

A comparative study on traumatic reticuloperitonitis and traumatic pericarditis in Egyptian cattle

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Abstract: This study was carried out on 15 Holstein cows divided into 3 groups of 5. Group 1 was the control, group 2 had traumatic reticuloperitonitis (TRP), and group 3 had traumatic pericarditis (TP). Comparison between the groups included clinical, hematological, biochemical, and ultrasonographic changes. TRP cows had arched backs, a sharp decrease in milk yield, and a reluctance to move, with abduction of the fore limbs. TP cows had edema of the brisket and submandibular region, with jugular vein distension and pulsation. TRP cows had a significant increase in PCV, leukocytes, and neutrophils, and a significant decrease in RBC, hemoglobin, and lymphocytic counts, as compared to the control group. TP cows had significant erythrocytopenia, leukocytosis, neutrophilia, monocytosis eosinopenia, and basopenia, and a significant decrease in the hemoglobin, lymphocytes, eosinophils, and basophils as compared to the controls. Serum AST, SLT, LDH, and CPK were significantly higher in the TP group than they were in the control and TRP groups. It was concluded that TP cows had more significant changes in hematology, biochemistry, ultrasonography, and histopathology than the TRP cows.

Key words: Cattle, pericarditis, reticuloperitonitis, traumatic

Introduction

Among the numerous diseases of foreign body syndrome in ruminant species, traumatic reticuloperitonitis (TRP) and traumatic pericarditis (TP) are the most common. TRP is a sporadic disease in ruminants caused by perforation of the reticulum due to ingestion of foreign materials, which is a common cause of abdominal surgery in cattle. Cattle are more susceptible to foreign body syndrome than small ruminants because they do not use their lips for prehension and are more likely to eat chopped feed (1). Lack of oral discrimination in cattle may lead to ingestion of foreign bodies that would be rejected by other species. Moreover, the honeycomb-like structure of the reticulum provides many sites for fixation of a foreign body, and contractions of the

reticulum may be sufficient to push a sharp foreign body through the wall, inducing the disease.

A study on cattle that included 60 traumatic reticulitis cases reported that TP was the most common sequela, occurring in 40 cases (2). This means that all cattle affected with TP also have TRP, as pericarditis is a major complication of reticuloperitonitis.

The present study aimed to compare the diagnosis of TRP and its most common complication (TP) because of the high incidence of foreign body syndrome in intensive cattle breeding in Egypt. Comparative diagnoses were based on clinical examination, hematological examination, biochemical analysis, and ultrasonographic

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examination, and were confirmed by PM and histopathological examinations.

Materials and methods

Animals

The study included 15 Holstein cows aged between 2 and 5 years. Tentative diagnosis of both TRP and TP was based on clinical findings and ultrasonographic examination. Data concerning age, number of days off feed, and number of days sick are presented in Table 1. Based on necropsy findings, the cows were classified into 3 groups of 5. Group 1 (control group) included 5 apparently healthy cows, group 2 included 5 cows with TRP, and group 3 contained 5 cows with TP. Routine clinical examinations were carried out and body temperature, pulse, and respiratory rate were recorded for each animal.

Clinical examination

All cows were subjected to a thorough clinical examination, as described by Rosenberger (3).

Pain test

Pain tests were conducted according to the methods of Rosenberger (3). Briefly, pain tests included the back grip test, pole test, and palpation for tenderness. To perform the back grip test, a fold of skin over the withers was pulled up so that the animal's back was suddenly pressed down. This displaced the organs in the region of the xiphoid cartilage and produced a painful reaction if fibrinous adhesions were present in that area. For the pole test, a pole 1-2 m long was placed under the animal and held at each end by 2 assistants. The pole was pulled upwards slowly, and then allowed to fall suddenly, starting at the xiphoid region and proceeding backwards at intervals of 1 handbreadth. For palpation for tenderness, a strong pressure was applied with a fist to the reticular projection field.

Hematological examination

Into heparinized tubes, 5 mL of blood was collected from each cow by venipuncture of the jugular vein for hematological examination. Examinations included determination of total and differential leukocytes (WBCs) and total erythrocytic count, PCV %, and Hb content (4).

Biochemical analysis

By puncturing the jugular vein 10 mL of blood was collected into test tubes without anticoagulant and left to clot, and then clear serum was obtained. Biochemical analysis included spectrophotometric determination of serum glucose level, serum total protein and fibrinogen level, serum potassium and sodium level, serum chloride, serum urea nitrogen, serum creatinine, serum calcium, serum phosphorus, AST and ALT, serum lactate dehydrogenase (LDH), and serum creatinine phosphokinase (CPK).

Ultrasonographic examination of the reticulum

Ultrasonographic examination of all cows was conducted, as previously described (1,5). The area over the reticulum, and the left and right sides of the thoracic cavity up to the elbow joints were clipped, and the remaining hair was removed using depilatory cream. To facilitate examination, transmission gel was applied and the cows were examined with 3.5-MHz linear and sector transducers.

Ultrasonographic examination of the heart

Echocardiography was performed according to Braun et al. (6). A 3.5-MHz sector transducer was applied to the cardiac area on both sides (4th intercostal space) and on the ventral midline.

Histopathological examination

After slaughtering the affected cows PM examinations were conducted, and specimens from the pericardium and myocardium were immediately collected into 10% neutral buffer formalin, and then

Table 1. Means and SD of ages, number of days off feed, and number of days sick for control, TRP, and TP cows.

Group Variable	Control group (n = 5)	TRP group (n = 5)	TP group (n = 5)
Age (years)	3 ± 1	2.5 ± 2	3.5 ± 1.5
Number of days off feed	none	15 ± 2.6	12.6 ± 4.8
Number of days sick	none	20.2 ± 4.5	15 ± 2.6

stained with H&E after routine processing for histopathological examination (7).

