Research Article

Laboratory, Radiographic and Ultrasonographic Findings of Acute Traumatic Reticuloperitonitis in Buffaloes (*Bubalus bubalis*)

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Abstract

**Background and Objective:** Traumatic reticuloperitonitis (TRP) is one of the most important diseases in buffaloes. The study objective is to describe the clinical, laboratory, radiographic and ultrasonographic findings in buffaloes suffering from acute (TRP). **Methodology:** This study was carried out on 20 apparently normal buffaloes (control group) and 20 buffaloes with acute TRP (diseased group). Full case history was obtained and all animals were subjected to thorough clinical examination, pain tests and electronic metal detector, complete blood pictures, blood serum biochemical analysis, radiographic and ultrasonographic examinations. Rumenotomy was performed in 13 affected buffaloes. **Results:** Diseased buffaloes showed sudden onset of anorexia, sharp drop in milk yield, fever, ruminal atony, constipation, increased respiratory and heart rates. Moreover, the animals were reluctant to lie down or move. Out of 20 diseased buffaloes, 17 had positive pain tests and 14 had positive metal detection. All diseased buffaloes shared marked leucocytosis associated with neutrophilia and shift to the left. A significant increase in the serum level of AST (p>0.05) was the only abnormal serum biochemical analysis. Radiographic examination revealed metallic foreign objects in the reticulum of seven buffaloes, normal sized and shaped heart with clear margins. The main ultrasonographic findings of diseased buffaloes included changes in the shape, contour and contraction of the reticulum. Buffaloes with acute TRP had a reticulum either with its even contour and its half-moon shaped structure (n = 14) or slight loss of its shape with slight loss of its contour (n = 6). The diseased buffaloes had biphasic reduced reticular contractions (1.9±0.6/5 min). The reticulum was displaced from the diaphragm with a distance of 0.7-3.4 cm in 17 buffaloes. However, reticular abscess was not imaged, peritoneal effusions were imaged in 16 buffaloes. **Conclusion:** Buffaloes with acute TRP show characteristic and complementary clinical, laboratory, radiographic and ultrasonographic findings which are helpful for diagnosis and follow up this disease.

**Key words:** Buffaloes, hardware disease, reticulum, traumatic reticuloperitonitis, ultrasonography

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

Traumatic reticuloperitonitis (TRP) is one of the most important diseases in buffaloes particularly in developing countries resulting in high economic losses. It develops as a consequence of perforation of the reticulum\textsuperscript{1,2}. Buffaloes commonly ingest foreign objects due to loss of discrimination against metal objects in their feed and incomplete mastication of feed before swallowing. The swallowed metallic objects fall directly or indirectly into reticulum and the honeycomb-like reticular mucosa allows trapping of the sharp foreign objects. Contractions of the reticulum facilitate penetration of the wall by the foreign objects and consequently allow leakage of ingesta and bacteria into the peritoneal cavity resulting in TRP\textsuperscript{3,4}.

Preliminary diagnosis of digestive disorders in ruminants could be achieved by ordinary diagnostic procedures such as visual inspection, palpation, percussion and auscultation\textsuperscript{5}. However, recent advances such as radiography, ultrasonography and laparoscopy have been applied for diagnosis of TRP in cattle and buffaloes\textsuperscript{6}.

Radiography is an efficient technique for identifying metal foreign bodies, whereas ultrasonography rarely identifies metallic objects including magnets. Radiography is best suited for the detection of metallic foreign bodies in and outside the reticulum and the position of the foreign body is the most reliable indicator for diagnosing TRP by radiography. In contrast, ultrasonography is the method of choice for detecting fibrinous deposits and abscesses that cannot be detected by using radiography. Although, neither radiography nor ultrasonography alone achieve a complete definitive diagnosis of TRP, the two techniques complement one another well\textsuperscript{7,8}.

On last few years ultrasound has been used successfully for diagnosis of various surgical affections in buffaloes\textsuperscript{9-12}. Ultrasonography provided exact information concerning the various sequelae of TRP in cattle and buffaloes\textsuperscript{13}. Moreover, ultrasonography made it possible to determine the location and extent of the lesions accurately, the site best suited for abdomino and thoraco-centesis\textsuperscript{1,3}. 

Differentiation between acute TRP, Traumatic Pericarditis (TP), other diseases marked by stasis of the gastrointestinal tract, other causes of peritonitis, particularly perforated abomasal ulcers and other acute inflammatory conditions such as nephritis, endocarditis and metritis is a challenge in the veterinary practice. The differential diagnosis of these diseases was based on clinical, hematological, biochemical and ultrasonographic changes in bovine\textsuperscript{14}.

