

AN OVERVIEW OF TRAUMATIC RETICULOPERICARDITIS IN CATTLE AND BUFFALOES

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ABSTRACT

Traumatic reticulopericarditis occurs due to the ingestion of foreign bodies that penetrate the reticulum towards the diaphragm and then the pericardium, resulting in traumatic pericarditis. It is a common disorder in cattle and buffalo, especially in developing countries associated with high economic losses and animal welfare. Indiscriminate eating habits and the mechanization of food are predisposing factors. The most common clinical signs are tachycardia, distention of the jugular veins, muffled heart sounds and submandibular, brisket and ventral edema. However, they are present in several pathologies, making early diagnosis difficult. Anemia, hyperfibrinogenemia, leukocytosis, neutrophilia, elevation of serum levels of the enzymes aspartate aminotransferase (AST), gamma glutamyl transferase (GGT), lactate dehydrogenase (LDH), serum bilirubin, creatine kinase (CK), hyperproteinemia, hypoalbuminemia and cytological analysis of cavity effusions with the presence of inflammatory cells are common laboratory findings. Radiography can identify foreign bodies, however inflammatory reactions and the presence of fibrinous exudates make it difficult to visualize. Ultrasonography and echocardiography, assist in the detection and characterization of effusions and the association of these tools with the

assessment of cardiac biomarkers, are considered useful methods for making an early diagnosis. The prognosis is unfavorable and treatment is generally unsatisfactory, and proper management of this disorder is essential to prevent major losses. Therefore, the objective of the present review was to highlight the current progress of the disease in cattle and buffaloes due to its importance in animal production and health.

Keywords: *Bubalus bubalis*, buffaloes, traumatic, pericarditis, foreign body, cattle

INTRODUCTION

Traumatic reticulopericarditis is a sporadic disease in ruminants triggered by the penetration of the pericardium by long, thin and sharp foreign objects originating from the reticulum (Braun, 2009; Eo *et al.*, 2017). Its occurrence is common in developing countries and in small herds (Khalphallah *et al.*, 2017).

Traumatic pericarditis is most commonly reported in cattle and buffaloes (Braun *et al.*, 2007a; Buczinski *et al.*, 2010; Kumar *et al.*, 2012; Attia, 2016), but it has description in goats (Akkoç, 2007; Çevik, *et al.*, 2010), sheep (Torki *et al.*, 2011), mule deer (*Odocoileus hemionus*) (Foreyt and Leathers,

1986), waterbuck (*Kobus ellipsiprymnus*) (Eo *et al.*, 2017), canines (Kolm *et al.*, 2001), equine (Bertone and Dill, 1985) and Toco toucans (*Ramphastos toco*) (Máinez *et al.*, 2016).

The small distance between the reticulum and the pericardium facilitates the perforation of these by a contaminated foreign body resulting in traumatic pericarditis (ATHAR *et al.*, 2012). The presence of a mixed bacterial infection of the reticulum causes severe local inflammation, with accumulation of serous or fibrinous inflammatory products, which can subsequently trigger toxemia and heart failure, being lethal in most cases (Abuseida *et al.*, 2016 and Al-abbadi, 2015; Constable *et al.*, 2017).

The disorder generates great economic and animal welfare losses due to the marked decrease in production, cost of treatment, fetal losses and potential fatalities, usually associated with progressive disturbances in cardiac function (Aref and Abdel-hakim, 2013; Nugusu *et al.*, 2013; Attia, 2016).

Due to its importance in health and animal production, traumatic reticulopericarditis is still a matter of worldwide concern. Thus, the objective of the present review was to highlight the recent advances in relation to the disease in cattle and buffaloes.

Etiopathogenesis

Traumatic reticulopericarditis is one of the main complications of ingesting long, thin and sharp foreign bodies, such as needles, pieces of wire, wood splinters and nails that can penetrate the reticulum, diaphragm, peritoneum, pericardial sac, resulting in pericarditis traumatic (Mohamed, 2010; Khalphallah *et al.*, 2017).

Cattle do not have proper oral discernment, are not very selective and cannot distinguish

metallic objects in food mixes. These materials can stick to the reticulum mucosa due to their anatomical conformation in a honeycomb shape without causing damage, however reticular physiological contractions, pressure of the fetus in advanced gestation and uterine contractions at the time of delivery, promote penetration of the wall reticular (Ghanem, 2010; Anteneh and Ramswamy, 2015; Ibrahim and Gomaa, 2016).

