Advance techniques in traumatic reticuloperitonitis diagnosis: review

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Abstract

Traumatic reticuloperitonitis (TRP) is a sporadic disease of ruminants that is caused by perforation of the reticulum by ingested foreign materials; it is a common reason for abdominal surgery in cattle. The disease may appear in forms of local and acute peritonitis, local chronic peritonitis and as unspecific form Anorexia, decrease in milk production, fever, ruminal stasis or ruminal hypo motility, tachypnea, grinding of teeth, reluctance to move and stance with an arched back and abducted elbows. The diagnoses are based on clinical examination, hematological examination, and other techniques.

Key words: Traumatic reticuloperitonitis (TRP), diagnosis, circulating cardiac troponin-I (cTn-I) and cardiac troponin-T (cTn-T).

التقنيات الحديثة في تشخيص التهاب الشبكية والخلب الكلومي

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الخلاصة

يعتبر التهاب الشبكية والخلب الكلومي من الامراض المتفرقة في المجترات والذي يحدث عن طريق اختراق جدار الشبكية بواسطة جسم غريب وهو من الاسباب الشائعة لأجراء العمليات الجراحية في الابقار . ربما يظهر المرض بشكل التهاب الخلب الحاد او التهاب الخلب الموضعي المزمن مع ظهور حالات القهم وهبوط في انتاج الحليب ، الحمى ، ركود حركة الكرش وزيادة سرعة التنفس. كما يلاحظ جز في الاسنان وممانعة الحيوان في الحركة ، تقوس الظهر وتباعد المرفقين . يعتمد التشخيص على اجراء الفحص السريري والفحوصات الدموية والتقنيات الاخرى الحديثة .
الكلمات المفتاحية: التهاب الشبكية والخلب الكلومي ، التشخيص

Introduction

Traumatic reticuloperitonitis (TRP) or hardware disease is a common disease of cattle but is rarely seen in small ruminants (1). It is the most common cause of anterior abdominal pain in cattle (2). The ingestive behaviour of cattle predisposes them to the accidental swallowing of thin sharp piece of metal foreign objects that settle in the reticulum (3). Ingestion of a foreign body may also be associated with diseases that cause pica, such as phosphorus deficiency. Subsequently, the foreign object may enter the reticulum and (a) without clinical diseases; (b) penetrate the reticulum wall only with intra-mural inflammation; (c) perforate the reticulum wall penetrate into the peritoneal cavity, and create localized peritonitis; or (d) migrate into the peritoneal

and thoracic cavities. The diaphragm, pericardium, and heart muscle are located just cranial to the reticulum (4), with the liver positioned medially and dorsally and the spleen laterally and dorsally. These organs may sometimes be penetrated by foreign bodies and become involved in the inflammatory process. The importance of this disease is not only due to its higher prevalence among other digestive disorders, but also due to the difficulty in early prediction and difficulty in evaluation of its sequel by physical examination (5,6). Therefore, an additional new diagnostic technique like ultrasonography is often helpful (7). It has been used for demonstration of physiological and pathological states of reticulum in cattle with

TRP(8,9). Radiological examination of reticulum with the animal in dorsal recumbency, is an accurate diagnostic method for the evaluation of cattle with suspected traumatic reticuloperitonitis (10). In spite of early diagnostic and prophylactic methods such as magnet implantation, metal detector and remover, there are still huge economic losses to be treated in the cattle industry (11,12).

Clinical signs

The signs of TRP are dependent upon the site of reticular perforation and lesions caused by the foreign body in the surrounding areas. There are numerous scientific papers describing the clinical signs of TRP in cattle. The disease may appear in

forms of local and acute peritonitis, local chronic peritonitis and as unspecific form (13); Anorexia, decrease in milk production, fever, ruminal stasis or ruminal hypo motility, tachypnea, grinding of teeth, reluctance to move and stance with an arched back and abducted elbows, signs of a heart rate of more than 100 bpm, distended jugular veins and muffled heart sounds or abnormal pericardial sounds. The heart rate was higher than normal, it ranged from 100 to 130 bpm. There are pericardial sounds, such as splashing, rubbing or squeaking sounds. Both jugular veins are distended, oedema of the throat region, brisket and ventral abdomen are the most common signs (14,15), as seen in Fig. (1).

