displacement o the abomasum and Abomasal volvulus: Saunders Elsevier. Veterinary medicine, A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs and Goats, pp: 354-367.
2. Stengärde, L., 2010. Displaced Abomasum and Ketosis in Dairy Cows -Blood Profiles and Risk Factors. Ph.D. Thesis (Clinical Sciences) Faculty of Veterinary Medicine and Animal Science - Swedish University of Agricultural Sciences -Uppsala.
3. Dezfouli, M.M., Z. Eftekhari, S. Sadeghian, A. Bahounar and M. Jeloudari, 2013. Evaluation of hematological and biochemical profiles in dairy cows with left displacement of the abomasum. Comp Clin Path., 22: 175-179.
4. Stariè, J., H.S. Biricik, G. Aksoy and T. Zadnik, 2010. Surgical treatment of displaced abomasum in cattle using Ljubljana method. Acta Vet., 79: 469-473.
5. Constable, P.D., G.Y. Miller, G.F. Hoffsis, B.L. Hull and D.M. Rings, 1992. Risk factors for abomasal volvulus and left abomasal displacement in cattle. Am. J. Vet. Res., 53: 1184-92.
6. Breukink, H.J. and T. De Ruyter, 1976. Abomasal displacement in cattle: influence of concentrates in the ration on fatty acid concentrations in ruminal, abomasal and duodenal contents. Am. J. Vet. Res., 37: 1181-1184.
7. Doll, K., M. Sickinger and T. Seeger, 2009. New aspects in the pathogenesis of abomasal displacement. Vet J., 181: 90-96.
8. Lester, G.D. and J.R. Bolton, 1994. Effect of dietary composition on abomasal and duodenal myoelectrical activity. Res Vet Sci., 57: 270-6.
9. Wittek T., I. Sen and P.D. Constable, 2007. Changes in abdominal dimensions during late gestation and early lactation in Holstein-Friesian heifers and cows and their relationship to left displaced abomasum. Vet. Rec., 161: 155-61.
10. Delgado-Lecaroz, R., L.D. Warnick, C.L. Guard, M.C. Smith and D.A. Barry, 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: 301-305.
11. Radostits, O.M., I.G. Mayhew and D.M. Houston, 2000.Veterinary clinical examination and diagnosis, WB Saunders. London, pp: 440-444.
12. Shaver, R.D., 1997. Nutritional risk factors in the etiology of left displaced abomasum in dairy cows: a review. J. Dairy Sc., 80: 2449-2453.
13. Van Winden, S.C. and R. Kuiper, 2003. Left displacement of the abomasum in dairy cattle: Recent development in epidemiological and etiological aspects. Vet. Res., 34: 47-56.
14. Geishauser, T., K. Leslie and T. Duffield, 2000. Metabolic aspect in the etiology of displaced abomasum. Vet. Clin North Am Food Anim Pract., 16: 255-65.
15. Braun, U., N. Pusterla and M. Schönmann, 1997. Ultrasonographic findings in cows with left displacement of the abomasum. Vet. Rec., 141: 331-335.
16. Braun, U., 2003. Ultrasonography in gastrointestinal disease in cattle. Vet J., 166: 112-124.
17. Ok, M., M. Arican and K. Turgut, 2002. Ultrasonographic findings in cows with left and right displacement of abomasums. Revue Med. Vet., 153: 15-18.

18. Feldman, B.F., J.G. Zinki and V.C. Jain, 2000. Schalm's Veterinary Hematology, 5th Ed., Lippincott Williams and Wilkins, Canda; 2000.
19. Doumas, B.T., D.D. Bayse, R.J. Carter, T.J.R. Peters and R. Schaffer, 1981. A candidate reference method for determination of total protein in serum. I. Development and validation. Clin Chem., 27: 1642-50.
20. Drupt, F., 1974. Colorimetric method for determination of serum albumin. Pharm Biosciences, 9: 777.
21. Reitman, S. and S. Frankel, 1957. A colorimetric method for determination of serum AST and ALT. Am. J. Clin. Pathol., 25: 56.
22. Satoh, K., 1978. Serum lipid peroxide in cerebrovascular disorders determined by a new colorimetric method. Clin Chim Acta., 90(1): 37-43.
23. Glinder, E.M. and J.D. King, 1972. Rapid colorimetric determination of calcium in biological fluid with methyl thymol blue. Am. J. Clin. Path., 58: 376-382.
24. Hawk, P.B., 1965. Hawk's Physiological Chemistry. 4th Ed. Oser, B L, Mc. Grow-Hill, Inc New York.
25. Skeggs, L.T. and H.C. Hochstrasser, 1964. Colorimetric method for determination of serum chloride. Clin. Chem., 10: 918-920.
26. Scribner, B.H. and J.C. Caillouetter, 1954. Improved method for determination of bicarbonate in serum. J. Am. Med. Assoc., 155: 644-648.