The targeting of the foreign body when perforating the reticulum causes injuries in several adjacent organs and allows the content to leak into the thoracic or peritoneal cavity (Abdelaal, *et al.*, 2009; Khalphallah *et al.*, 2017).

Pericarditis is an inflammation of the pericardium that occurs after trauma, causing an accumulation of serous and fibrinous inflammatory products in the pericardial sac (Kumar *et al.*, 2012; Yildiz *et al.*, 2019). This is divided into three general forms, effusive, fibrinous and constrictive, and their combinations can occur (Athar *et al.*, 2012). The effusive consists of the accumulation of liquid with proteins inside the pericardial sac, the fibrinous is triggered by the posterior deposition of fibrin, while the presence of fibrinous tissue in the pericardium or epicardium, result in constrictive due to the progressive loss of ventricular elasticity (Pekins *et al.*, 2004; Athar *et al.*, 2012; Constable *et al.*, 2017).

As the effusion develops, the accumulated fluid compresses the atria and the right ventricle, thus, there is no complete filling of the organ, causing congestive heart failure (Sasikala *et al.*, 2018). In addition, the absorption of toxins leads to toxemia, resulting in death in most cases (Braun, 2009; Constable *et al.*, 2017).

Epidemiology

Cattle are more affected than small

ruminants, as they do not use their lips for apprehension and consume a large amount of crushed feed that may contain metallic debris (Misk and Semieka, 2001; Ashfaq *et al.*, 2015).

The occurrence of the disease in pasture farming is greater, due to the possibility of inadequate management of the environment near construction sites and reforms. It is common in developing countries, in small herds and during the dry season, because grazing occurs close to the ground and can receive contaminated food (Shamar and Kumar, 2006; Khalphallah *et al.*, 2017).

The incidence is higher in animals over one year old (Fubini *et al.*, 2018) and in females, mainly in the final third of pregnancy (Braun *et al.*, 2007a; Mohamed, 2010; Attia, 2016). The association of the weight and size of the pregnant uterus makes it possible for the organ to work as a pendulum when the animal moves, applying physical pressure to the rumen and reticulum, collaborating for penetration by an existing object (Fubini *et al.*, 2018).

Traumatic reticulitis has been diagnosed in different parts of the world. A study in New York showed that 60 fatal cases of reticuloperitonitis represented 3% of the total adult cattle examined over an eight-year interval, with 40 cases of traumatic reticulopericarditis identified (Roth and King, 1991). Cramers *et al.* (2005) reported that 16% of 1491 animals slaughtered in Denmark, had foreign bodies in the reticulum and of these, in 10% chronic reticular lesions were observed. A study in India on forestomach diseases showed a 14% prevalence of cases of traumatic reticuloperitonitis in cattle and buffaloes (Sharma *et al.*, 2015).

In Brazil, some studies have demonstrated the occurrence of traumatic reticulopericarditis in cattle. Oliveira *et al.* (2013) recorded the presence of 62 cases of pericarditis, in a total of 18.877 animals slaughtered in the state of Minas

Gerais, with a prevalence of 0.33%. Lucena *et al.* (2010) reported that traumatic reticulopericarditis represented 19.3% of the lethal disorders caused by physical agents in cattle from 1964 to 2008. Marques *et al.* (2018) observed that of the 43 cases of reticulitis diagnosed in their study, 31 had traumatic reticulopericarditis with a mortality rate of 100%.

Clinical signs

Clinical signs vary, depended to the severity of the disease and the extent of the lesions (Mohamed, 2010; Kumar *et al.*, 2012). The primary clinical sign observed is tachycardia, however it is not specific, as it is present in several physiological or pathological conditions (Attia, 2016). Muffling of cardiac sounds, asynchronous cardiac sounds, oedema in the submandibular, brisket and ventral region, positive venous pulse and distention of the jugular vein may be characteristic (Braun, 2009; Abu-seida and Al-abbadi, 2016; Khalphallah *et al.*, 2017).

Anorexia, depression, weight loss, increased body temperature, pale or congested mucous membranes, with increased capillary filling time, tachypnea, bruxism, abdominal pain, abduction of thoracic members and reluctance to move have also been reported (Ghanem, 2010; Mohamed, 2010; Sasikala *et al.*, 2018; Singh *et al.*, 2019). Diarrhea and scanty stools can also be seen (Subramanian *et al.*, 2003).

Braun (2009) describes that tachycardia can be mild or severe above 130 beats per minute (bpm) depending on the degree of heart compression by pericardial effusion.

The increase in body temperature and tachypnea are suggestive of a systemic reaction, possibly related to a toxemia due to foreign body injury (Ghanem, 2010).

