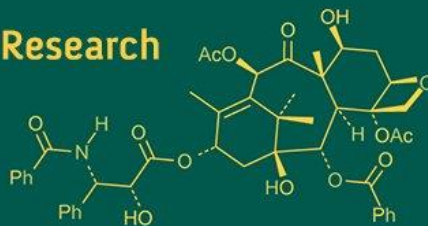
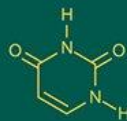
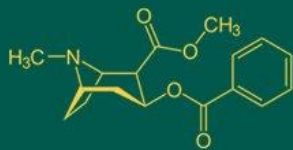


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Divyam Choudhary
Department of Veterinary
Medicine, CSK Himachal
Pradesh Agriculture
University, Palampur,
Himachal Pradesh, India

Ajay Katoch
Department of Veterinary
Medicine, CSK Himachal
Pradesh Agriculture
University, Palampur,
Himachal Pradesh, India

Ankur Sharma
Department of Veterinary
Medicine, CSK Himachal
Pradesh Agriculture
University, Palampur,
Himachal Pradesh, India

Amit Kumar
Department of Veterinary
Surgery and Radiology, CSK
Himachal Pradesh Agriculture
University, Palampur,
Himachal Pradesh, India

Adarsh Kumar
Department of Veterinary
Surgery and Radiology, CSK
Himachal Pradesh Agriculture
University, Palampur,
Himachal Pradesh, India

Corresponding Author:
Divyam Choudhary
Department of Veterinary
Medicine, CSK Himachal
Pradesh Agriculture
University, Palampur,
Himachal Pradesh, India

Multimodal diagnostic assessment of traumatic Reticuloperitonitis in cattle and buffaloes: Clinical manifestations, Haematological and biochemical profiles, radiographic insights, and ultrasonographic evaluation

Divyam Choudhary, Ajay Katoch, Ankur Sharma, Amit Kumar and Adarsh Kumar

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Abstract

Traumatic Reticuloperitonitis (TRP) is a significant disorder in ruminants, particularly cattle and buffaloes, caused by the ingestion of sharp metallic objects leading to perforation of the reticulum. This study assessed the prevalence, clinical presentation, and diagnostic approaches for TRP in 7 cases (4 cattle and 3 buffaloes) out of 729 animals presented, revealing a prevalence of 0.96%. Clinical findings included complete anorexia, brisket edema, jugular pulsation and absent rumination in all animals. Physiological deviations showed elevated heart rate, respiration rate, and absence of rumen motility. Haematological examination revealed leukocytosis, neutrophilia, and elevated platelet counts, while biochemical profiles showed elevated glucose, BUN, AST, and ALP levels, indicating systemic inflammation and compromised liver and renal functions. Rumen fluid analysis revealed elevated pH, yellowish-brown watery consistency, and reduced protozoal motility. Radiographs detected metallic foreign bodies in 75% of cattle and 66.67% of buffaloes, confirming reticular perforation into the thoracic cavity. Ultrasonographic findings supported peritoneal and pericardial effusions, indicating severe inflammation. This study emphasizes the importance of early diagnosis using radiography, ultrasonography, and haematological markers for the effective management of TRP in ruminants.

Keywords: Diagnosis, foreign body, radiography, reticulum, traumatic Reticuloperitonitis

Introduction

Traumatic Reticuloperitonitis (TRP), commonly referred to as "hardware disease," is a prevalent and economically significant disorder in ruminants, especially cattle and buffaloes. It occurs when sharp foreign objects, such as nails or pieces of wire, are ingested and become lodged in the reticulum. The reticulum's contractions can cause these objects to perforate its wall, leading to localized or diffuse peritonitis, abscess formation, or severe conditions like diaphragmatic hernia and pericarditis.