Statistical analysis

The obtained data are presented as mean \pm SD. The data were analyzed using one-way analysis of variance (ANOVA) to test for significant differences between the 3 groups using Sigma Stat v.3.1 software (SPSS, Inc., Chicago, IL, USA). The differences in means were considered statistically significant at $P < 0.05$.

Results

Clinical Findings

Cows with TRP had anorexia, arched back (Figure 1A), and a sharp decrease in milk production, were reluctant to rise or move (Figure 1B) and exhibited anxiousness. Abduction of the elbow joints was also

observed, indicating cranial abdominal pain (Figure 1C), as well as repeated chronic tympany. The TP cows had muffled heart sounds, jugular distension, and pulsation and edema of the brisket and submandibular regions (Figure 1D).

Physical examination

Rectal temperature in the cows with TRP and TP was significantly higher ($P < 0.05$) than in the control cows. The respiratory rate in the TRP and TP cows was significantly higher than in the controls. The pulse rate in the cows affected with TRP and TP was significantly higher than in the controls (Table 2).

Hematological examination

There was significant erythrocytopenia (reduced RBCs) and lower Hb concentrations in the cows with TRP and TP, as compared to the control group. On the other hand, PCV was significantly higher in the cows with TRP and TP than in the controls. Moreover,

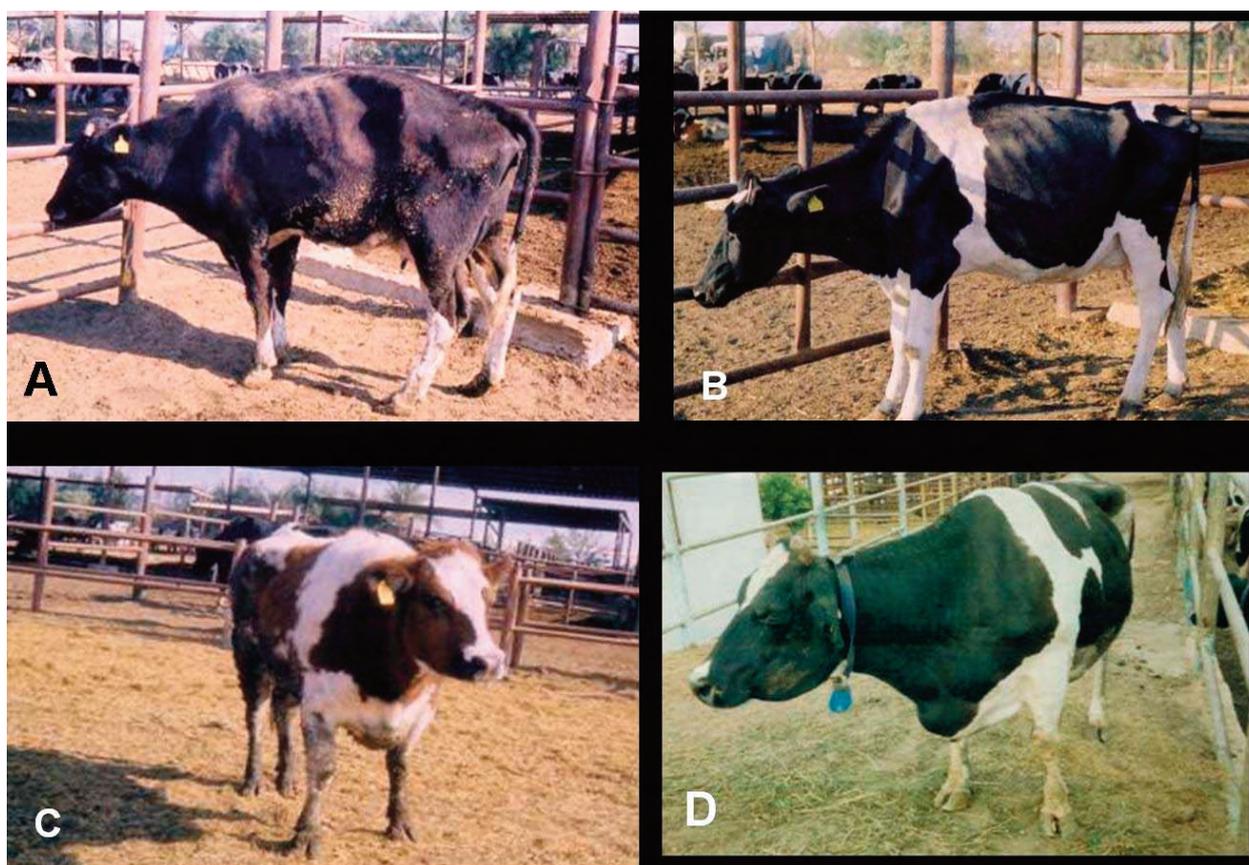


Figure 1. Cows with TRP had arched backs (A), reluctance to move (B), and abduction of the forelimbs (C). Cows with TP had severe dullness and depression, and edema of the brisket and submandibular regions (D) (arrows).

Table 2. Clinical examination of control cows, TRP cows, and TP cows.

Group Variable	Control group (n = 5)	TRP group (n = 5)	TP group (n = 5)
Rectal temperature	38.5 ± 0.4 ^a	39.5 ± 0.7 ^b	40.3 ± 0.5 ^b
Resp. rate /minute	36.2 ± 2.5 ^a	48.5 ± 4.5 ^b	51.0 ± 3.5 ^b
Pulse rate /minute	71.5 ± 3.5 ^a	89 ± 6.3 ^b	93.5 ± 5.8 ^b
Ruminal movement	3/2 min	1/2 min	1/2 min
Characters of feces	Semi-solid dark green flat cakes	Poorly digested and scanty	Firm scanty feces
Pain tests	Negative (no painful reaction)	Positive (painful grunting)	Positive (painful grunting)

One way analysis of variance is used. Values are represented by means ± SD. Different superscripts in the same row indicate a significant difference at P < 0.05

there was significant leukocytosis, neutrophilia, and lymphopenia in the cows with TRP, as compared to the controls. The cows with TP had significant leukocytosis, neutrophilia, and monocytosis, as compared to the control and TRP groups (Table 3).