Associated with brisket oedema and positive venous pulse, the suppurative stage of pericarditis occurs, in which there is a reduction in myocardial contractility (Khalphallah *et al.*, 2017).

Clinical pathology

Laboratory tests are useful tools to auxiliary in diagnosis. In hematological evaluation, anemia occurs because to different degrees of dehydration, blood loss during penetration of the object or as result of the chronic inflammatory process (Ghanem, 2010; Braun *et al.*, 2018).

The serum increase in total plasma protein and fibrinogen is observed as a hepatic response due to severe, but not exclusive inflammation of this disease (Ghanem, 2010; Habasha and Yassein, 2014; Attia, 2016; Braun *et al.*, 2018).

The glutaraldehyde test is a non-specific inflammation indicator due to the increase in fibrinogen and globulin, being a useful method used to differentiate inflammatory from non-inflammatory heart failure (Braun *et al.*, 2007a; Braun, 2009).

Leukocytosis with neutrophilia are commonly described and attributed to the inflammatory or infectious response caused by foreign body penetration (Braun, 2009). According to Habasha and Yassein (2014), these changes associated with monocytosis are present in cattle with chronic peritonitis.

In serum biochemistry, hyperproteinemia, hyperglobulinemia and hypoalbuminemia are described due to the characteristic inflammatory response (Hussein and Staufenbiel, 2014; Neamatallah, 2015). Albumin reduction occurs by prioritizing the synthesis of acute phase proteins by the liver, in order to prevent inflammation and contribute to healing (Cray *et al.*, 2009).

The increase in the glutamyl transferase

(GGT), aspartate aminotransferase (AST), serum bilirubin, dehydrogenase enzyme (LDH) e creatine kinase (CK) were also reported (Ghanem, 2010; Abu-seida and Al-abbadi, 2016; Khalphallah *et al.*, 2017; Sasikala *et al.*, 2018). Braun (2009) suggests that elevations in serum concentrations of liver enzymes generally indicate chronic lesions associated with right heart failure with secondary hepatic congestion.

The reduction of protozoa in the analysis of ruminal content is notable (Sasikala *et al.*, 2018).

Abdominocentesis can be valuable when the lesion is not located and reveal the presence of inflammatory cells with a predominance of neutrophils in the cytological analysis (Wittek *et al.*, 2010). In pericardiocentesis, a protein concentration >3.5 g / dL, leukocyte count >2500 / μ L, straw yellow to reddish, foamy and foul odor pericardial fluid are characteristics of the disease (Elhanafy and French, 2012).

Diagnosis

Clinical findings provide a preliminary diagnosis, but may be present in several pathologies, requiring additional tests to confirm the disease. Foreign body tests such as withers clamping, painful percussion on the reticulum with a rubber hammer and pole test are important when foreign bodies are suspected of being ingested, being more common in cattle when compared to buffaloes (Braun *et al.*, 2007a; Mohamed, 2010; Braun *et al.*, 2019). Eventually, characteristic lesions of traumatic reticulopericarditis observed in on postmortem examination supply the diagnosis (Braun, 2009).

Electrocardiography

The electrocardiography (ECG) is an important parameter for an animal with

cardiovascular disorders (Reddy *et al.*, 2015). Decreased amplitude of the QRS complex, electrical alternation (configuration of the P, QRS or T complexes regularly) and distortion or elevation in the ST segment are common ECG changes in cases of traumatic pericarditis (Foos, 1985; Tharwat, 2011).

Radiography

Laterolateral radiographic images are obtained from the thorax and the caudoventral reticulum with the animal standing, but for accurate localization of a foreign body, a dorsoventral view is necessary, which cannot be performed in adult cattle due to the great depth of the thorax (Braun, 2009).

Furthermore, right or left lateral radiographs of the cardiac and reticular area of the decubitus animals are also reported (Athar *et al.*, 2012). In the left lateral decubitus, it is possible to notice the cardiac silhouette and the diaphragm outline and obscured, showing opaque areas (Misk and Semieka, 2001). Despite, to avoid complications such as the spread of infections in the affected animals, it is advisable to perform the examination standing (Abu-seida and Al-abbadi, 2016).

Radiographic changes may not be detected in early pericarditis and if there is a concomitant large amount of pleural fluid, it is not possible to differentiate it from pleuritis (Imran *et al.*, 2011; Athar *et al.*, 2012).