Despite improvements in farm management and the use of preventive measures like ruminal magnets, TRP continues to affect cattle and buffalo populations. The incidence of TRP has decreased over the past decades, with prevalence rates ranging from 2% to 12% in different studies (Braun *et al.*, 2020 ^[13]; Waldner *et al.*, 2009) ^[29]. In buffaloes, the prevalence can be higher, especially in regions where metal debris is common, posing a persistent risk (Gerspach *et al.*, 2011) ^[16]. Clinical signs of acute TRP include fever, anorexia, reduced rumen motility, and abdominal pain, while chronic cases may present with subtle and less specific symptoms, making early diagnosis challenging.

Recent advancements in diagnostic techniques, particularly radiography and ultrasonography, have greatly enhanced the ability to detect foreign bodies and associated reticular injuries. Treatment options range from conservative management with magnets and antibiotics to surgical intervention in advanced cases. However, timely diagnosis and appropriate management remain critical to reducing the economic impact of TRP on livestock production.

This study investigates the clinical signs, haemato-biochemical findings, diagnostic approaches, and This study investigates the epidemiology, clinical signs and diagnostic approaches.

Materials and Methods

This study was conducted at the Department of Veterinary Medicine, Teaching Veterinary Clinical Complex, College of Veterinary & Animal Sciences, CSKHPKV, Palampur, from June 2022 to November 2023. A total of 729 bovines (618 cattle and 111 buffaloes) were presented. Based on history, clinical signs, and physical examination, 7 animals (4 cattle and 3 buffaloes) were confirmed to have thoraco-abdominal disorders, including traumatic reticulo-peritonitis (TRP). Detailed signalment, including species, age, sex, and duration of illness, was recorded. History from owners included primary complaints, onset of clinical signs, appetite, water intake, and defecation characteristics. General clinical examinations were performed to assess physiological parameters (heart rate, respiration, rectal temperature, rumen motility), conjunctival mucus membrane colour, hydration status, and thoracic auscultation.

Blood samples were collected for haematological and biochemical analyses. Haematological parameters were measured using the Mindray BC-5000 Vet Auto Hematology Analyzer, while biochemical parameters such as ALT, AST, ALP, GGT, total bilirubin, glucose, total protein, BUN, and creatinine were analyzed using the Agappe Mispa CXL Pro Plus analyzer. Rumen liquor was collected and analyzed for colour, odour, consistency, protozoal count, motility, and pH.

Radiographic examinations of the thorax and abdomen were performed using the Allengers HF MARS 80 system, focusing on the diaphragm, reticulum, and sternum. Ultrasonography was conducted using the SonoSite M Turbo system to examine the reticulum and pericardium. Data were statistically analyzed using Prism 9, with comparisons made using the t-test and ANOVA at 1% and 5% significance levels.

Results

This study investigated the diagnosis of traumatic reticuloperitonitis (TRP) in cattle and buffaloes presented. Six apparently healthy cattle and buffaloes were selected to serve as healthy control for comparison.

Managemental History and Clinical Observations

The managemental history and clinical observations in cattle and buffaloes suffering from TRP are presented in table I.

In this study, all cattle ($n = 4$) and buffaloes ($n = 3$) exhibited complete anorexia and absence of water intake, indicating severe systemic involvement due to Traumatic Reticuloperitonitis (TRP). A sharp reduction in milk yield and absence of rumination were observed in 100% of the cases. The duration of illness was predominantly between 6-10 days in buffaloes, while cattle had varied illness duration. Recurrent bloat was reported in 50% of cattle and 33.33% of buffaloes. Defecation was absent in all cattle and most buffaloes. Both species were largely stalled, with no significant dietary changes reported. The managemental history and clinical observations are presented in table I and II, respectively.

In cattle ($n = 4$), jugular pulsation and brisket oedema were present in all cases, along with signs of weakness (75%) and kyphosis (75%). Half of the cattle appeared dull, while others were alert. Scanty and mucoid faeces were observed in all cattle. Buffaloes ($n = 3$) had better overall body condition, with 66.67% displaying normal general condition, and only one showing dullness. Unlike cattle, none of the buffaloes showed jugular pulsation, but brisket oedema was present in 66.67%. Both species showed signs of dehydration and displayed scanty, mucoid faeces. With a pinch test was positive in three cattle and two buffaloes. Auscultation of thoracic region revealed muffled heart sound in majority of the affected cattle and buffaloes.