Serum biochemical analysis

Sodium, potassium, and chloride levels were significantly lower in the cows with TRP and TP than in the controls; however, fibrinogen, AST, ALT, CPK, LDH, blood urea nitrogen, and creatinine were significantly higher in the TRP and TP groups than in the control group (P < 0.05). Enzymatic activity of AST and ALT was significantly higher in the TP group than in the TRP group, the level of CPK enzyme was significantly higher in the TP group than in the TRP group, and the glucose level was significantly lower in the TP group than in the control group (Table 4).

Ultrasonographic examination

Healthy bovine reticulum appeared half moon-shaped with a smooth contour. In the TRP group (Figure 2) ultrasonographic examinations showed fibrinous changes that appeared as echogenic deposits. Reticular abscesses were also seen as echogenic capsules with a hypoechoic center. None of the foreign bodies or magnets could be visualized. In the cows with TP there was hypochoic pericardial effusion interspersed with echogenic deposits, representing a fibrin mesh with medial displacement of the heart chambers away from the thoracic wall (Figure 3).

PM examination

In the TRP group we observed extensive fibrinous adhesions between the cranioventral aspects of the reticulum, the ventral abdominal wall, and the

Table 3. Hematological examination of control cows, cows with TRP, and cows with TP.

Group Variable	Control group (n = 5)	TRP group (n = 5)	TP group (n = 5)
RBCs (10 ⁶ /μL)	7.5 ± 0.3 ^a	6.2 ± 0.5 ^b	3.5 ± 0.6 ^c
Hemoglobin (g/dL)	9.8 ± 0.5 ^a	8.1 ± 0.3 ^b	7.3 ± 0.4 ^b
PCV (%)	34.6 ± 2.5 ^a	38.5 ± 2.1 ^b	39.6 ± 2.6 ^b
WBCs (10 ³ /μL)	8.7 ± 0.5 ^a	13.5 ± 0.4 ^b	19.8 ± 0.3 ^c
Differential count			
Neutrophils	3.2 ± 0.6 ^a	10.3 ± 0.2 ^b	15.5 ± 0.4 ^c
Lymphocytes	4.8 ± 0.3 ^a	2.5 ± 0.3 ^b	2.3 ± 0.2 ^b
Monocytes	0.5 ± 0.1 ^a	0.4 ± 0.2 ^a	0.7 ± 0.2 ^b
Eosinophils	0.05 ± 0.01 ^a	0.06 ± 0.01 ^a	0.02 ± 0.01 ^b
Basophils	0.03 ± 0.02 ^a	0.02 ± 0.001 ^a	0.088 ± 0.02 ^b

The values are represented by mean ± S.D. Different superscripts in the same row indicate a significant difference at P < 0.05

Table 4. The biochemical analysis in control cows, TRP cows, and TP cows.

Group Variable	Control group (n = 5)	TRP group (n = 5)	TP group (n = 5)
Sodium (mEq/L)	142.5 ± 1.4 ^a	124.8 ± 3.5 ^b	123.5 ± 2.8 ^b
Potassium (mEq/L)	4.6 ± 0.01 ^a	3.1 ± 0.5 ^b	2.9 ± 0.3 ^b
Chloride (mEq/L)	99.2 ± 3.0 ^a	79.5 ± 2.3 ^b	81.3 ± 2.5 ^b
Calcium (mg/dL)	9.8 ± 0.2 ^a	8.5 ± 0.6 ^b	8.1 ± 0.5 ^b
Phosphorus (mg/dL)	4.5 ± 0.3 ^a	4.0 ± 0.5 ^a	3.9 ± 0.6 ^a
Fibrinogen (g/dL)	0.6 ± 0.2 ^a	1.3 ± 0.3 ^b	1.5 ± 0.2 ^b
Total proteins (g/dL)	7.5 ± 1.8 ^a	7.8 ± 1.5 ^a	7.7 ± 1.3 ^a
AST (IU/L)	45.0 ± 6.3 ^a	65.5 ± 4.6 ^b	312 ± 15.5 ^c
ALT (IU/L)	17.8 ± 1.5 ^a	36.5 ± 1.8 ^b	263 ± 13.0 ^c
LDH (IU/L)	456.5 ± 4.5 ^a	506 ± 12.5 ^b	618 ± 21 ^c
CPK (IU/L)	65.6 ± 4.1 ^a	90.5 ± 3.8 ^b	198 ± 10.5 ^c
Blood urea nitrogen (mg/dL)	32.2 ± 3.5 ^a	38.5 ± 4.5 ^b	41.6 ± 5.2 ^b
Creatinine (mg/dL)	1.2 ± 0.4 ^a	2.5 ± 0.2 ^b	2.8 ± 0.3 ^b
Glucose (mg/dL)	53 ± 12.5 ^a	50.5 ± 10.0 ^a	35.8 ± 6.5 ^b

The values are represented by mean ± SD.

Different superscripts of the same raw indicate a significant difference at $P < 0.05$.

diaphragm. Adhesions and multiple abscesses were observed on either side of the reticulum. Large quantities of turbid, foul-smelling peritoneal fluid that contained fibrinous clots were present. The hearts in the TP group exhibited thickening of the pericardial sac. Cross sections of the pericardium and heart muscle showed thickening of the pericardium, with accumulation of pus between the pericardium and cardiac muscle (Figure 4).