Radiography shows loss of thorax details, changes in heart shape and opacity, and radiopaque foreign bodies, such as needles and other metallic objects, can be observed, perforating the reticle, diaphragm or heart (Khalphallah *et al.*, 2017; Sasikala *et al.*, 2018). However, the non-visualization of the object may occur due to inflammatory

reactions and the presence of fibrinous exudates in the pericardial sac, not excluding the suspicion of the disease (Makhdoomi *et al.*, 2018; Sasikala *et al.*, 2018).

In a study with cattle diagnosed with traumatic reticulopericarditis, 71% (20 of 28 animals) presented in the radiographic evaluation the obscured cardiophrenic angle and complete loss of the cardiac silhouette and ventral diaphragm due to extensive fibrinopurulent lesions (Braun *et al.*, 2007b).

Ultrasonography

Ultrasonography is often chosen for diagnosis, imaging and characterization of effusions (Braun, 2009; Athar *et al.*, 2012). Abdominal findings reveal changes typical of traumatic reticulitis, such as waviness and thickening of the reticular wall, decreased motility and amplitude of reticular contraction and increased distance between the abdominal wall and the reticulum (Abu-seida and Al-abbadi, 2016).

The presence of pleural fluid displacing the lungs and moderate to severe peritoneal fluid is evident in cattle and buffalo. (Braun, 2009; Kumar *et al.*, 2012; Sagwan *et al.*, 2018). Braun (2009) and Khalphallah *et al.* (2017) also verified reticular displacement. There are often moderate to severe ascites attributable to heart failure (Athar *et al.*, 2012).

It is possible to notice the presence of reticular abscesses, which have an echogenic capsule of varying thickness involving a hypoechogenic to moderately echogenic center, in addition to abdominal and pulmonary abscesses that can have different sizes (2 to 20 cm) (Abu-seida and Al-abbadi, 2016).

Foreign bodies are observed by ultrasound as hyperechogenic structures that penetrate the

reticular wall with comet tail artifact (Abu-seida and Al-abbadi, 2016). However, this examination hardly identifies metallic objects, such as magnets (Khalphallah *et al.*, 2015).

Echocardiography

The echocardiographic examination is a simple and well-established tool for cardiac evaluation, being performed from the third to fifth intercostal space of both antimers (Buczinski, 2009; Hassan and Torad, 2015).

In suppurative pericarditis, a large amount of hypoechogenic to echogenic fluid is usually observed in the pericardial sac, while in fibrinous is possible to evidence echogenic fibrin deposits and cords in the epicardium (Abu-seida and Al-abbadi, 2016). Other findings include cardiomegaly, thickening of the walls and increased cardiac contractions, in addition to vegetation of the tricuspid, mitral and pulmonary valves (Ghanem, 2010; Khalphallah *et al.*, 2017) and the obscured heart due to the effusion (Schweizer *et al.*, 2003).

Ferrosocopy

Performing a metal detector scan on the ventral and lateral thoracic and abdominal wall can provide information on the presence of ferromagnetic foreign bodies (Sawandkar *et al.*, 2009), although it is not possible to differentiate between perforating and non-perforating objects (Reddy and Sasikala, 2012).

In a study of 38 animals diagnosed with traumatic reticulopericarditis, 21 of them had foreign body detection through ferrosocopy (Hussain *et al.*, 2018), despite not being a tool widely used in suspected cases.

Pericardiocentesis

Pericardial fluid can be collected by

centesis in the location with the greatest audibility of cardiac sound, usually in the fourth or fifth intercostal space on the left side (Athar *et al.*, 2012). However, the procedure can cause deleterious effects, spreading the infection to the pleural cavity (Braun, 2009). In the chronicity of the disease, few amounts of liquid can be found, making it difficult to obtain a sample.

Cardiac biomarkers

Cardiac biomarkers are considered useful indexes for the early diagnosis of traumatic pericarditis. Cardiac Troponin I (cTnI), cardiac Troponin T (cTnT), creatine kinase myocardial band (CK-MB) and nitric oxide are considered important biomarkers of cardiac diseases because they elevate their serum concentration even without the characteristic signs of the disease (Mellanby *et al.*, 2007; Neamat-allah, 2015; Attia, 2016). Venkatesan *et al.* (2020) found that the evaluation of cTnI at the place of care proved to be a simple diagnostic measure, which facilitated the assessment of myocardial involvement and cell damage in cattle affected by traumatic reticulopericarditis.

Laparoscopy

It is a promising technique for the diagnosis and treatment of several abdominal diseases in cattle (Babkine *et al.*, 2006), because it provides greater practicality, rapid postoperative recovery and low risk of complications (Babkine and Desrochers, 2005; Seeger *et al.*, 2006). Although, massive adhesions hinder the visibility of the reticulum (Braun *et al.*, 2020).