Physiological parameters

The physiological parameters of cattle and buffaloes suffering from TRP are presented in table II. Cattle and buffaloes with Traumatic Reticuloperitonitis (TRP) exhibited significant deviations in clinical parameters when compared to healthy animals. In cattle, the diseased group showed a notable increase in heart rate ($82.5 \pm 3.07/\text{min}$) and respiration rate ($53.75 \pm 6.25/\text{min}$), while rumen motility was completely absent (0/3 min). Similarly, buffaloes displayed a significantly higher rectal temperature ($103.10 \pm 0.1^\circ\text{F}$, $p < 0.01$) and respiration rate ($45.00 \pm 1.00/\text{min}$, $p < 0.01$) compared to healthy counterparts. Both species demonstrated markedly reduced rumen motility, indicative of severe digestive disturbances caused by TRP.

Hemato-biochemical Changes

The hemato-biochemical changes in cattle and buffaloes suffering from TRP are presented in table III.

In TRP cases, leukocytosis, neutrophilia, and elevated hematocrit were observed. Significant increases in ALP, AST, BUN, and glucose levels were also noted in TRP-affected animals.

Cattle and buffaloes with Traumatic Reticuloperitonitis (TRP) exhibited significant haematological alterations compared to healthy controls. Total leukocyte count (TLC) was significantly elevated in diseased cattle ($20.4 \pm 1.82 \times 10^3/\mu\text{L}$, $p < 0.01$) and buffaloes ($19.85 \pm 1.55 \times 10^3/\mu\text{L}$). Neutrophil counts were markedly increased in both species, with buffaloes showing the highest value ($75.81 \pm 1.49\%$, $p < 0.01$), while lymphocyte percentages decreased significantly in affected animals. Additionally, eosinophil percentages were lower in diseased buffaloes ($0.7 \pm 0.03\%$, $p < 0.01$). Platelet counts were notably elevated in both cattle and buffaloes with TRP. Thin smear examination of blood sample revealed presence of large immature neutrophils (Plate 1) indicative of left shift.

Cattle and buffaloes suffering from Traumatic Reticuloperitonitis (TRP) exhibited significant changes in biochemical profiles. Blood glucose levels were significantly higher in both species, with buffaloes showing a significant rise ($105.06 \pm 1.36 \text{ mg/dL}$, $p < 0.01$) compared to healthy controls. Elevated BUN levels were noted, particularly in buffaloes ($48.02 \pm 4.32 \text{ mg/dL}$), indicating compromised renal function. AST levels were elevated in buffaloes ($335.33 \pm 204.93 \text{ U/L}$), suggesting extensive tissue damage. Additionally, buffaloes displayed a significant increase in total bilirubin ($0.77 \pm 0.07 \text{ mg/dL}$, $p < 0.05$), pointing to possible liver dysfunction. In cattle, ALP levels were higher in the diseased group ($147.84 \pm 28.38 \text{ U/L}$) compared to healthy animals.

Rumen Liquor Examination

The rumen liquor examination presented in table IV revealed a significantly elevated pH in cattle with TRP (7.50 ± 0.27 , $p < 0.05$) compared to healthy controls (6.67 ± 0.13). Similarly, buffaloes with TRP showed yellowish-brown rumen fluid and watery consistency in 75% and 100% of cases, respectively. Protozoal count and motility were severely reduced, with 100% of buffaloes showing poor motility. In contrast, healthy cattle and buffaloes had normal green-coloured, slightly viscous rumen fluid, with high protozoal motility (+ + +) in the majority of cases.