Several studies have been conduct on chronic TRP\textsuperscript{11,15,16} however, there are scarce studies concerned with acute TRP in buffaloes. Accordingly, the present study aimed to describe the clinical, laboratory, radiographic and ultrasonographic findings in buffaloes suffering from acute TRP.

MATERIALS AND METHODS

Animals: This study was carried out on 40 buffaloes that classified into two groups. These groups included control group (n = 20) and TRP diseased group (n = 20). The control group was selected from healthy non-pregnant females buffaloes belonged to the herd of veterinary teaching hospital and from the neighboring villages around Assiut city, Egypt. The control group had 15 buffaloes with 5-7 years old and 5 heifers with 1-2 years old. The diseased buffaloes were treated in accordance with guidelines established by Faculty of Veterinary Medicine, Assiut University Committee on Animal Care. Legal and ethical requirements have been met with regards to the human treatment of animals described in the study. A complete case history was obtained for all diseased buffaloes.

Clinical examination: All buffaloes underwent a thorough clinical examination described before\textsuperscript{17}. Pain tests and electronic metal detector were applied in all diseased buffaloes.

Blood sampling: Whole blood and serum samples were collected and all precautions of sample collections and preparation for accurate evaluation of hematological and biochemical indices were taken into consideration as reported before\textsuperscript{18}.

Complete Blood Count (CBC) assessment: A fully automated blood cell counter machine (Medonic CA620 Vet hematology analyzer-Sweden) was used to determine various hematological parameters. Differential Leukocytic Count (DLC) was determined using four field meander method\textsuperscript{19}.

Biochemical assays: Spectrophotometric method using Phillips Pye Unicam spectrophotometer (U.V. Visible Mod. 800) was adopted to determine serum concentrations of liver enzymes: Aspartate aminotransferase (AST), γ-glutamyl transferase (GGT) and alkaline phosphatase (AP), serum total protein, serum albumin, cholesterol and triglycerides (TG). Serum globulin was determined by subtraction of albumin from total protein and its value was used to calculate
Albumin/Globulin ratio (A/G ratio). All kits and reagents were obtained from spectrum reagents (Egyptian Company for Biotechnology, Egypt).

**Radiographic examination:** Radiography was performed in recumbent position according to the method described before under the effect of xylazine hydrochloride (Xylaeject®, ADWIA-Egypt) at a dose of 0.05 mg kg⁻¹ b.wt. All radiographic examinations were performed using fixed radiographic apparatus (Philips, super 80 CP). The radiographic setting factors included 60-70 kVp, 50-60 mA and 75-90 cm FFD for imaging of the caudal thoracic and cranial abdominal region.

**Ultrasonographic examination:** All internal organs of diseased and healthy buffaloes were examined ultrasonographically by using a 3.5 MHz sector transducer (FF Sonic, Model UF-4000, Tokyo, Japan) to detect either the normal organs in the control animals or the affected one in diseased buffaloes. The examined organs included heart, reticulum, rumen, abomasum, omasum, spleen, liver, right kidney and intestines⁴.

**Rumenotomy:** It was performed after radiography and ultrasonography in 13 buffaloes with acute TRP. Rumenotomy was carried out using Weingarth’s ring technique⁵.

**Statistical analysis:** Data were analyzed using statistical software program. All data were presented as Mean±Standard Deviation (SD). Analysis of variance of the obtained data was done and significance level was set at p<0.05.

**RESULTS**

**Clinical findings:** The mean admission time was 2±0.8 days from the onset of the disease. The diseased buffaloes showed sudden onset of anorexia, sharp drop in milk yield, fever 39±0.7°C (normal: 38.3±0.4°C), decreased ruminal motility 0.5±0.2/2 min (normal: 2.7±0.5/2 min), rapid shallow thoracic respiration 35±1.7 min⁻¹ (normal: 24±3.1 min⁻¹), increased heart rate 76.4±6.1 min⁻¹ (normal: 71.5±3.7 min⁻¹) and emaciation (Fig. 1). Moreover, the animals were reluctant to lie down or move and suffered from constipation. Mucous membranes including conjunctiva were moderately congested or normal and episcleral capillaries were moderately engorged or filled with absence of true jugular pulsation. Out of 20 diseased buffaloes, 17 had positive pain tests and 14 had positive metal detection.