Fig. (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 oedema of the brisket and submandibular regions (D).

Diagnosis

The complexity of development and the possibility that a number of syndromes can occur together makes the tentative diagnosis difficult. The disease must be distinguished from ketosis, simple indigestion and

subclinical acute ruminal impaction (17). In practice, the diagnosis is mainly made by physical examination although additional diagnostic methods (such as hematologic tests, abdominocentesis, radiography,

ultrasonography, laparoscopy or exploratory laparoruminotomy) might be used. Because complications of the disease are frequent, a more-accurate indication of its presence or severity would be valuable (18).

Haematological examination

There is significant erythrocytopenia (reduced RBCs) and lower Hb concentrations in the cows with TRP. On the other hand, PCV is significantly high in the cows with TRP. Moreover, there is significant leukocytosis, and lymphopenia in these cows (19,20).

In acute local peritonitis

A neutrophilia, (mature neutrophils) and a left shift (immature neutrophils) are common. This is a regenerative left shift. Both the neutrophilia and the left shift will be increased on the first day and will last for up to 3 days, and in uncomplicated cases the count begins to return to normal. In chronic cases the levels do not return completely to normal for several days or longer periods and there is usually a moderate leukocytosis, neutrophilia and a monocytosis.

In acute diffuse peritonitis

A leukopenia with a greater absolute number of immature neutrophils than mature neutrophils (degenerative left shift) occurs, which suggests an unfavourable prognosis if severe. The degree of lymphopenia is an indication of a stress reaction to inflammation.(21). There is prolonged prothrombin time (PT), thrombin time (TT) and activated partial thromboplastin time (APTT). So, the TRP causes significant coagulation abnormalities and haematological alterations in dairy cattle (22).

Biochemical analysis

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 ALP, serum lactate dehydrogenase (LDH), and serum creatinine phosphokinase (CPK). There is an increase in total plasma protein (TPP) and plasma fibrinogen(PF) levels among cattle with TRP(23). Polyclonal gammopathy is

characteristic for the electrophoretogram of cows with chronic local TRP (CL-TRP), and purulent pericarditis (PPC). Various degrees of hypoalbuminaemia, hyper-alpha-globulinaemia and low A/G ratios are the associated changes in all cases of TRP. Hyper-beta-globulinaemia is noticed in cases with CL-TRP. Hyper-gamma-globulinaemia is evident in cases with acute local TRP (AL-TRP), CL-TRP. Hyperproteinaemia is noticed in cows with local complications of TRP including AL-TRP, CL-TRP and RA. Hypoproteinaemia associated with severe hypoalbuminaemia and very low A/G ratios (<0.4) characterized cows with acute diffuse TRP(AD-TRP), PPC or fibrinous pericarditis (FPC). So, the concentrations and electrophoretic patterns of serum proteins in cow differ according to the anatomical location of the foreign body and the associated pathological lesions.(24). Sodium, potassium, and chloride levels are significantly lower in the cows with TRP than in the normal; however, AST, ALT, CPK, LDH, blood urea nitrogen, and creatinine are significantly higher in the TRP than in the control group and the glucose level is significantly lower. 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(25). Circulating cardiac troponin-I (cTn-I) and cardiac troponin-T (cTn-T) can be used to determine myocardial cell damage in cattle with traumatic reticuloperitonitis (26). Troponin is a globular protein complex localised on thin filaments of striated muscle and consists of three subunits; Tn-T, Tn-I and Tn-C; all three subunits are integrally involved in the contraction and relaxation of the myofibrils (27). Troponin complex proteins have been determined in the heart muscle and blood of domestic animals (28). A previous study suggested that circulating cTn might be used for the diagnosis of cattle suffering from myocardial degeneration due to foot-and mouth disease (29), but the potential relationship between the acute myocardial cell damage caused by TRP and circulating cTn has not been studied extensively. Although serum cTnI concentrations were significantly higher in

cattle with pericarditis compared with healthy cattle, they were not significantly different from concentrations in cattle with endocarditis, congenital cardiac disease, mediastinal abscess, reticulitis, caudal vena cava thrombosis, or chronic suppurative pneumonia. Serum cTnI cannot be used to distinguish cattle with pericarditis from cattle with other primary cardiac diseases. In addition, serum cTnI concentrations cannot distinguish between cattle with primary cardiac diseases and those with other non-cardiac, intrathoracic disorders(30).