Radiographic and Ultrasonographic Findings

Radiographic findings are presented in table V. Radiographs revealed the presence of sharp foreign bodies penetrating the reticulum in TRP cases (Plate 2 and 3). Radiographic examination revealed that 75% of cattle (3/4) and 66.67% of buffaloes (2/3) had sharp metallic foreign bodies penetrating through the reticulum into the thoracic cavity. Additionally, one case in both cattle and buffaloes showed a foreign object lying close to the sternum, penetrating through the diaphragm and positioned near the apex of the heart. These findings underscore the severity of reticular perforation and its extension into the thoracic cavity in TRP-affected animals.

Ultrasonographic findings confirmed peritoneal and pericardial effusions in advanced TRP cases (Plate 4 and 5). The sonograms showed echogenic complex effusions and fibrinous material within the peritoneal cavity, indicated by arrows. Additionally, the pericardial sac was notably dilated, containing complex effusions and fibrinous deposits, which are characteristic of severe pericarditis secondary to TRP.

Discussion

Managemental History & Clinical Observations

The clinical signs observed in this study, such as complete anorexia, reduced rumination, decreased milk yield, and recurrent bloat, were consistent with previous reports by Singh (2008) [25], Abdelaal *et al.* (2009) [3], Athar *et al.* (2010a) [7], 2010b [8], 2010c), Braun (2009) [11], Hussain *et al.* (2021c) [18], and Kumar *et al.* (2022) [20]. These studies documented similar systemic involvement and digestive disturbances in cattle and buffaloes suffering from Traumatic Reticuloperitonitis (TRP), confirming the presence of typical symptoms like reduced feed intake and ruminal stasis. The clinical signs of TRP, such as anorexia and abdominal pain (e.g., kyphosis and grunting), result from the inflammatory response triggered by sharp metallic foreign bodies penetrating the reticulum. This causes localized or generalized peritonitis, leading to significant digestive dysfunction, further compounded by fever, reduced motility, and spread of inflammation to surrounding organs like the diaphragm and liver.

Physiological Parameters

The elevated heart rate (tachycardia), respiration rate (tachypnea), and rectal temperature in this study align with the findings of Athar *et al.* (2010b) [7], Braun *et al.* (2018) [12], 2020), and Hussain *et al.* (2021c) [18]. Both cattle and buffaloes exhibited significant deviations in these physiological parameters, suggesting severe systemic inflammation and GI stasis typical of TRP. Tachycardia occurs as the body attempts to maintain circulation amidst the pain, dehydration, and potential septicemia. Meanwhile,

increased respiration rates result from discomfort and the presence of effusions in the thoracic cavity, complicating normal breathing. Elevated rectal temperature represents the febrile response to the infection and inflammation resulting from the reticular wall's perforation by a foreign object.

Hemato-biochemical Changes

Leukocytosis, neutrophilia, and elevated hematocrit levels observed in this study are consistent with previous research from Radostits *et al.* (2007) [24], Athar *et al.* (2010c) [8], Mohammed (2010) [21], Hussain *et al.* (2011) [19], Braun *et al.* (2018) [12], and Hussain *et al.* (2021c) [18]. These studies reported similar patterns of systemic inflammation and stress in animals suffering from TRP, with neutrophilia being a significant indicator of the body's response to foreign material. The increase in immature neutrophils (left shift) points to a severe infection demanding rapid production of white blood cells. Elevated hematocrit levels suggest dehydration due to decreased water intake and fluid losses from inflammation.

The increases in ALP, AST, BUN, and glucose levels observed in the study mirror the findings of Mohammed (2010) [21], Hussain *et al.* (2011) [19], Tharwat *et al.* (2012) [27], Braun *et al.* (2018) [12], 2020), and Hussain *et al.* (2021c). These changes suggest liver and kidney dysfunction associated with inflammation from TRP. ALP and AST are liver enzymes that increase when the liver is affected, often due to inflammation near the reticulum. Elevated BUN reflects impaired kidney function, possibly resulting from the inflammatory response and dehydration. Additionally, elevated glucose levels represent a stress-induced response, as cortisol secretion increases glucose production to help the body fight infection and inflammation.

