

Pericarditis in Bovines- A Review

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Abstract Pericarditis is the most common pericardial disease of cattle. It is an inflammation of the pericardium that results in accumulation of pericardial fluid within the pericardial sac. In cattle, it is mostly caused by the perforation of the pericardial sac by an infected foreign body through the reticulum. Clinical signs of pericarditis are tachycardia, muffled heart sounds, absence of lung sound in the ventral thorax, asynchronous abnormal heart sounds. Distension of the jugular veins and pulsation and submandibular, brisket and ventral abdominal edema are usually present. There is leukocytosis with shift to left and hyperfibrinogenaemia (indicating inflammation). The condition is difficult to diagnose only on the basis of clinical signs. However, imaging techniques like radiography and ultrasonography can be of high diagnostic value in detecting the condition. Treatment is usually not rewarding, but the disease can be prevented to a large extent by the proper managerial practices like feeding of magnets, preventing access to potential and non-potential foreign bodies in the feed and fodder of the animals.

Keywords *Pericarditis, Cattle, Ultrasonography*

1. Introduction

The heart is partially surrounded by a serous membrane called pericardium and it creates a closed cavity called pericardial space that contains small amount of fluid for lubrication [1]. The pericardium is divided into an outer fibrous part and an inner serous part. The fibrous pericardium is a thin sac that covers most of the heart. The outer surface of the fibrous pericardium is covered by the pericardial mediastinal pleura which becomes sternopericardial ligament at the cardiac apex. The base of fibrous pericardium continues onto great arteries and veins that leave and enter the heart. The serous pericardium forms a continuous covering of the heart and inner surface of the fibrous pericardium. The parietal layer is a sheet of continuous mesothelial cells fused to the fibrous pericardium. The visceral layer covers the heart and forms the epicardium. The pericardial cavity is the space between the parietal and visceral layers of the serous pericardium.

Pericarditis is inflammation of the pericardium with accumulation of fluid or exudate between the visceral and parietal pericardium [2]. It is the most common pericardial disorder in cattle [3]. In cattle, it is often attributable to a reticular foreign body that has penetrated the reticular wall, diaphragm and pericardial sac. It is associated with progressive disturbances in heart function and almost always results in death [4]. It is acute, subacute or chronic inflammation of the pericardium due to penetration of pericardium by sharp foreign body. Since distance from the reticulum to the pericardium is only a few cms, sharp contaminated foreign body can easily pierce the diaphragm and enter the pericardium. Rarely, traumatic pericarditis may be caused by the penetration of the wire through the skin, with subsequent migration into the sternabrae and pericardial sac [5]. Krishnamurthy et al reported a case of traumatic reticulo-pericarditis in a cross bred cow caused by penetration of an 8 cm pointed coconut broomstick [6]. Pericarditis attributable to haematogenous spread of infectious diseases (such as colibacillosis, pasteurellosis, salmonellosis and anaerobic infections) is much less common and is usually masked by signs of septicemia [7]. Idiopathic hemorrhagic pericarditis has been recorded as the less common cause of pericardial effusions in cattle with good prognosis [8, 9].

There are three general forms of pericarditis, effusive, fibrinous and constrictive although combination of three can also occur. Effusive pericarditis is characterized by accumulation of a protein rich fluid within the pericardial sac. Subsequent fibrin deposition will lead to fibrinous pericarditis and if fibrin within the pericardial sac matures to fibrinous tissue and fibrosis of the pericardium or epicardium then constrictive pericarditis will result [10]. The incidence is more in cattle and buffaloes than in camels. The incidence of traumatic pericarditis is found more in pregnant or recently parturated animals, due to increased intraabdominal pressure pushes the foreign body towards the thorax. Pericardium may be pierced at one or more places and in few cases; the object may either pierce the myocardium or may come out through the thoracic wall. Sometimes the object may fall back into the reticulum. Trauma to pericardium causes inflammation and exudates continue to accumulate in the pericardial sac. Adhesions between epicardium and pericardium and fluid accumulation in pericardial sac, impairs the ability of the heart to act as a pump and shows signs of congestive heart failure. Right-sided heart failure is common than left sided, as right ventricular wall is thinner than left ventricular wall. Absorptions of toxins lead to toxemia. Death after foreign body penetration of pericardium is usually caused by progressive fibrosing constrictive pericarditis and epicarditis, cardiac tamponade from perfora of the coronary artery has also been found [11].