Qualitative cTn analyses:

The concentration of cTn-T in heparinised blood is determined qualitatively by means of a commercial kit (TropT Sensitive Rapid Assay; Roche) with an absolute detection limit of 0.08 ng/ml. The concentration of cTn-I is determined in samples of serum with a commercial kit (card-I-kit Combo Test; AboaTech) with an absolute detection limit of 0.3 ng/ml. Both tests were carried out according to the manufacturers' instructions and the results were recorded as positive

when two purple lines appeared within 15 to 20 minutes of testing (Fig. 2) (26).

Quantitative cTn-I analyses:

A commercially available ELISA kit (CARD-I-KIT ELISA Troponin I; Labmaster) is used to determine the concentration of cTn-I according to the manufacturer's instructions. The optical densities of the samples were compared with a standard curve prepared from standards containing 0 to 14ng/ml of cTn-I derived from human hearts. Mammalian myocardium has a high reactivity in the cTn-immunoassay, and this reactivity is highly selective, being more than 1000 times greater than in skeletal muscle. There are structural homologies between human beings and some animals for amino acid sequences of cTn-T, and the amino acid sequences are also identical among animals. (31). However, the critical question is whether high-sensitive troponin assays are clinically useful and in particular, whether some specific laboratory biomarkers (such as cTnI and cTnT) yield better diagnostic (or prognostic) accuracy and cost-effectiveness when compared with

Fig. (2) Cardiac troponin-T (top) and cardiac troponin-I (bottom) test kits applied to cattle with traumatic reticuloperitonitis; two coloured lines appear in the reading windows if the result is positive, only one line appears if the result is negative.

echocardiography in patients with cardiovascular disease. Only specific and well-designed clinical trials will answer this important question(32). Standardization of cardiac troponin I (cTnI) measurement is important because of the central role for diagnosis of myocardial infarction. In blood, cTnI is present as a heterogeneous mixture of different molecular species. The analytical problem caused by this heterogeneity may be circumvented by recognition of a unique, invariant part of the molecule that is common to all components of the mixture. Antibodies used for the development of cTnI assays should selectively recognize epitopes within this invariant part, leading to a consequential increase in the homogeneity of immunoassay reactivity. This should be associated with the use of a reference material that represents the natural and major antigen in blood after tissue release, i.e., the troponin complex. Although a primary reference material for cTnI is available, studies indicate that cTnI assays remain without harmony after recalibration using this material. To achieve closer comparability of cTnI values between assays, the use of a secondary reference material, consisting of a panel of human serum pools, is proposed for use by manufacturers to calibrate their assays. To assign true cTnI concentration values to this secondary reference material, establishment of a reference measurement procedure for cTnI is required.(33). The cTn-I concentrations ranged from 0.39 to 7.74 ng/ml in the TRP cases in which the qualitative cTn-I kit was positive. Haptoglobin (Hp) is an α 2-globulin, synthesized in the liver. It is one of acute phase proteins whose serum levels increase in acute infections. It is believed that in cattle, Hp is involved in the regulation of lipid metabolism (34).The other form of Acute phase proteins (APPs)that is considered with the haptoglobin (Hp) as diagnostic and prognostic biomarkers is serum amyloid A (SAA),which play an important role in the differential diagnosis of TRP using receiver operating characteristic (ROC) analysis.(35).Also, Total oxidant and antioxidant capacities and nitric oxide levels

are important in cattle with traumatic reticuloperitonitis (36).

Laparoscopy

Right flank laparoscopy using a flexible fiberoptic laparoscope, 14 mm diameter and 1120 mm working length, is a reliable diagnostic aid for the presence of traumatic reticuloperitonitis (37). Laparoscopy in cattle is a promising tool for clinical diagnosis and treatment. The lower cost of the materials available in addition to the possibility of an intervention on an animal that is sedated does not entail more costs than an exploratory laparotomy. The application of this tool during abdominal explorations and biopsies allows the avoidance of invasive and often useless surgical interventions and even with the diagnosis and prognosis of certain conditions(38).