Rumen Liquor Examination

The elevated rumen pH and reduced protozoal motility in TRP-affected animals noted in this study align with reports from Brar (2004) [9], Aref *et al.* (2017) [5], Braun *et al.* (2018) [12], and Vijayakumar *et al.* (2022) [28]. The disrupted rumen fermentation process due to decreased feed intake, especially roughage, results in reduced volatile fatty acid production and higher rumen pH. The watery consistency of rumen fluid, along with the decreased microbial activity, reflects compromised digestive function as TRP interferes with normal rumen motility and fermentation patterns.

Radiographic and Ultrasonographic Findings

Radiographic confirmation of sharp foreign bodies penetrating the reticulum in this study corroborates the findings of Braun (2008, 2009) [11], Chaudhri *et al.* (2009) [15], Athar *et al.* (2010b) [7], Hussain *et al.* (2011), Arora *et al.* (2013) [6], Braun *et al.* (2020), and Kumar *et al.* (2022). Radiographic evidence revealed the foreign bodies causing peritonitis, with some cases showing complications like pericardial effusion. The foreign bodies are often visualized penetrating the reticular wall or lying free in the reticulum, indicating the cause of localized or diffuse peritonitis and subsequent complications like pleural effusion or pericarditis.

Ultrasonographic evaluations revealing pericardial and peritoneal effusions in this study are consistent with findings from Abdelaal *et al.* (2009) [3], Abouelnasr *et al.* (2012) [4], Mostafa *et al.* (2015) [22], Pal (2017), Abd El Raouf *et al.* (2020), and Kumar *et al.* (2022) [20]. The presence of

fibrinous deposits and complex effusions in the pericardial cavity indicates advanced stages of TRP, where inflammation has spread to adjacent tissues.

Ultrasonography's ability to detect reticular motility, abscesses, or adhesions makes it a critical diagnostic tool for identifying severe complications related to TRP.

Table 1: Major findings in cattle and buffaloes with Traumatic reticulo-peritonitis (TRP)

Parameter	Observation	Cattle (n = 4)	Buffalo (n = 3)
Appetite	Anorexia	4 (100%)	3 (100%)
Water intake	Absent	4 (100%)	3 (100%)
Change in milk yield	Sharp reduction	4 (100%)	3 (100%)
Rumination	Absent	4 (100%)	3 (100%)
Duration of illness	6-10 days/>10 days	1 (25%)/2 (50%)	3 (100%)
Bloat	Recurrent	2 (50%)	1 (33.33%)
Defecation frequency	Absent	4 (100%)	2 (66.67%)
Type of feeding	Stallfed	2 (50%)	3 (100%)
General body condition	Weak	3 (75%)	1 (33.33%)
Jugular pulsation	Present	4 (100%)	-
Brisket oedema	Present	4 (100%)	2 (66.67%)
Kyphosis	Present	3 (75%)	-
Abdominal distension	Bilateral	2 (50%)	1 (33.33%)
Dehydration	Severe	2 (50%)	-
Type of faeces	Scanty and Mucoid	4 (100%)	3 (100%)
Mucus in faeces	Present	4 (100%)	3 (100%)
Bruxism (Teeth grinding)	Present	1 (25%)	-
Conjunctival mucus membrane	Anaemic	1 (25%)	1 (33.33%)

Table 2: Haemato-biochemical changes in cattle and buffaloes with Traumatic reticulo-peritonitis (TRP)