2. Materials and Methods

2.1. Diagnosis

The diagnosis of the traumatic pericarditis is based on clinical, haematobiochemical, radiographic, ultrasonographic and pericardiocentesis findings.

A. Clinical Signs The clinical presentation of pericarditis can vary, depending upon the volume and rate of development of the pericardial effusions and cause. A decrease in appetite and productivity may be the non-specific indicators heart disease (Gonzalez et al). Clinical signs include venous distension and pulsation, tachycardia, and bilaterally muffled heart sounds [12, 13] edema of jaw dewlap and ventral abdominal region extending up to the udder, anorexia, drop in milk yield, reluctance to walk or walk with short steps and with stiff gait, pyrexia, increased pulse rate, abdominal respirations, arched back and abducted elbows. Diarrhea or scant feces is often present [14]. Pinching of withers to depress the back or deep palpation of the ventral abdominal wall behind the xiphoid sternum commonly elicits a painful grunt. Mucous membrane may be congested and have a prolonged capillary refill time. In severe cases, there may be even edema of the conjunctiva with grape like masses of edematous conjunctiva hanging over the eyelids. Arterial pulses are weak. Distension of jugular veins may be attributable to right-sided cardiac insufficiency, the most important cause of which is traumatic pericarditis, valvular endocarditis, cardiomyopathy and cardiac

lymphosarcoma [15, 16, 7, 17]. The clinical signs of jugular engorgement and oedema of the brisket and ventral abdominal wall may also be seen in cases of pseudopericarditis. Pressure caused by tumours, abscesses, Echinococcus cysts, swollen lymph nodes resulting from tuberculosis and leukosis, one-sided pleuritis and diaphragmatic hernia to the base of cranial and caudal vena cava returning blood to the heart have been reported to cause pseudopericarditis in cattle. These mediastinal lymph nodes may also be swollen due to theileriosis and cause pressure on the vena cava [18] and consequently mimics the symptoms of pericarditis.

The most consistent findings on auscultation are tachycardia, muffling of heart sounds, and absence of lung sounds in the ventral thorax. Dorsally the lung sounds are louder than normal [2]. The severity of tachycardia depends primarily on the degree of compression of the heart by pericardial effusion as in cows with idiopathic pericarditis, pericardiocentesis with removal of the fluid results in an immediate decrease in heart rate and cure [8]. The heart sounds are muffled because of pericardial effusion and fibrinous changes in the pericardial sac. The presence of characteristic asynchronous abnormal heart sounds depend on the type of lesions [7]. When the changes are predominantly fibrinous, the sounds are of a rubbing, squeaking or scratching in nature. The predominance of fluid, there are splashing or gurgling sounds, which vary continuously in pitch, loudness, duration and point of maximal intensity. Absence of edema and jugular vein distension does not rule out pericarditis because pericardial fluid can drain into the reticulum via a patent foreign body tract [7]. The respiratory rate is often elevated because of cardiac insufficiency or direct involvement of the lungs. The ruminal motility is usually reduced or absent [4]. On auscultation, initially pericardial friction sounds are heard as parietal and visceral layers rub against each other. In later stages, sounds become muffled due to accumulation of more fluid in pericardial sac. There will be upward and backward displacement of the heart in extreme cases making cardiac sounds audible at the level of shoulder. If the animals survive this advanced stage of pericarditis, it may lead to chronic form called as constrictive pericarditis where heart sounds are muffled due to adhesions between epicardium and pericardium. There will be no pulmonary or limb edema. Effect will be more on thin walled right ventricle than on thick walled left ventricle, so blood pools in systemic circulation. Pleural effusions without cardiac disease must be considered in cattle with muffled heart sounds [19]. Auscultation of muffled heart sounds has high specificity and likelihood ratio for detecting cases of pericarditis [3]. Enlargement of liver may be detectable by palpation behind the upper part of the right costal arch in the cranial part of the right paralumbar fossa [17].