Necropsy and histopathological

In acute cases, distension of the pericardial sac is found foul-smelling liquid with fibrin and

the appearance of 'scrambled eggs' (Abu-seida and Al-abbadi, 2016). In chronic cases, the pericardial sac is adhered to the pericardium by fibrinous junctions and thickened (Athar *et al.*, 2012).

Findings may also include presence of fluid peritoneal fluid with the presence of fibrin, fibrinous adhesions between the reticulum and / or diaphragm, spleen, abomasum, rumen, liver, abdominal wall and between the intestinal loops and omentum, as well as splenic, pulmonary abscesses, reticular, abdominal and hepatic, depending on the direction of the object when penetrating the reticulum (Ghanem, 2010; Chanie and Tesfaye, 2012; Abu-seida and Al-abbadi, 2016).

The foreign body is usually found in the exam, although its recovery may not be possible even with its visualization in complementary exams, due to adhesions and extension of the inflammatory process (Braun *et al.*, 2007a).

Histopathology shows the presence of nodular hyperplasia of the stratified squamous epithelium in the reticulum (Sasikala *et al.*, 2018), high infiltration of inflammatory cells in the pericardium and myocardium, mainly of neutrophils and mononuclear cells, in addition to myocardial hyalinosis (Ghanem, 2010; Abu-seida and Al-abbadi, 2016).

TREATMENT

Treatment for the disease is generally ineffective and used for the animals' short-term survival. Conservative therapeutic management using diuretics to reduce oedema, venous return and cardiac preload (Buczinski *et al.*, 2010), broad-spectrum systemic antibiotics and drainage of the pericardial sac can be used, but are rarely effective (Abu-seida and Al-abbadi, 2016). The

administration of nonsteroidal anti-inflammatory drugs and pericardial lavage have also been described (Shalini *et al.*, 2017; Sasikala *et al.*, 2018; Premkumar *et al.*, 2019).

Pericardiotomy or pericardiectomy are reported in animals in order to drain the present content, remove the foreign body if found and irrigate the pericardial cavity with sterile isotonic saline associated with antibiotics (Athar *et al.*, 2012; Abu-seida and Al-abbadi, 2016). According to the authors cited earlier, the long-term pericardial drain can be installed to perform the procedures twice a day for better results.

Exploratory laparotomy with or without left side rumenotomy is recommended in an attempt to remove objects from the reticulum or abdominal cavity (Makhdoomi *et al.*, 2018). Postoperative complications, such as dehiscence, subcutaneous emphysema and peritonitis may be present (Miesner and Reppert, 2017).

Prognosis

The prognosis depends on the early diagnosis, the value of the animal, the stage of the disease and the therapeutic attempts, being considered unfavorable in most cases (Buczinski *et al.*, 2009; Mohamed, 2010; Premkumar, *et al.*, 2019).

Prevention

Management appropriate of feed supply, good nutrition, passage of processed foods on magnets to remove metallic debris, be careful with the use of metal wires to contain silage and other foods provided, prevent access to areas polluted with objects, such as wood chips, are recommended precautions for reduce the incidence of the disease (Orpin and Harwood, 2008; Nugusu *et al.*, 2013; Reddy *et al.*, 2014; Francoz and Guard, 2015).

Moreover, oral administration of reticular magnets in animals has become a prophylactic measure, being efficient in cattle before one year of age (Anteneh and Ramswamy, 2015; Miesner and Reppert, 2017). The increase in the incidence of traumatic reticuloperitonitis in buffaloes after four years of using magnets is justified by the fixation of several foreign objects in the same (Abu-seida and Al-abbadi, 2016). Therefore, the introduction of a new magnet after this period is of great importance in protecting animals (Al-abbadi *et al.*, 2014).

CONCLUSIONS

Traumatic reticulopericarditis is still a challenge in veterinary medicine, especially in developing countries. Clinical and epidemiological findings assist in the presumptive diagnosis of the disease however, complementary exams are necessary for a definitive diagnosis. Although the condition has no specific clinical signs, it has several regular hematological, biochemical and radiographic characteristics. In addition, the use of ultrasonography and echocardiography for cardiac evaluation, detection and characterization of effusions associated with the analysis of cardiac biomarkers as the most useful laboratory indicators, has provided recent advances in diagnosis and prognosis, which is generally considered poor. Treatment is usually not rewarding, so it is essential to use preventive measures to prevent the disease.

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