**Laboratory findings:** All data are collected in Table 1. Blood picture indicated that all buffaloes with acute TRP shared marked leucocytosis associated with neutrophilia and shift to the left (increase population of immature neutrophils). A
A significant increase in the serum level of AST (p<0.05) was the only abnormal serum biochemical analysis.

**Radiographic findings:** In all control buffaloes, lateral radiographs of the reticulum showed no metal objects inside.

<table>
<thead>
<tr>
<th>Indices</th>
<th>Control group (n = 20)</th>
<th>TRP group (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBCs (T/L) (× 10^6)</td>
<td>7.54±2.98</td>
<td>6.62±4.13</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>38.00±3.24</td>
<td>32.93±3.52</td>
</tr>
<tr>
<td>Hb (g L⁻¹)</td>
<td>118.00±4.50</td>
<td>133.30±12.4</td>
</tr>
<tr>
<td>TWBCs (g L⁻¹) (× 10^9)</td>
<td>6.71±1.63</td>
<td>22.53±3.76</td>
</tr>
<tr>
<td>Neutrophiles (%)</td>
<td>26.40±9.13</td>
<td>50.50±3.76</td>
</tr>
<tr>
<td>Lymphocytes (%)</td>
<td>60.80±7.73</td>
<td>33.75±4.86</td>
</tr>
<tr>
<td>Monocytes (%)</td>
<td>7.80±4.63</td>
<td>7.25±2.50</td>
</tr>
<tr>
<td>Eosinophiles (%)</td>
<td>3.60±2.07</td>
<td>4.75±1.21</td>
</tr>
<tr>
<td>Band cells (%)</td>
<td>1.40±0.52</td>
<td>3.75±1.06*</td>
</tr>
<tr>
<td>Total proteins (g L⁻¹)</td>
<td>94.70±10.7</td>
<td>96.70±7.40</td>
</tr>
<tr>
<td>Albumin (g L⁻¹)</td>
<td>55.00±8.40</td>
<td>56.10±5.90</td>
</tr>
<tr>
<td>Globulin (g L⁻¹)</td>
<td>45.70±6.60</td>
<td>40.60±4.60</td>
</tr>
<tr>
<td>A/G ratio</td>
<td>1.38±0.59</td>
<td>1.59±0.40</td>
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<tr>
<td>GGT (U L⁻¹)</td>
<td>14.95±5.23</td>
<td>14.41±2.33</td>
</tr>
<tr>
<td>AP (U L⁻¹)</td>
<td>36.11±8.40</td>
<td>41.81±4.34</td>
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<tr>
<td>AST (U L⁻¹)</td>
<td>32.92±4.77</td>
<td>91.20±8.96*</td>
</tr>
<tr>
<td>Cholesterol (mmol L⁻¹)</td>
<td>106.77±10.96</td>
<td>89.33±7.41</td>
</tr>
<tr>
<td>TG (mmol L⁻¹)</td>
<td>3.62±0.20</td>
<td>3.27±0.91</td>
</tr>
</tbody>
</table>

*Significant (p<0.05), TRP: Traumatic reticuloperitonitis, RBCs: Total red blood corpuscles, PCV: Packed cell volume, Hb: Haemoglobin concentration, TWBCs: Total white blood cells count, A/G:Albumin/globulin ratio, AST: Aspartate aminotransferase, AP: Alkaline phosphatase, GGT: Gamma-glutamyl transferase and TG: Triglycerides

Radiography had a diagnostic significance in seven buffaloes with acute TRP. It usually showed normal sized and shaped heart with clear margins. The reticulum was either free from any metallic foreign bodies (Fig. 3) or containing metal foreign objects (Fig. 4).

**Ultrasoundographic findings:** Ultrasoundographic findings in buffaloes with acute TRP were restricted only to the reticulum without extension to any other organ. The reticulum was usually with either its even contour and half-moon shaped structure (n = 14) or slight loss of its shape and contour (n = 6) due to thickening in the reticular serosa with echogenic fibrinous deposits interspersed with hypoechoic pockets of exudates commonly imaged caudoventral to the reticulum and sometimes cranially or laterally (Fig. 5a). The mean reticular thickness was 1.5±0.2 cm (normal: 0.5±0.06 cm).