B. Clinical Pathology On hematological examination, a pronounced leukocytosis, with a total leucocytes count of 16 000-30 000/ μ L with shift to left accompanied with neutrophilia and eosinopenia is usual. In the other forms of pericarditis, changes in the blood depend upon the other lesions present and on the causative agent [17]. The glutaraldehyde test, a nonspecific indicator of inflammation due to elevation of fibrinogen and globulin, is an important diagnostic tool because the clotting time is shorter than normal in >90% of cattle [19]. The test can be used to differentiate inflammatory and non-inflammatory right-sided cardiac insufficiency. Hyperfibrinogenaemia, a sensitive indicator of inflammation is also common finding [20, 21, 22]. Hemoconcentration may be present if the animal is dehydrated or toxemic. The activities of γ -glutamyltransferase (γ -GT) and aspartate aminotransferase (ASAT) and the serum concentration of bilirubin are increased, indicating hepatic congestion. Cardiac troponin proteins, which are usually present in blood either at very low concentrations or below the limit of detection of most assays, are released into the circulation in cows with pericarditis [23] hence, may be of value in determining the degree of heart damage in cows with traumaticreticulo-peritonitis [24]. Electrolyte concentrations are usually normal, but serum calcium and potassium concentrations may be low because of anorexia [2].

Electrocardiography can aid in the diagnosis. The ECG changes most commonly associated with pericarditis in large animals are decreased amplitude or QRS complex (less than 1.5 mV in the base-apex lead), electric alternans (altered configuration of the P, QRS, or T complexes on a regular basis)

and ST segment elevation or slurring [25, 26, 27]. Removal of large volumes of pericardial fluid does not usually result in immediate changes in QRS amplitude [17]. In a study conducted by McGuirk et al it was noted that persistence of atrial fibrillation was associated with poor performance and progressive cardiac disease, whereas conversion to normal sinus rhythm uniformly led to clinical improvement [28].

C. Radiography There is relatively few studies on radiography in cattle with traumatic pericarditis [29, 5, 30, 19, 4]. In cattle, traumatic pericarditis usually results in the gas and fluid accumulation in the pericardium which is visible radiographically and is relatively specific for this disease [2]. In the early stages of traumatic pericarditis, good thoracic detail is evident radiographically while poor differentiation of thoracic structures is evident at progressive stages [30]. Partington and Biller [31] examined 115 consecutively acquired bovine cranial abdominal radiographs and found standing lateral abdominal radiographs to be a valuable tool for the diagnosis of cranial abdominal disorders. The sensitivity and specificity of radiography in detecting traumatic reticuloperitonitis and pericarditis was 83% and 90% respectively. A metallic foreign is usually detected radiographically in the cranial reticulum or caudal thorax in cattle with traumatic pericarditis. Radiographic changes may not be detected in early or uncomplicated pericarditis and if fluid accumulation is large and there is concurrent pleural effusion, are indistinguishable from pleuritis. However, it is difficult to distinguish between pleural and pericardial effusion on the basis of radiography [32, 13]. Radiodense foreign bodies are usually pieces of wire or nails, although other metallic foreign bodies are sometimes seen on the radiograph [4]. Traumatic pericarditis cannot however be ruled out if a foreign body is not seen as thick radiodense adhesions may obscure a foreign body from view or the foreign body may have migrated back into the reticulum, where it may be seen lying freely in the organ or penetrating the reticular wall. Occasionally the offending foreign body attaches to a magnet administered after the damage has occurred. Latero lateral radiographic views are taken of the caudoventral thorax and reticulum with the animal standing (Braun) [4] or right or left lateral radiographs of the cardiac and reticular areas with the animals in dorsal or lateral recumbency are indicated to know the presence and position of foreign body. The cardiac shadow may increase with disappearance of phrenico-cardiac-pulmonary triangle in positive cases [33].