Histopathological examination

There was thickening of the pericardium due to accumulation of fibrinous inflammatory exudate between the pericardium and myocardium. Under high power we observed a fibrinous network trapping inflammatory cells: mostly neutrophils and mononuclear cells. The myocardium in the TP cows had severe inflammatory cell infiltration replacing the cardiac muscle that had atrophied. Moreover, the myocardium of the cows severely affected by TP exhibited hyalinosis (Figure 5).

Discussion

In the present study clinical cases of cows with TRP and TP were diagnosed and compared to healthy control cows. Differentiation between TRP and TP was based on clinical, hematological, biochemical, and ultrasonographic changes. The diagnosis of TRP

and TP was later confirmed by postmortem examination.

The clinical signs we observed in the cows with TRP were similar to those previously reported (2,5,8). In cases in which the foreign body penetrated the diaphragm and reached the pericardium the cows had additional signs, including muffled heart sounds, jugular distension, and pulsation and edema of the brisket and submandibular regions (Figure 1D). These clinical signs may have been due to cardiac insufficiency resulting from septic pericarditis (9).

Based on physical examination of the cows (Table 2), significantly higher rectal temperature was observed in the cows with TRP and TP than in the controls, indicating a systemic reaction. The observed significant increase in the respiratory rate indicates respiratory distress associated with toxemia and septicemia caused by the foreign body penetration. These results are in agreement with those previously reported. Ruminal movements were markedly depressed (1 movement/2 min) compared to ruminal movements in the clinically healthy cows (3 movements/2 min), indicating significant hypomotility of the rumen in the cows with TRP and TP. These results are similar to those previously reported (8).

The hematological changes (Table 3) observed in the cows with TRP and TP are comparable to those

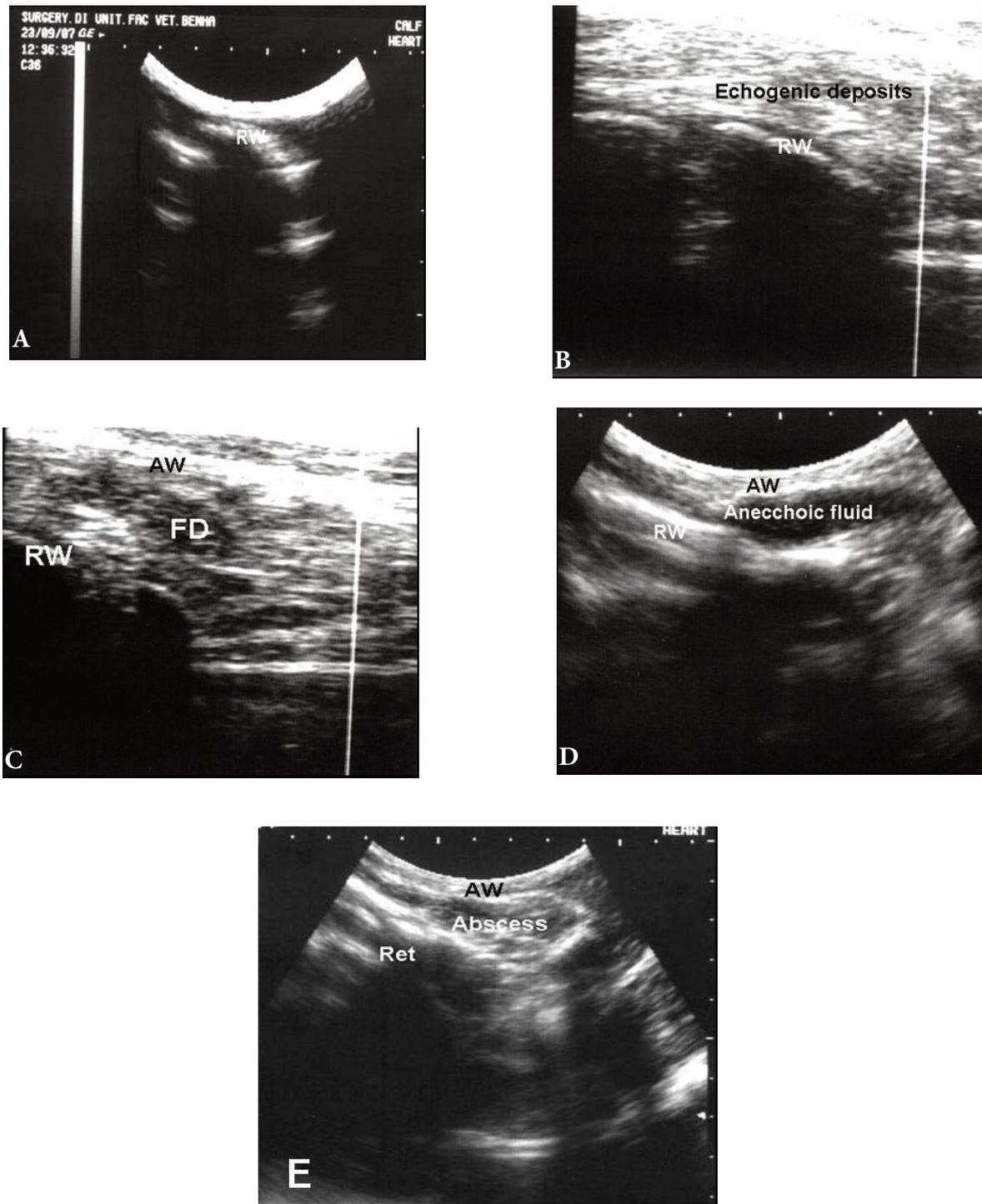


Figure 2. Ultrasonographic images of the reticulum in a control cow and cow with TRP viewed from the left ventral thorax. Image A shows the half moon-shaped structure of a normal reticulum. Image B shows the echogenic deposits between the ventral abdominal wall and the reticular wall (RW). Image C shows fibrin deposition (FD) between the ventral abdominal wall and the reticular wall (RW). Image D shows accumulation of anechoic fluid between the abdominal wall and the reticulum, suggesting abscessation. Image E shows an abscess with a circumscribed echogenic capsule (E); the reticular contents (RC) appear anechoic.