Parameter	Cattle		Buffalo	
	Healthy n = 6 (Mean ± S.E)	Diseased n = 4 (Mean ± S.E)	Healthy n = 6 (Mean ± S.E)	Diseased n = 4 (Mean ± S.E)
TLC (X10 ³ /ul)	7.84±0.24	20.4±1.82 **	10.72±0.61	19.85±1.55 **
Neutrophil (%)	28.33±0.73	66.18±.63 *	36.02±1.06	75.81±1.49 **
Lymphocyte (%)	64.55±0.78	30.6±10.42 *	52.18±2.16	17.15±1.25 **
Eosinophil (%)	3.7±1.06	0.68±0.25	2.47±0.49	0.7±0.03 **
Haematocrit (%)	33.92±1.55	44.48±2.74 *	34.25±1.68	35.2±5.3
Platelets (X10 ⁹ /L)	393±17.85	626.5±117.73	370.17±27.73	725.5±98.5
ALT/SGPT (U/L)	37.55±2.18	40.42±3.07	34.17±2.36	47.66±14.99
ALP (U/L)	76.16±19.12	147.84±28.38	104.5±11.46	90.28±6.93
AST/SGOT (U/L)	80.23±3.31	114.97±31.62	129.33±7.72	335.33±204.93
Total Bilirubin (mg/dl)	0.49±0.05	0.57±0.26	0.46±0.08	0.77±0.07 *
BUN (mg/dl)	18.92±0.81	30.64±12.35	26.89±1.49	48.02±4.32
Blood Glucose (mg/dl)	53.73±1.36	115.39±21.19 *	59.15±3.96	105.06±1.36 **

Values with * and ** in a row differs significantly ($p<0.05$) and ($p<0.01$) respectively from healthy animals

Table 3: Clinical parameters of cattle with Traumatic reticulo-peritonitis (TRP)

Parameter	Cattle		Buffalo	
	Healthy n = 6 (Mean ± S.E)	Diseased n = 4 (Mean ± S.E)	Healthy n = 6 (Mean ± S.E)	Diseased n = 3 (Mean ± S.E)
Rectal temperature (°F)	100.57±0.22	100.73±0.35	100.38±0.22	103.10±0.1**
Heart rate (/min)	72.33±1.45	82.5±3.07*	66.33±1.15	80.00±10.00
Respiration rate (/min)	26.67±1.67	53.75±6.25*	27.17±1.08	45.00±1.00**
Rumen motility (/3 min)	2.67±0.21	0±0**	2.83±0.17	0.50±0.50

Values with * and ** in a row differs significantly ($p<0.05$) and ($p<0.01$) respectively from healthy animals

Table 4: Rumen liquor examination of cattle with thoraco-abdominal disorders

Parameter	Observations	Cattle		Buffalo	
		Healthy n = 6 (Mean ± S.E)	Cattle n = 4 (Mean ± S.E)	Healthy n = 6 (Mean ± S.E)	Buffalo n = 3 (Mean ± S.E)
pH		6.67±0.13	7.50±0.27*	7.25±0.25	6.58±0.15
Colour	Green	6(100)	1(25%)	6(100%)	-
	Olive	-	-	-	-
	Yellowish brown	-	3(75%)	-	3(100%)
Consistency	Normal/Slightly Viscous	6(100)	1(25%)	6(100%)	-
	Watery	-	3(75%)	-	3(100%)
Protozoal count and motility	±	-	1(25%)	-	3(100%)
	+	-	2 (50%)	-	-
	++	1(16.67)	1 (25%)	2(33.33%)	-
	+++	5(83.33)	-	4(66.67%)	-

Values with * and ** in a row differs significantly ($p<0.05$) and ($p<0.01$) respectively from healthy animals

Table 5: Radiographic features in cattle and buffaloes diagnosed with traumatic reticulo-peritonitis (TRP)

Radiographic feature	Cattle (n = 4)	Buffalo (n = 3)
Sharp foreign body penetrating through the reticulum into thoracic cavity	3	2
Potential foreign body lying close to sternum penetrating through diaphragm into thoracic cavity lying close to apex of the heart	1	1

Table 6: Peritoneal fluid examination of cattle with traumatic-reticulo peritonitis (TRP)