D. Ultrasonography Reasonable cardiac images can be obtained with 3.5- to 5-MHz probes for the diagnosis of common conditions. Linear probes are limited to scanning in the vertical plane, but much information can still be acquired. The heart is imaged in the third to sixth intercostal spaces. The ipsilateral foreleg must be positioned forward to allow access to the more cranial spaces. The most common cardiac conditions amenable to diagnosis by generalist ultrasonographers are pericardial disorders, valvular endocarditis, and ventricular septal defects. Pericardial effusions should not be confused with bilateral pleuritis in which anomalies of the pleural space and the lung parenchyma can also be found [34]. Ultrasonography is the method of choice for imaging and characterizing pericardial effusion. Pericardial effusion results in separation of the pericardium from the epicardium, and is most evident over the ventricles. Affected cattle usually have a large amount of hypoechogenic to echogenic pericardial fluid and echogenic deposits and strands of fibrin may be seen on the epicardium. Sometimes strands of fibrin are seen floating in the fluid between the epicardium and pericardium [5, 13, 35, 4]. Abscesses are rarely seen within the pericardial sac. The pericardial layer which is not seen in healthy animals is typically seen as a thick echoic membrane surrounding the heart. The cardiac ventricles are moderately to severely compress depending on the amount of fluid. The lungs are compressed and displaced medially and dorsally [4]. Bright hyperechoic pinpoint echoes representing free gas are often imaged in cattle with pericarditis. Gas in the pericardium may limit the ability to obtain an echocardiographic evaluation of all cardiac structures [2]. In idiopathic pericarditis, the effusion has been reported to be anechoic to hypoechoic, with fibrin adhered to the epicardium in most cases. More echogenic pericardial effusions are seen in animals with septic pericarditis [36]. Ultrasonography of the abdomen usually reveals reticular changes typical of traumatic reticuloperitonitis, such as reduced motility and echogenic deposits. Frequently there is

moderate to severe ascites attributable to cardiac insufficiency. Caudal vena cava often appears dilated and appears round to oval instead of triangular in cross section [4]. Echocardiography permits the differentiation of effusive and fibrinous pericarditis [37, 8]. Echocardiography is useful to confirm the suspicion of pericarditis, to observe the impact of pericardial effusions on the cardiac chambers or function, to differentiate pericardial and pleural effusion and to choose the optimal site of the pericardiocentesis [35].

E. Pericardal Fluid Analysis Site for Pericardiocentesis may be selected echocardiographically. Pericardial fluid may be sampled by centesis with a 10 cm 18 gauge needle over the site of maximum audibility of the heart sound, usually the 4th or 5th intercostal space on the left side. Smell of the pericardial fluid reminiscent of retained placenta and toxic metritis is sufficiently diagnostic in cattle with traumatic pericarditis [17]. Protein concentration of greater than 3.5 g/dL and an elevated WBC count of greater than 2500/ μ L with urine colored to slightly blood tinged, foamy, and foul smelling pericardial fluid in cattle is characteristic of pericarditis [2]. The fluid represents an inflammatory response and may be submitted for bacteriological examination. Fluid analysis and bacterial and viral culture results vary according to the aetiological agent involved. A mixed population of Gram positive and Gram negative aerobic and anaerobic organisms (gastrointestinal flora) [2] sensitive to cephalixin, gentamicin, cotrimethoxazole, tetracycline and erythromycin is usually present [38, 39]. Pericardiocentesis is not without risk. Potential complications include pneumothorax, fatal arrhythmia, leakage of pericardial material into the thorax, resulting in pleuritis and cardiac puncture leading to hemorrhage or death [12]. In chronic cases, only small amounts may be present and a sample may not be obtainable