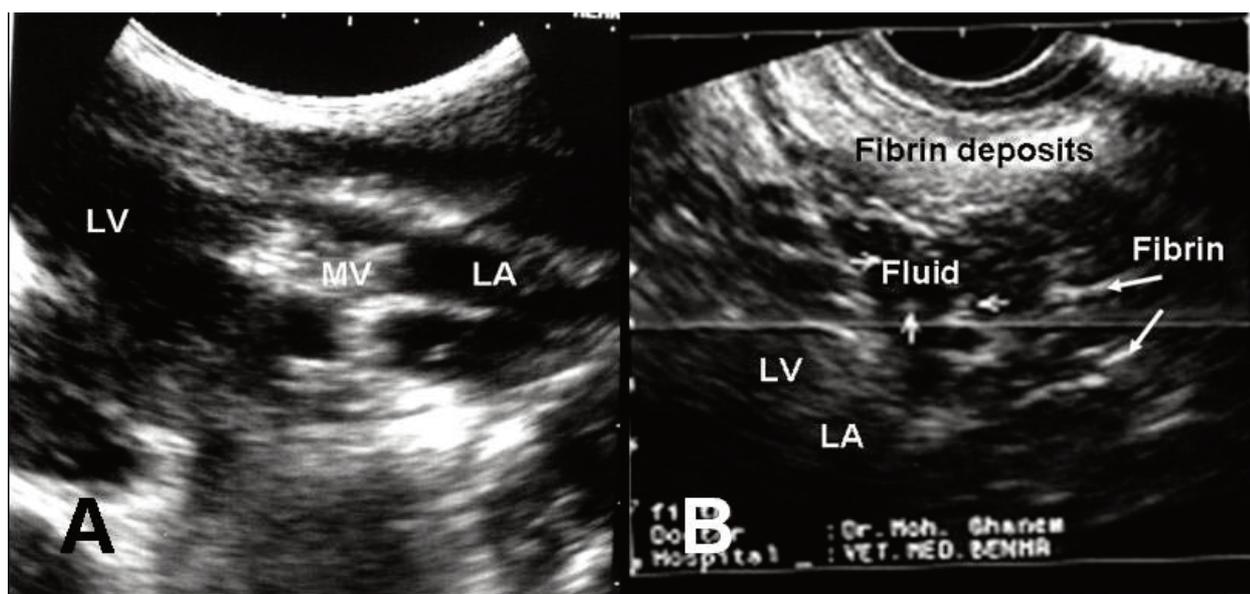


Figure 3. Echocardiography of a control healthy cow (A) and a cow with TP (B). Notice that the left ventricle (LV) is clearly separated from the left atrium (LA) by the mitral valve (MV), which has 2 clear leaflets, and all the chambers are localized directly after the thoracic wall. In the cow with TP hyperechoic fibrin deposits appear under the thoracic wall, followed by a fibrin mesh and anechoic fluid with medial displacement of the heart chambers away from thoracic wall.

previously noted (5,10,11). The observed reduction in RBCs and hemoglobin indicates anemia, which could be attributed to the loss of blood during penetration of the reticulum or the chronic inflammatory process (11). Nonetheless, the observed increase in hematocrit values could be attributed to dehydration associated with fluid loss due to the reduction of food and water intake in the animals with TRP and TP (3). Significant leukocytosis with neutrophilia was noted in the cows with TRP, which has been previously reported (5,12). Leukocytosis and neutrophilia were indicative of inflammatory responses that might have been due to infection associated with the penetration of the reticulum and diaphragm. On the other hand, there was significant lymphopenia, which might have been due to a reduction in cellular immunity associated with the stress of penetration (8). In the TP cows there was significant leukocytosis, neutrophilia, and monocytosis, as compared to the control and TRP groups, indicating that the TP cows had many of the characteristics of a large internal abscess, which induces a more severe response (8). In contrast, there was lymphocytopenia and eosinopenia, which are consistent with previous reports (8).

Serum electrolyte analysis (Table 4) showed significant reductions in the levels of sodium, potassium, and chloride in the cows with TRP and TP, which was attributable to ruminal hypomotility and/or vagal indigestion. Hypokalemia might be attributed to anorexia, but might also be exacerbated by ion exchange caused by alkalosis and/or abomasal reflux into the rumen. In the present study the Ca concentration was significantly lower in the TRP and TP cows than in the controls, whereas the phosphorus concentration did not differ significantly. These results are consistent with previous reports. The concentrations of these elements have been reported to vary in cattle with TRP (13). Hypocalcemia can occur due to reduced calcium uptake as a result of illnesses that affect the appetite and decrease its absorption (14). Therefore, hypocalcemia observed in the present study probably developed in association with gastrointestinal stasis and insufficient dietary uptake, as previously reported (15).