Parameter	Observations	Cattle		Buffalo	
		Healthy n = 6	Diseased n = 4	Healthy n = 6	Diseased n = 3
Colour	Yellow	-	2 (50%)	-	2 (66.67%)
	Brownish Red	-	2 (50%)	-	1 (33.33%)
	Straw	6 (100%)	-	6 (100%)	-
Odour	Absent	6 (100%)	2 (50%)	6 (100%)	2 (66.67%)
	Putrid	-	2 (50%)	-	1 (33.33%)
Volume	<50 ml	6 (100%)	1 (25%)	6 (100%)	1 (33.33%)
	>50 ml	-	3 (75%)	-	2 (66.67%)
Turbidity	Present	-	2 (50%)	-	1 (33.33%)
	Absent	6 (100%)	2 (50%)	6 (100%)	2 (66.67%)

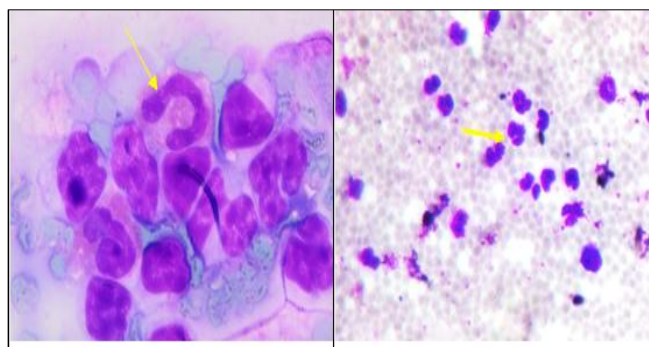
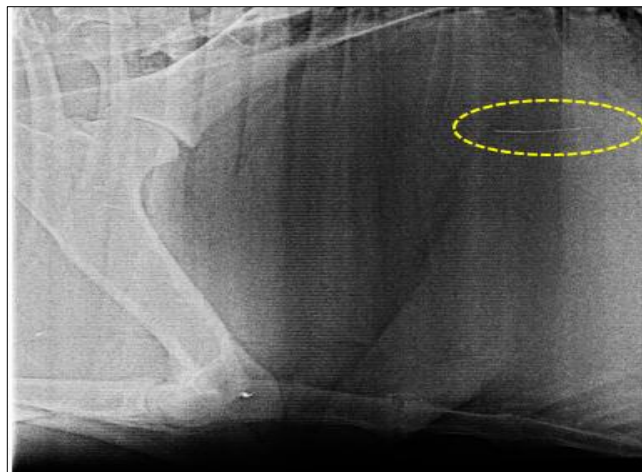
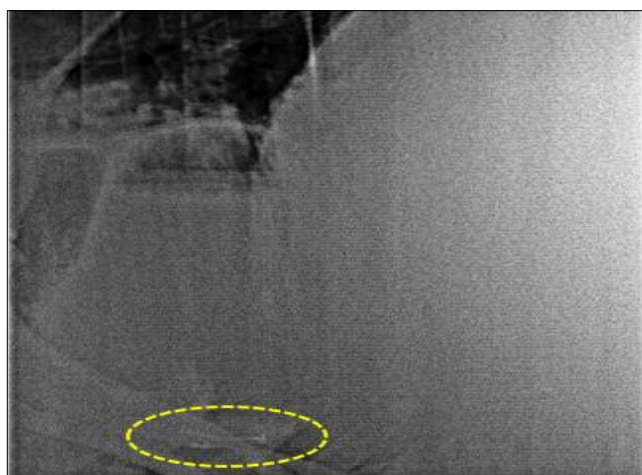
Table 7: Cytological smear examination of peritoneal fluid in cattle and buffaloes with traumatic-reticulo peritonitis (TRP)