In buffaloes with acute TRP, the reticulum displaced from the diaphragm and abdominal wall by echogenic fibrinous deposits (Fig. 5b) and by a fibrinous echogenic mass (Fig. 5c) for a distance about 0.7-3.4 cm (2.8±0.6 cm) between the reticulum and abdominal wall. There was a

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Fig. 2(a-b): (a) Lateral radiographic view of the cranial abdomen, (b) Caudal thorax of a 3-years-old non-pregnant buffalo showing normal radiographic appearance of reticulum, heart and diaphragm, 1: Heart, 2: Diaphragm, 3: Reticulum and 4: Sternum.
Fig. 3(a-b): (a) Lateral radiographic view of the cranial abdomen, (b) Caudal thorax of a 4-years-old pregnant buffalo with acute TRP showing free reticulum, clear diaphragmatic line, normal sized and shaped radiopaque heart, 1: Heart, 2: Diaphragm, 3: Reticulum and 4: Sternum

significant reduction in the reticular contractions to 1.9±0.6/5 min (normal: 4.75±0.4/5 min).

All diseased buffaloes had no reticular abscess meanwhile, peritoneal effusions were usually imaged in 16 animals. Peritoneal effusions appeared as accumulation of echogenic fibrinous deposits forming echogenic tree (Fig. 5d) or echogenic band (Fig. 5e) ventrally to the reticulum and dorsally to the ventral abdominal wall.
Fig. 5(a-e): (a) Ultrasonograms of buffaloes with acute TRP imaged from the left ventral thorax showing slight thickening and corrugation in the reticular serosa, (b) Loss of even contour and half-moon shaped structure of the reticulum and displaced reticulum due to accumulation of fibrinous deposits and hypoechoic exudates caudoventral and cranial to the reticulum or due to echogenic fibrinoid mass between reticulum and diaphragm, (c) 1: Abdominal wall, 2: Diaphragm, 3: Musculophrenic vein, 4: Reticulum, 5: Thickening in the reticular serosa, 6: Echogenic fibrinous mass, (d) Ultrasonogram of a 7-year-old buffalo with acute TRP imaged from the left ventral aspect of the thorax showing uneven reticular serosa with loss of its half-moon shaped structure, displacement of the reticulum with peritoneal effusions in the form of echogenic fibrinous tree (e) Echogenic bands, 1: Abdominal wall, 2: Reticulum, 3: Peritoneal effusions, 4: Echogenic fibrinous tree and 5: Echogenic fibrinous bands (extended from reticular serosa to abdominal wall). These findings are summarized in Table 2.

Rumenotomy revealed the presence of ropes, small parts of rubber bags in the rumen, nails, pins and wires in the reticulum. Absence (n = 3) or presence (n = 10) of adhesions between the reticulum and surrounding organs including the diaphragm was also detected in 13 operated buffaloes. No diaphragmatic hernia was recorded in all diseased buffaloes.

**DISCUSSION**

Foreign body syndrome in buffaloes is still a challenge in veterinary practices all over the world22-24. Hardware disease
synonymously known as TRP or Sharp Foreign Body Syndrome (SFBS) is a common and serious disease in buffaloes particularly in developing countries due to bad management of the animals. Unfortunately, foreign body syndrome is the major problem facing the bovine producers all over Egypt and results in devastating economic losses.

The present study was conducted only on buffaloes with acute TRP. The diagnosis of acute TRP depended mainly upon case history and clinical, laboratory, radiographic and ultrasonographic findings in comparison with normal buffaloes.

The recorded clinical findings in buffaloes with acute TRP agreed with those reported in cattle before. All recorded clinical signs could be attributed to acute inflammatory changes induced by penetration of the reticulum by the sharp foreign body.

In the present study, electronic metal detector could identify metal objects in the reticulum but did not distinguish between perforating and nonperforating foreign bodies. Additionally, it could not detect sharp non metallic foreign objects. Similar findings were also reported before.

Although, not always necessary, laboratory findings may be helpful in the diagnosis of acute TRP. Blood pictures showed marked leucocytosis associated with neutrophilia and shift to the left in buffaloes with acute TRP. This is in agreement with a previous study.

In buffaloes with acute TRP, there was a significant increase in serum level of AST. In this respect, previous study demonstrated that haematological picture and serum biochemical profiles in cases of TRP showed changes which could be used as a diagnostic tool because it reported highly significant increase in blood globulin and fibrinogen levels and decrease in albumin and plasma protein: Fibrinogen ratio (PP:F)28. However, the blood levels of Total Plasma Protein (TPP) and Plasma Fibrinogen (PF) increase among cattle with TRP and those with other gastrointestinal diseases. Meanwhile, Benjamin29 reported that the changes in hematological and biochemical parameters such as elevation of blood fibrinogen, aspartate aminotransferase and alkaline phosphatase were indicative of inflammatory changes in the body and not restricted only to traumatic reticulo-peritonitis/pericarditis.