Biochemical examination of serum (Table 4) showed a significantly higher ($P < 0.05$) fibrinogen level in the TRP and TP groups, as compared to the control group, which might have been due to its

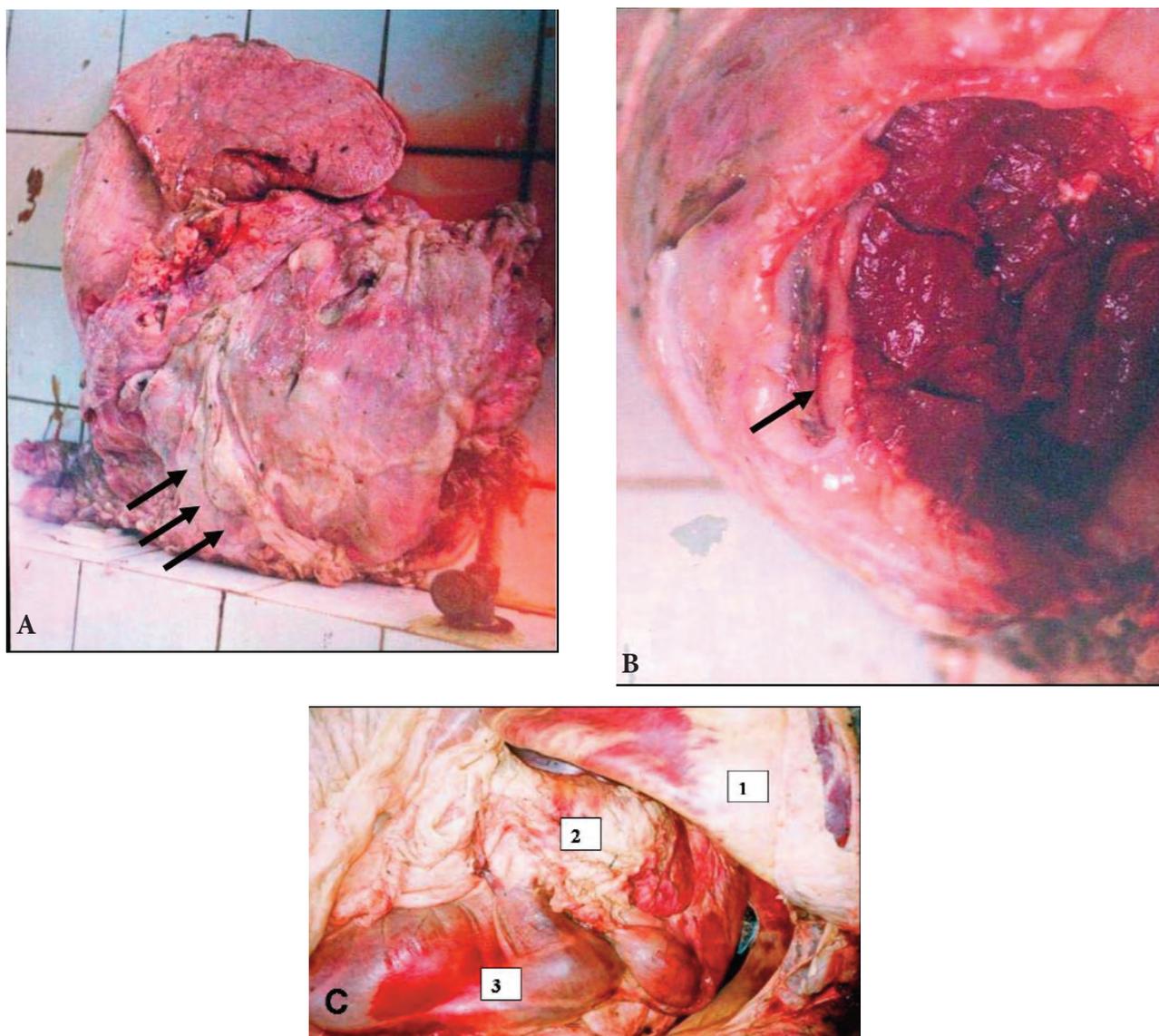


Figure 4. PM examination of cows with TP and TRP. (A) The heart of a cow with TP shows thickening of the pericardial sac (arrows). (B) A cross section of the pericardium and heart muscle shows thickening of the pericardium, with accumulation of pus between the pericardium and cardiac muscle. (C) A cow with TRP shows suppurative inflammation with extensive fibrous adhesions. 1: Abdominal wall; 2: fibrous adhesion; 3: reticulum.

enhanced hepatic synthesis as the result of a severe inflammatory process following foreign body penetration (14). The level of total protein was not significantly different between the groups, although it was slightly higher in the TRP and TP groups, probably due to dehydration.

The enzymatic activity of AST and ALT was significantly higher ($P < 0.05$) in the cows with TRP and TP than in the controls. The increase in liver

enzymatic activity suggests that TRP is associated with impaired hepatic function that might be due to hepatic damage secondary to TRP. These results are in agreement with those previously reported (7). The enzymatic activity of AST and ALT was significantly higher in the TP group than in the TRP group, suggesting that more severe damage to the liver and muscles is associated with TP. Moreover, serum enzymatic activity of creatine phosphokinase (CPK)

and lactate dehydrogenase (LDH) in the cows with TRP and TP was significantly higher than in the controls. Increased CPK activity in serum generally indicates that skeletal and cardiac muscles are affected (12). It was also observed that the level of CPK enzyme was significantly higher in the TP group than in the TRP group, which may indicate that the release of the enzyme is higher than expected when myocardial cells (in addition to skeletal muscle) are involved in the pathogenesis (16). Inflammation and damage to the myocardium was later confirmed by histopathological examination. On the other hand, it has been demonstrated that the LDH level increases after injury to the liver, skeletal muscle, cardiac

muscle, and kidney (16); therefore, the significant increase of this enzyme in the TRP group may suggest that these organs were affected. Additionally, the LDH level was significantly higher in the TP group than in the TRP group, which might have been due to the severity of skeletal and cardiac muscular damage, in addition to liver and kidney involvement in the cows with TP.

The levels of blood urea nitrogen and creatinine were significantly higher in the TRP and TP cows than in the controls, which might have been due to renal insufficiency that resulted from dehydration and a reduction of renal blood flow with subsequent prerenal azotaemia (8).