2.2 Treatment

Treatment of pericarditis in cattle is often unrewarding and usually is addressed toward salvage or short term survival to calving. Treatment should be attempted only in a valuable animal or in an animal carrying a high value embryo. Diuretics are effective in eliminating the severity of peripheral edema; they further reduce venous return and preload in animals with pericarditis [2]. Medical therapy with systemic antibiotics and drainage of the pericardial sac rarely, if ever, permanently cures affected cattle. Therefore most therapeutic efforts have been surgical [12]. Various case reports have described few cattle with a positive outcome and a long term survival [40, 41, 42, 43, 44, 45, 46, 47, 48, 6, 49, 50]. Thoracotomy and pericardiectomy or pericardiotomy have been performed in many fashions in an effort to provide drainage, search for the foreign body, and prevent fluid or later constrictive damage to the heart.

Following thoracotomy, pericardiotomy or pericardiectomy is done. Pericardiotomy involves incising the pericardium and draining the fluid. The foreign body if present is removed and the pericardial cavity is thoroughly irrigated with sterile isotonic saline solution containing antibiotics. An indwelling pericardial drain to allow twice-daily lavage and drainage and instillation of antibiotics may be performed till there is no discharge from the pericardial sac.

Pericardiectomy is indicated in cases of constrictive pericarditis where the mediastinal adhesions are thick and the rigid pericardium and epicardium may interfere with the cardiac filling. Complete removal of pericardium is difficult due to its attachment at the thin walled atria and great vessels. Therefore, partial pericardiectomy is performed by removal of pericardium from the ventricles [33]. However, the surgical procedure risk is prolonged, expensive and of considerable risk [2].

A. Prognosis The prognosis of the case varies with the etiological agent. Pericardial disease is usually associated with traumatic reticulopericarditis, but may be caused by neoplastic infiltration (lymphosarcoma) or hematogenous seeding, or by way of local extension. These disorders typically carry a poor prognosis and treatment is thus avoided. There is more favorable prognosis for the

treatment of idiopathic effusive pericarditis reported in cattle and horses with the use of pericardiocentesis, pericardial lavage, and corticosteroids and NSAIDs [37, 9, 8]. Prognosis has been reported to be better for cattle in good body condition, with relatively normal appetite, able to ambulate and less than 5 years old [51].

B. Necropsy Findings Gross postmortem examination in acute cases shows distention of pericardial sac with foul-smelling grayish fluid containing flakes of fibrin. There may be organization of the fibrinous exudate and serous surface of the sac (epicardium) may be covered with heavy deposits of fibrin. This fibrin frequently gives the appearance of "scrambled eggs". In chronic cases, the pericardial sac is grossly thickened and fused with the pericardium by strong fibrinous adhesions surrounding loculi of varying size which contain pus or straw colored fluid [52, 17, 12, 2]. The causative foreign body can usually be found provided that it has not been previously removed via a rumenotomy [19, 53]. However, sometimes due to extensive adhesions retrieval of the foreign body is not possible even though it has been visualized on radiographs [19].

D. Prevention and Control Traumatic pericarditis in cattle can be prevented by routine administration of magnets to heifers at the time of pregnancy diagnosis [2]. Following oral administration, most magnets do not enter the reticulum directly, but are first deposited in the cranial sac of the rumen before entering the reticulum following ruminal contractions [54]. Cattle should be kept away from construction sites and crop fields should be monitored for metal debris. The processed feed can be passed over magnets to recover any magnetic foreign bodies prior to being fed to cattle.

3. Conclusion

The findings of the clinical examination alone do not always allow a definitive diagnosis of traumatic Pericarditis as the typical signs such as tachycardia, muffled heart sound, distension of the jugular veins and edema may not be present in every case. In doubtful cases, radiography and ultrasonography of the heart and reticulum are indicated. Radiography detects metallic foreign bodies and their location within the abdomen or thorax. With ultrasonography, effusion in the thorax, pericardium and abdomen can be detected and characterized. Treatment is usually not rewarding. However, the disease may be prevented by proper managerial practices.

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