27. Severinghaus, J.W., P. Astrup, J.F. Murray, 1998. Blood Gas Analysis and Critical Care Medicine. Am J. Resp Crit Care Med., 157: S114-22.
28. SAS, 2002. SAS/STAT users guide. SAS Institute INC, Cary, NC 27513, USA.
29. Sevinc, M., M. Ok and A. Basoglu, 2002. Liver function in Dairy Cows with Abomasal Displacement. Revue Méd Vét., 153: 477-480.
30. Constable, P.D., W. Grünberg, R. Staufenbiel and H.R. Stämpfli, 2013. Clinicopathologic variables associated with hypokalemia in lactating dairy cows with abomasal displacement or volvulus. J. Am. Vet. Med. Assoc., 242: 826-35.
31. Zanik, T.A., 2003. Comparative study of the hemato-biochemical parameters between clinically healthy cows and cows with displacement of the abomasums. Acta Vet., 53: 297-309.
32. Eades, S.C., 1993. Endotoxemia in dairy cattle: Role of eicosanoids in reticulorumen stasis. J. Dairy Sci., 76: 414-20.
33. Geishauser, T., 1995. Abomasal displacement in the bovine - a review of character, occurrence, etiology and pathogenesis. Zentralbl Veterinarmed A., 42: 229-51.
34. Cullor, J.S., 1992. Shock attributable to bacteremia and endotoxemia in cattle: clinical and experimental findings. J. Am. Vet. Med. Assoc., 200: 1894-1902.
35. Aslan, V., M. Ok, M. Boydak, I. Sen, F.M. Birdane and F. Alkan, 2003. The Study on the Relationship of Abomasal displacement and fatty liver syndrome in dairy cows. Acta Vet Scand., 1: 139.
36. Cole, E.H., 1986. Veterinary Clinical Pathology" 4th Ed., WB Saunders Company West Washington Square, Philadelphia, Toronto.
37. Abd El-Raof, Y.M. and M.M. Ghanem, 2007. Clinical, hemato-biochemical and ultrasonographic study in abomasal displacement in cows with trials of treatment. The Second Scientific Conference, Fac Vet Med., (Moshtohor), Benha University, pp: 290-307.38.
38. Geishauser, T., D. Reiche, C. Seeh, B. Thünker, S. Verwohlt and K. Failing, 1996. PH, sodium, potassium, magnesium, calcium, phosphate and chloride in the rumen and abomasal contents of cows with abomasal displacement. Dtsch Tierarztl Wochenschr., 103: 16-20.
39. Horst, R.L., J.P. Goff, T.A. Reinhardt and D.R. Buxton, 1997. Strategies for preventing milk fever in dairy cattle. J. Dairy Sci., 80: 1269-80.
40. Geishauser, T., K. Leslie, T. Duffield, D. Sandals and V. Edge, 1998. The association between selected metabolic parameters and left displaced abomasum in dairy cows. Zentralbl Veterinarmed A., 45: 499-511.
41. Houe, H., S. Østergaard, T. Thilsing-Hansen, R.J. Jørgensen, T. Larsen and T. Sørensen, 2001. Milk fever and subclinical hypocalcaemia. Acta. Vet. Scand., 42: 1-29.
42. Delgado-Lecaroz, R., L.D. Warnick, C.L. Guard, M.C. Smith and D.A. Barry, 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: 301-305.
43. Ward, J.L., D.F. Smith, S.L. Fubini and D.M. Deuel-Aromando, 1994. Evaluation of abomasal outflow diversion as an experimental model of hypochloremic, hypokalemic metabolic alkalosis in lactating cows. Can. J. Vet. Res., 58: 13-9.
44. Kaneko, J.E., W.J. Harvey and L.M. Bruss, 1997. Clinical Biochemistry of Domestic Animal. 5th ed., Academic Press Sandiego, California, USA, pp: 857-883.
45. Winden, S.V., 2002. Displacement of the abomasum in dairy cows - risk factors and pre-clinical alterations. Ph.D. Thesis (Animal Med.), Fac. Vet. Med., Dissertation Utrecht University, Netherlands.

46. Dirksen, G., 1990. Die Klinische Untersuchung des Rindes. 3rd edn. Eds G. Dirksen, H.-D. Grunder, M. Stober. Berlin, Paul Parey, pp: 338.
47. Braun, U. and B. Feller, 2008. Ultrasonographic findings in cows with right displacement of the abomasum and abomasal volvulus. Vet. Rec., 162: 311-315.
48. Braun, U., E. Amrein, U. Koller and C. Lischer, 2002. Ultrasonographic findings in cows with dilatation, torsion and retroflex ion of the caecum. Vet. Rec., 150: 75-79.
49. Braun, U., O. Marmier and N. Pusterla, 1995. Ultrasonographic examination of the small intestine of cows with ileus of the duodenum, jejunum, or ileum. Vet Rec., 137: 209-215.