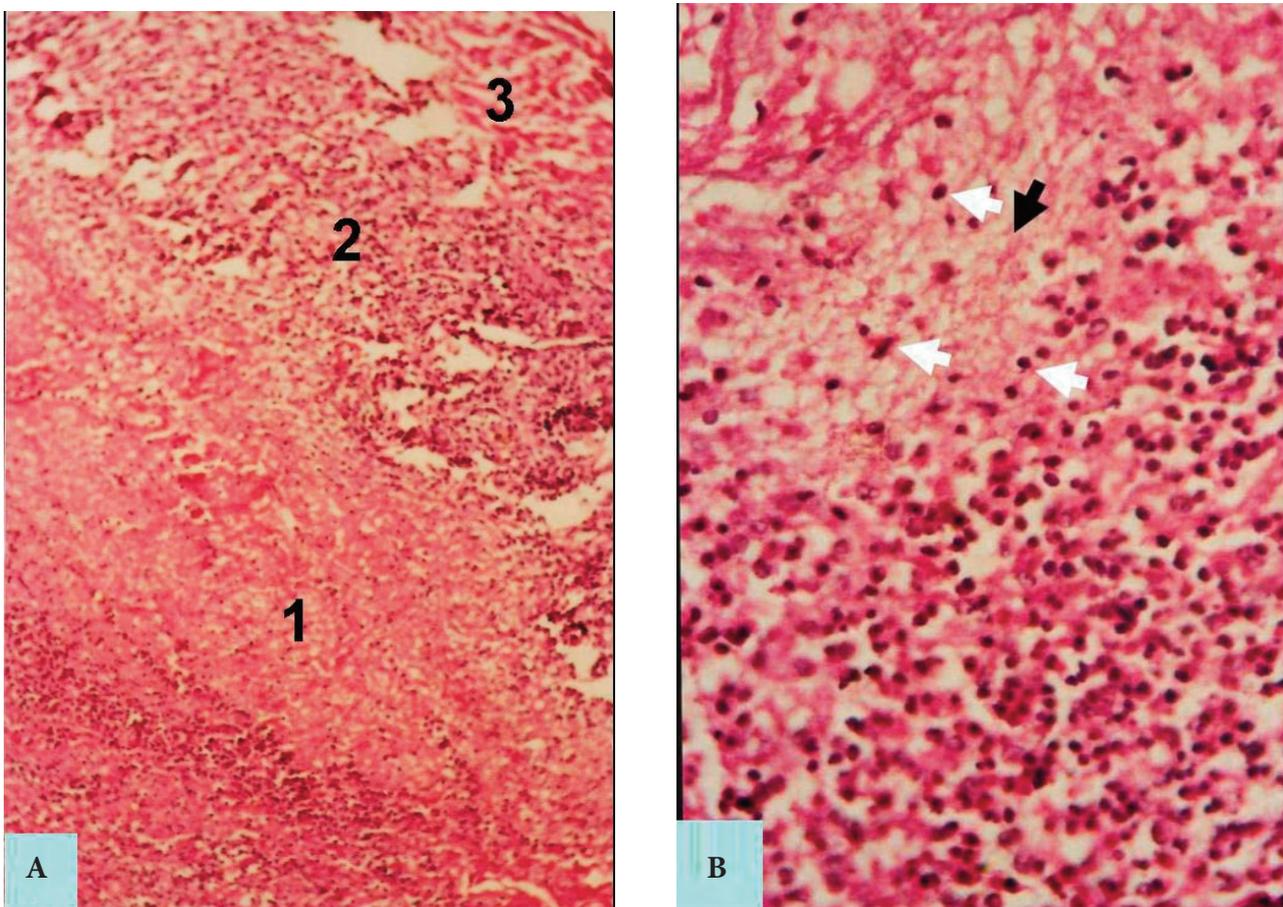


Figure 5. Histopathological examination of cows with TP. Image A depicts the pericardium of a cow with TP and shows thickening of the pericardium (1) due to accumulation of fibrinous inflammatory exudate (2), which is apparent between the pericardium and myocardium (3) (H&E 200 \times). Image B is a high power version of image A and depicts the fibrinous network (black arrow) trapping inflammatory cells (white arrows): mostly neutrophils and mononuclear cells (H&E 400 \times). Image C shows that the myocardium of cows with TP had severe inflammatory cell infiltration (blue arrows) replacing atrophied cardiac muscle (yellow arrows) (H&E 400 \times). Image D is the myocardium of a TP cow with hyalinosis (yellow arrows) (H&E 400 \times).