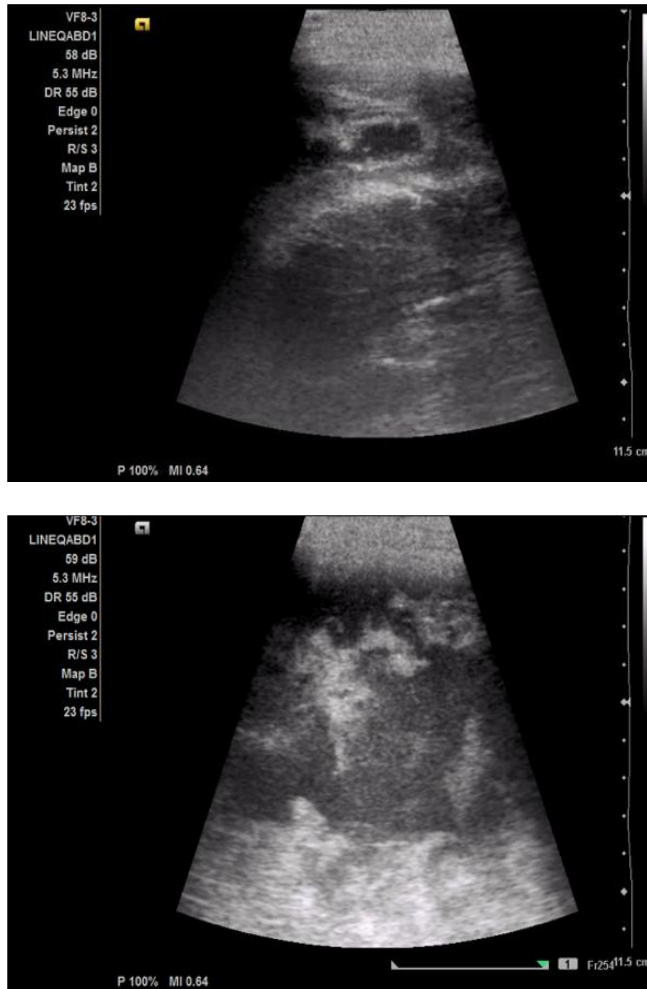
	Degenerated inflammatory cells	Bacteria	Fibrin
Cattle (n = 4)	3 (75%)	2 (50%)	3 (75%)
Buffalo (n = 3)	2 (66.67%)	1 (33.33%)	2 (66.67%)

Table 8: Peritoneal fluid D-dimer estimation of cattle with traumatic-reticulo peritonitis (TRP) and intestinal obstruction

D-dimer (mg/L)	Healthy n = 6 (Mean ± S.E)	Diseased (Mean ± S.E)
Cattle (n = 4)	0.40±0.06	0.70±0.08*
Buffalo (n = 3)	0.34±0.08	0.61±0.25

Values with * and ** in a row differs significantly ($p < 0.05$) and ($p < 0.01$) respectively from healthy animals

**Plate 1:** Presence of immature neutrophils on Giemsa stained blood cytosmear**Plate 2:** Radiograph showing a penetrating radiopaque metallic (encircled) foreign body**Plate 3:** Potential foreign object (encircled) penetrating through the diaphragm into the thoracic cavity, near the apex of the heart**Plate 4:** Sonogram showing echogenic (complex effusions) and fibrinous material in the peritoneal cavity (arrow)



Plates 5: Pericardial sac dilatation with complex effusions and fibrinous material (arrow)

Conclusion

Traumatic Reticuloperitonitis (TRP) is a serious condition affecting cattle and buffaloes, primarily caused by the ingestion of sharp foreign objects. Clinical signs, including anorexia, reduced rumen motility, brisket edema, and jugular pulsation, were observed in all affected animals. Haematological evaluations revealed leukocytosis, neutrophilia, and elevated platelet counts, indicating systemic inflammation. Biochemical analyses showed significant increases in ALP, AST, BUN, and glucose levels, reflecting compromised liver and renal function. Radiographic examinations confirmed metallic foreign bodies in the reticulum, with many cases exhibiting penetration into the thoracic cavity. Ultrasonographic findings highlighted peritoneal and pericardial effusions, suggesting severe inflammation. Rumen liquor analysis revealed significantly elevated pH, reduced protozoal motility, and watery, yellowish-brown fluid in affected animals. These findings underscore the importance of timely diagnosis using clinical signs, haematological and biochemical assessments, radiography, and ultrasonography for the effective management of TRP in ruminants.

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