Braun et al.25 explained the importance of radiography as an aid in the diagnosis of TRP in cattle while Braun et al. compared ultrasonographic and radiographic findings in cows with TRP. In this respect, radiography could be a confirmed tool for diagnosis of acute TRP when visible metallic foreign bodies such as nails, needles and pins, present beyond the border of the reticulum, unattached to the magnet in the reticulum and positioned off the floor of the reticulum. However, radiography failed to either identify inflammatory changes that occurred on the reticular serosa, reticular abscesses and non metallic sharp objects like glasses, contraction and relaxation of the reticulum. Moreover, the portable radiographic machines unable to penetrate the area of reticulum of the standing adult buffalo therefore, the affected animal may need to be transported to where there is a radiographic unit with sufficient power. During radiographic examination, the animal should not be positioned in dorsal recumbency to avoid the stress on adhesions and diffuse peritonitis due to gravitational spread of infection.

Ultrasonography should be used simultaneously with radiography for the diagnosis of acute TRP in buffaloes. In this study, there was no case with positive radiography and had negative ultrasonography. Conversely, there were several cases with positive ultrasonography and had negative radiography. The foreign bodies in these cases could be displaced posterior to the reticulum or of non metallic nature.

Ultrasonography is considered as a very beneficial and easy tool for diagnosis of TRP in buffaloes. The examination is conducted on standing, non-sedated animals for visualization of physiological and pathological conditions of the reticulum in cattle and buffaloes suffered from TRP. The current study also reported that ultrasonography in some cases of acute TRP particularly those of mild degree was diagnostic without the aid of radiography through its ability to detect the reduction in the reticular contractions. Slight peritoneal effusions and moderate disruption in the even contour of the reticulum wall with slight loss of its half-moon shape and thickening in the reticular serosa were also observed. These results relatively agreed with previous studies. Although, other studies recorded metallic foreign bodies by ultrasound, no foreign body could be imaged by ultrasound in this study. This could be attributed to the small number of the examined buffaloes in this study. Ultrasonographically, metallic foreign body appeared as hyper echogenic structures penetrating the wall of reticulum with comet tail artifact.

The acute TRP cases were characterized by certain ultrasonographic findings, mainly restricted to the reticulum including the contour, shape and contraction of the reticulum. This is due to short time between the onset of the disease and the admission of animals for treatment. The loss of shape and contour of reticulum is due to accumulation of fibrinous deposits interspersed with pockets of exudates on the serosa of the reticulum. The displacement of reticulum from diaphragm and abdominal wall is also due to accumulation of fibrinous deposits and masses between the
reticulum, abdominal wall and diaphragm. Reduction of the reticular contraction compared to control animals could be attributed to adhesions. No reticular abscess was imaged in this study. This could be attributed to early admission of the affected buffaloes for treatment. Other ultrasonographic finding is peritoneal effusions which appeared as accumulation of echogenic fibrinous deposits forming echogenic tree or echogenic bands extending from reticular serosa to abdominal wall. Similar findings had been reported in cattle12.

Rumenotomy was carried out in 13 diseased buffaloes for justification of diagnosis and removal of foreign objects. Rumenotomy confirmed all radiographic and ultrasonographic findings. The owners of other diseased buffaloes refused rumenotomy.

There are several sequelae to acute TRP in buffaloes including chronic localized or diffuse TRP, reticular, splenic, hepatic, abdominal and thoracic abscesses, traumatic pericarditis, diaphragmatic hernia, traumatic pleuropneumonia, vegal indigestion and acute haemorrhage with sudden death. Ultrasonography is the most accurate tool for the differential diagnosis of these complications13.

Several measures have been recommended to prevent TRP in buffaloes including passing feed over magnets, avoiding the use of baling wire, keeping buffaloes away from areas of new construction, removal of old fences and buildings, administration of a rumen magnet and reapplication of a second new magnet four years later in animals at high risk4,30.

CONCLUSION

Buffaloes with acute TRP show characteristic and complementary clinical, laboratory, radiographic and ultrasonographic findings which are helpful for diagnosis and follow up this affection.

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