Metal detection

Metal detectors were used at one time to aid in the diagnosis of traumatic reticuloperitonitis. Ferrous metallic foreign bodies can be detected with metal detectors but the instruments are of limited use because most normal dairy cows are positive for metal over the reticular area.(21). Electronic metal detectors can identify metal in the reticulum but do not distinguish between perforating and nonperforating foreign bodies. The metal detector is an important auxiliary test, which has been used because it is a non-invasive, fast and cheap test. However, it does not determine if the foreign bodies are sharp or if they are really perforating the reticulum wall.(39).

Radiography examination

Radiography of the reticulum is very useful for the diagnosis of TRP. They are performed on standing animals and allow the detection of a metallic foreign body and the determination of its location in or outside the reticulum. Different parameters may be observed on radiographs for the diagnosis of TPR. They include presence or absence of a foreign body, position of the foreign body, presence of focal gas shadows or gas-fluid interface near the reticulum, the shape, size, and location of the reticulum. Of these parameters, location of the foreign body is

the most reliable indicator for the diagnosis of TRP.(40).

Ultrasonographic examination

Abdominal ultrasonography is an excellent diagnostic and prognostic tool. It aids in deciding whether the animal should undergo surgical or medical treatment or be slaughtered (41). It is an ideal diagnostic tool for investigating gastrointestinal disorders in cattle. In animals with traumatic reticuloperitonitis, inflammatory fibrinous changes and abscesses can be imaged(42). So, ultrasonography provided exact information concerning the various sequel of TRP in animals. Moreover, ultrasonography made it possible to determine the location and extent of the lesions accurately, and the site best suited for abdominal and thoracocentesis. Reduced or absent biphasic reticular contractions and deposition of inflammatory materials on its serosal surface were the classical ultrasonographic identifies in TRP, according to (43-Mohamed and Oikawa,2007) described reticular and thoracic abscesses as circumscribed masses with an echoic to echogenic content. Healthy bovine reticulum appeared half-moon shaped with a smooth contour which plays a crucial role in the ruminant digestive tract because the primary cycle of rumen motility always starts with a reticular contraction (44). Ultrasonography is helpful for the diagnosis of traumatic reticuloperitonitis and differentiation of localised peritonitis from diffuse peritonitis (45,46). Intraoperative echocardiography can be applied to evaluate the entire bovine pericardial sac and heart.(37).

Confirmatory test

Paracentesis (abdominocentesis and thoracocentesis) under ultrasonographic guidance, laparotomy and post-mortem examinations are used to confirm the diagnosis (47). Abdominocentesis and Pericardiocentesis may be performed blind or with ultrasound guidance (48). The best site for abdominocentesis is uncertain because the rumen occupies a large portion of the ventral abdominal wall and avoiding penetration of it is difficult. Cattle have a low volume of peritoneal fluid and failure to

obtain a sample is not unusual (21). Laboratory evaluation of peritoneal fluid consists of determinations of total white blood cell count, differential cell count, total protein and culture for pathogens. The interpretation of the analysis of the peritoneal fluid can be unreliable because to date only a few correlations have been made between the laboratory findings and the presence or a absences of peritoneal lesions.

PM examination

In the TRP case sometimes there are extensive fibrinous adhesions between the cranioventral aspects of the reticulum, the ventral abdominal wall, and the Adhesions and multiple abscesses may be 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 (49).

Histopathological examination

Shows 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 (50). The myocardiums in the TP cows have severe inflammatory cell infiltration replacing the cardiac muscle that has atrophied. Moreover, the myocardium of the cows severely affected by TP exhibits hyalinosis likewise, the myocardium of the cows with TP have severe inflammatory cell infiltration replacing cardiac muscle that has 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

There is indicates that TRP and TP induced clinical, haematological, 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 toxæmic and septicæmic 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 could be confirmed by PM and histopathological examination.

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