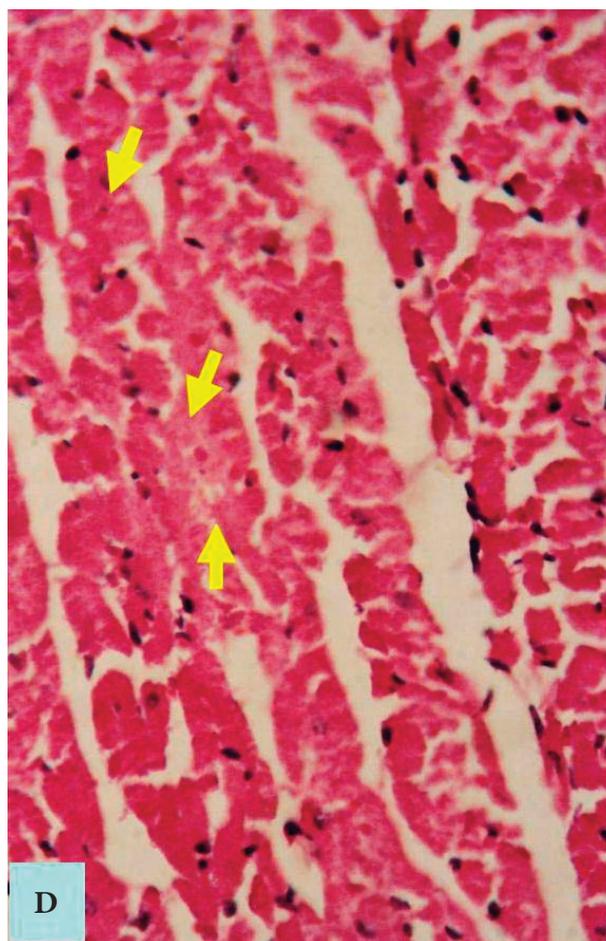
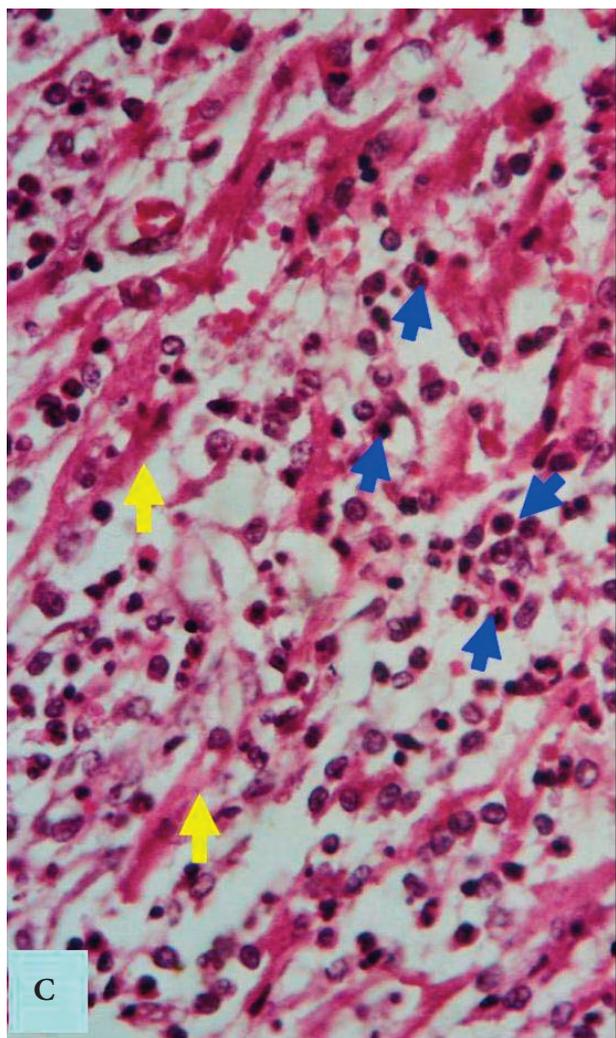


Figure 5. Cont.

The glucose level was significantly lower in the TP cows than in the controls. This result has been previously reported (10). The observed reduction in the glucose level might have been due to the anorexia observed in the cows with TP and subsequent starvation. Moreover, it has been reported that hepatogenic disorders due to circulatory deficiency (as occurs in dehydration) may be accompanied by decreased plasma glucose (4).

Based on ultrasonographic examination the healthy bovine reticulum appeared half moon-shaped, with a smooth contour (Figure 2) that contracted at regular intervals. Reticular contents are partially gaseous and thus cannot normally be seen with ultrasonography. These ultrasonographic findings of the normal bovine reticulum were similar

to those previously recorded (5). In the TRP group (Figure 2) ultrasonographic examinations showed fibrinous changes that appeared as echogenic deposits. Reticular abscesses were also observed as echogenic capsules with a hypoechoic center. None of the foreign bodies or the magnets could be visualized ultrasonographically because of the accumulation of fibrinous exudate. These findings are in accordance with those of other studies (5). An ultrasonogram of a cow with TP (Figure 3) shows hypoechoic pericardial effusion interspersed with echogenic deposits representing a fibrin mesh with medial displacement of the heart chambers away from the thoracic wall. This result is comparable to that obtained in other studies (5). On the other hand, in the control group the left ventricle was clearly

separated from the left atrium (LA) by the mitral valve (MV), which has 2 clear leaflets, and all the chambers were visualized directly under the thoracic wall.

The diagnosis of TRP and TP in the present study was confirmed after PM examination (Figure 4). There were extensive fibrinous adhesions between the cranioventral aspects of the reticulum, the ventral abdominal wall, and the diaphragm. Adhesions and multiple abscesses were observed on either side of the reticulum. Large quantities of turbid, foul-smelling peritoneal fluid that contained fibrinous clots were present. These PM findings are similar to those previously reported (8,9).

Histopathological examination (Figure 5) showed thickening of the pericardium due to accumulation of fibrinous inflammatory exudate, which was apparent between the pericardium and myocardium. With high magnification there was a fibrinous network observed to trap inflammatory cells: mostly neutrophils and mononuclear cells. Likewise, the myocardium of the cows with TP had severe inflammatory cell infiltration replacing cardiac muscle that had atrophied. Moreover, the myocardium of the cows severely affected by TP exhibited hyalinosis. These

histopathological changes confirm the occurrence of pericarditis and myocarditis in the cows with TP, and support our echocardiographic findings. These changes are similar to those previously reported (17).

In conclusion, taken as a whole the data recorded in the present study indicate that TRP and TP induced clinical, hematological, and biochemical changes in the affected cows. To date, this is the first comprehensive study to compare TRP and TP in cattle. TP induced more significant changes in the WBC (leukocytosis) and neutrophils (neutrophilia), and in the level of certain enzymes, such as liver (ALT and AST) and muscle (CPK and LDH) enzymes, suggesting a more toxemic and septicemic reaction. The diagnosis of these cases was differentiated and confirmed by ultrasonographic examination of the reticular and cardiac areas. Moreover, the effects of TRP and TP were confirmed by PM and histopathological examination.

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